Conceptual representation in bilingual memory: Effects of concreteness and cognate status in word association*

JANET G. VAN HELL
ANNETTE M. B. DE GROOT
University of Amsterdam

A word association experiment examined conceptual representation in bilingual memory. Dutch-English bilinguals associated twice to nouns and verbs that varied on concreteness and cognate status, once in the language of the stimuli (within-language), and once in the other language (between-language). Within- and between-language associations for concrete words and for cognates were more often translations of one another than those for abstract words and noncognates, and nouns evoked more translations than verbs. In both within- and between-language association, retrieving an associate was easier to concrete than to abstract words, to cognates than to noncognates, and to nouns than to verbs. These findings suggest that conceptual representation in bilingual memory depends on word-type and grammatical class: concrete translations, cognates, and noun translations more often share, or share larger parts of, a conceptual representation than abstract translations, noncognates, and verb translations. The results are discussed within the framework of distributed memory representation.

How are the meanings of words in the two languages of a bilingual organized in memory? This question has elicited considerable debate in the literature and centers around two views. The language-independent, or common storage view, claims that the words of a translation pair share a common conceptual (i.e., semantic) representation. In contrast, the language-dependent, or separate storage view claims that the bilingual's two languages are stored in two separate, language-specific stores. Each of the words in a translation pair has its own conceptual representation. The viability of these views has been investigated using a variety of tasks (for a review, see e.g., Keatley, 1992). Studies employing tasks that involve the retrieval of word meanings typically show that conceptual representations are shared in bilingual memory (see Kroll & De Groot, 1997, for a review; but see, e.g., Kolers, 1963). For example, evidence from cross-language priming studies, in which a prime in one language is followed by a target in the other language, suggests that at least under certain circumstances bilinguals are able to access conceptual information that is shared between the two languages. This position has been the starting point of many studies in bilingual memory. However, as already pointed out by Diller (1970), more and more studies suggest that *the* bilingual memory may be a conceptual artifact. For instance, bilinguals differ in their fluency in the second language (e.g., Kroll & Curley, 1988), or in their history of learning that language (e.g., Lambert, Havelka & Crosby, 1958), which may bring about different memory representations for different (groups of) bilinguals.

Even within the memory of a single bilingual, the organization of conceptual memory may differ, depending on word type. In earlier studies, using only nouns as stimulus materials, we found that concrete words were translated faster than abstract words by fairly fluent bilinguals (De Groot, 1992a; De Groot, Dannenburg & Van Hell, 1994; Van Hell & De Groot, 1998) and by novice learners of a second or foreign language (Van Hell & Candia Mahn, 1997). In addition, cognates (i.e., translation pairs in which the words are similar in sound and spelling) were translated faster than noncognates both by fairly fluent bilinguals (e.g., De Groot, 1992a; De Groot et al., 1994; Kroll & Stewart, 1994) and by novice learners of a foreign language (Lotto & De Groot,

* In carrying out this research, Janet G. van Hell was supported by the Dutch Organization for Scientific Research (NWO, Grant 575–56–073). Part of this study was presented at the Ninth Conference of the European Society for Cognitive Psychology, Würzburg, Germany, September 1996. We thank Evelien van Hell, Frans Padt, and Martin van Leerdam for their contributions to this study. We thank Alexandra Sholl, Anna Bosman, François Grosjean, Jim Clark, Judith Kroll, Marilyn Smith, and two anonymous reviewers for insightful comments on an earlier version of this paper.

Address for correspondence
Janet G. van Hell, Department of Special Education, University of Nijmegen, PO Box 9104, 6500 HE Nijmegen, Netherlands
E-mail: J.vanHell@ped.kun.nl

1998). These word-type effects in translation performance suggest that words, here nouns, with different characteristics are represented differently in bilingual memory.

The word-type effects observed in translation are corroborated by other bilingual studies, all using tasks that are considered to involve conceptual access. In a cross-language semantic priming study, Jin (1990) obtained a reliable priming effect for concrete but not for abstract words. In a free recall experiment, Paivio, Clark and Lambert (1988) presented lists of concrete and abstract words, once in the first and once in the second language of bilinguals. They found that concrete words benefited more from cross-language repetition than abstract words. Under the assumption that free recall is a retrieval task in which conceptual information is tapped (e.g., Durgunoglu & Roediger, 1987), this suggests that bilingual memory representations may differ for concrete and abstract words. (Though Paivio et al. (1988) and Jin (1990) do not list their stimulus materials, the examples they present suggest that their materials consisted of nouns.)

Differences were also found in the processing of cognates and noncognates. In a cross-language semantic priming experiment, De Groot and Nas (1991) observed a semantic priming effect for cognate nouns, but not for noncognate nouns. In experiments employing a cross-language semantic categorization task, in which participants had to decide whether a target word (typically a noun, e.g., "banane") is a member of a particular category (e.g., "fruit"), cognates were processed faster and more accurately than noncognates (e.g., Dufour & Kroll, 1995).

Taken together, differences observed in the processing of concrete and abstract nouns and of cognate and noncognate nouns may signify that these words are represented differently within the memory of a single bilingual. More specifically, and according to a localist view (e.g., Collins & Loftus, 1975), the meanings of abstract translation pairs may relatively often be represented in separate stores, whereas those of concrete translation pairs may relatively often share a conceptual representation. Or, if one takes a distributed view which assumes that the meanings of words are represented over an entire network of interconnected units or features (e.g., Hinton, McClelland & Rumelhart, 1986; Kawamoto, 1993; Masson, 1991), abstract translation pairs may share fewer meaning elements than concrete translation pairs in conceptual memory (De Groot, 1992b; Taylor & Taylor, 1990). A possible reason why conceptual representations of abstract words differ from those of concrete words is that the meanings of an abstract word and its translation tend to be less similar than those of concrete translation pairs (e.g., Taylor, 1976). That is, the meanings of abstract words may be less consistent, and more dependent on the linguistic context in which they appear, than those of concrete words (e.g., Breedin, Saffran & Coslett, 1994; Hampton, 1981). Because of this higher dependency on linguistic context, abstract word meanings may be more language-specific than concrete word meanings (Van Hell, 1998a). Alternatively, abstract words may have fewer semantic features than concrete words (e.g., De Groot, 1989; Kieras, 1978; Plaut & Shallice, 1993), and, hence, have fewer semantic elements to share with their translations. In all, differences in the meanings of abstract and concrete words across languages may result in different conceptual representations in the memory of bilinguals: concrete translation pairs may more often share a conceptual representation than abstract translation pairs (localist view), or may share larger parts of the representation (distributed view).[1]

Like abstract versus concrete translation pairs, the conceptual representations of cognates may differ from those of noncognates. De Groot and Nas (1991) proposed that cognates share a conceptual representation, whereas noncognates are stored in language-specific conceptual nodes. Or, taking a distributed point of view, the representations of cognates may share more meaning elements than those of noncognates (De Groot, 1992b). Conceivably, conceptual representations of cognates may be more similar than those of noncognates because cognates look more alike than noncognates (Anthony, 1953; Carroll, 1992; De Groot, 1992b). Noticing the salient similarity of cognates, one may be inclined to think that words that look and sound alike are also similar in meaning. Hence, when learning a cognate in the second language, learners may simply map the to-be-learned L2 word onto the existing conceptual representation of its translation in the native language. When learning noncognates, on the other hand, the dissimilarity in spelling and sound may prevent L2 learners from automatically mapping these L2 words onto the conceptual representation of their respective translations in L1. Consequently, cognates may more often share a conceptual representation (localist view), or may share more meaning elements (distributed view) than noncognates.

Conceptual representation in bilingual memory may not only depend on word type, but also on grammatical class. Bilingual studies aimed at

[1] Theories discussed here all assume that word meanings are represented in amodal (sub)symbols in memory. An alternative framework, based on modal symbolic representations, is provided by dual coding theory (cf. Paivio et al., 1988).

studying conceptual representation have typically used (concrete) nouns as their stimulus materials. Monolingual and cross-linguistic studies, however, suggest that syntactic differences between verbs (often denoting relational concepts) and concrete nouns (typically denoting referential concepts) have implications for their conceptual representation in memory. More specifically, verbs have a greater breadth of meaning than concrete nouns (Gentner, 1978; Miller & Fellbaum, 1991; Reyna, 1987), and their meaning appears more dependent on their linguistic context than the meaning of concrete nouns (Gentner, 1981). These differences may ensue from less dense conceptual representations of verbs as compared to nouns (e.g., Gentner, 1978, 1981; Reyna, 1987). Additionally, cross-linguistic research suggests that the meanings of verbs are less similar across languages (Gentner, 1981), and are more constrained by the structure of a specific language than those of concrete nouns (Choi & Bowerman, 1991). For example, Gentner (1981) had a bilingual translate a text into another language, and subsequently asked a second bilingual to translate this text back into the original language. Next, the doubly translated text was compared with the original text. More of the original nouns than verbs appeared in the doubly translated text, and Gentner took these results to suggest that the meanings of verbs vary more across languages than the meanings of concrete nouns. Differences between nouns and verbs observed in monolingual and cross-linguistic studies may have implications for the representation of nouns and verbs in bilingual memory. In particular, verbs may more often be represented in language-specific conceptual stores, whereas nouns more often share a conceptual representation in the memory of bilinguals. Or, adopting a distributed point of view, conceptual representations of verbs may share fewer meaning elements in a bilingual's memory than those of nouns.

To recapitulate, the focus of this study is on the representation of the meanings of words with different characteristics in bilingual memory. In particular, we examined the conceptual representation of abstract vs. concrete translation pairs, of cognates vs. noncognates, and of nouns vs. verbs.[2]

The task we used is a bilingual variant of the traditional word association task (Gekoski, 1980; Kolers, 1963; Taylor, 1976). Two common versions of this task are discrete and continued word association. In the discrete version, participants come up with a single association to a stimulus word. In the continued version, they produce as many associates to a word as possible within a prespecified amount of time. The word association task is assumed to reflect conceptual processing (De Groot, 1989). More specifically, the retrieval of word meanings seems to be involved in word association, as (monolingual) performance on this task was found to be influenced by the concreteness of stimulus words (e.g., Brown, 1971; De Groot, 1989), as well as by their meaningfulness or affectivity/emotionality (e.g., Cramer, 1968). For example, using the discrete and continued word association task, De Groot (1989) found that concrete words elicited faster, and a higher number of, associative responses than abstract words. Moreover, examination of the actual associative responses given reveals that the vast majority of the associative responses are related in meaning to the presented stimulus words (cf. De Groot, 1989; Postman & Keppel, 1970). Surprisingly few associative responses of adults reflect lexical variation on the stimulus words, such as rime or morphological inflections (with the exception of adjectives; see, e.g., Deese, 1964).

In the bilingual version of the word association task, bilinguals associate to a series of words, once in the language of the stimulus words, and once in the other language. The within- and between-language associative responses to each stimulus word are subsequently compared to see whether they are translations or not (Kolers, 1963; Taylor, 1976). A large amount of translations (or "same" responses) is considered evidence for a common conceptual store. In contrast, a large amount of different responses is taken to indicate a language-specific storage of word meanings in bilingual memory.

In a seminal study, Kolers (1963) collected discrete within- and between-language associative responses on the same series of stimuli, all nouns. Kolers' participants were native speakers of German, Spanish, or Thai, and all had English as their second language. Each participant took part in all four association conditions: within-language responses on the words presented in the native and in the second language, and between-language responses on native and second language words. Subsequently, the within- and between-language responses were compared to see whether they were translations ("same") or not ("different"). Kolers' main finding was that about 55 per cent of these responses were not translations (i.e., were different), and concluded that word meanings are represented in language-specific stores in bilingual memory.

Kolers' conclusion may have been too strong,

[2] As will be seen below, we interpreted this research question in terms of two different views on the representational format in memory: local and distributed memory representations. Note that our study is *not* designed to test the viability of these two views.

however, as he himself later recognized (Kolers & Gonzalez, 1980). His data revealed that about 31 per cent of the within- and between-language associates to the same stimulus were translations (“king-queen”, “king-reina”). Moreover, about 20 per cent of the within- and between-language associates were the same across all four association conditions (e.g., “king-queen”, “king-reina”, “rey-queen”, “rey-reina”). Hence, the responses reveal that at least a number of translation pairs share a conceptual representation in bilingual memory. Interestingly, Kolers (1963) found that the ten concrete words elicited more same responses within- and between-languages than the ten abstract words. A similar difference between concrete and abstract words was obtained by Taylor (1976) in a bilingual continued word association experiment. In addition, she found that cognates evoked more same responses than noncognates.

A basic question that can be raised about these early studies of Kolers (1963) and Taylor (1976) concerns the alleged consistency of associative responses. Kolers (1963) concluded that the high level of dissimilar associations within- and between-languages entailed that word meanings are stored separately in bilingual memory. Likewise, Taylor (1976) took the relatively low similarity of associations to noncognates and abstract words to indicate that these types of words were represented language-specifically. However, before valid conclusions can be drawn about the similarity and dissimilarity of the within- and between-language associative responses, one first has to know how often responses are similar when participants associate twice within the same language. Kolers (1963) and Taylor (1976) implicitly seemed to assume that participants’ within-language associative responses are highly consistent.

Some monolingual word association studies cast doubt on this assumption, however (Fox, 1970; Gekoski & Riegel, 1966; Howell, 1970). Howell (1970) had participants associate to a set of stimuli, and asked them to repeat this task one month later. The mean probability of repeating a response on the second session was .46. Likewise, Gekoski and Riegel (1966) and Fox (1970) found that 43 per cent and 48 per cent of the associative responses were repeated after a one-week and a two-month interval, respectively. This inconsistency of within-language responses qualifies the dissimilarity of the within- and between-language associations as observed by Kolers (1963) and Taylor (1976), and puts their conclusions in a different light. Therefore, in our word association study, we tested the (in)consistency of associative responses by asking half the participants to perform the within-language association task a second time.

In the present study, whose aim is to examine the representation of the meanings of words with different characteristics in bilingual memory, Dutch-English bilinguals performed the discrete word association task on a series of either Dutch or English stimulus words. The stimulus words, nouns and verbs, were orthogonally varied on concreteness and cognate status. All participants associated to these words twice, once in the language of the stimuli (within-language) and once in the other language (between-language). As in Kolers’ (1963) and Taylor’s (1976) studies, the within- and between-language associations were compared to see whether they were translations or not. If within- and between-language associative responses on abstract words, noncognates, and verbs are less often translations than those on concrete words, cognates and nouns, it can be concluded that the meanings of abstract words, noncognates, and verbs are more often represented in language-specific stores (localist view), or share fewer meaning elements across languages (distributed view), than those of concrete words, cognates, and nouns. Half of the participants performed the within-language association task a second time. The similarity of these repeated within-language associations serves as a “baseline” measure of consistency against which the similarity of the within- and between-language associations can be interpreted. Finally, in order to obtain converging evidence for the associative responses (“what has been said”), we measured the time it took participants to come up with an association, and how often they did not succeed in doing so within a prespecified amount of time (i.e., omission). No reaction time and omission data had been collected in the studies of Kolers (1963) and Taylor (1976). In line with the hypothesized differences in conceptual representation of concrete and abstract translation pairs, of cognates and noncognates, and of nouns and verbs, longer association times and more omissions should be observed for abstract words, noncognates and verbs than for concrete words, cognates and nouns.

Experiment

Method

Participants. Eighty first-year psychology students from the University of Amsterdam participated in the experiment. They were randomly allocated to one of the four task conditions. All were unbalanced bilinguals, with Dutch as their native language and English as their second. All were fairly fluent in their second language: they had learned English at school for about three to four hours a week, starting around the age of ten, until their enrollment in the university. Their training at the university required them to read mainly in English. After finishing the first session of the experiment they were asked to rate their comprehension and production abilities in English on a 7–point scale (1 = very low; 7 = same as in Dutch). The mean comprehension ratings ranged from 5.45 to 5.65. Mean production ratings ranged from 4.84 to 5.30. One factor ANOVAs revealed no significant differences in proficiency between the four groups of participants, either in comprehension, $F(3,76) = .30$, $p > .10$, or in production, $F(3,76) = 1.63$, $p > .10$. All participants received course credit for participation.

Materials. The critical test materials consisted of 90 Dutch words and their English translations: 60 nouns and 30 verbs (see Appendix A). We also included 30 adjectives as fillers; this was done to prevent a bias in participants to respond predominantly with nouns and verbs, which may occur if only nouns and verbs serve as stimulus words.[3] The ratio of nouns to verbs was 2:1; fewer verbs as compared to nouns is in accordance with differences in the distribution of these words in natural language.

The nouns, verbs and adjectives were orthogonally varied on concreteness and cognate status. The nouns were derived from a corpus of 440 Dutch words and their English translations, rated for imageability and cognate status (for more details, see De Groot et al., 1994). The verbs and adjectives were selected from a corpus of concreteness ratings of Dutch words, in which the same imageability instruction as in De Groot et al.'s corpus had been used (Van Loon-Vervoorn, 1985).[4] The cognate status of the verbs and adjectives was assessed in a new norming study, in which eighteen newly selected Dutch-English bilinguals, drawn from the same population as those participating in the actual experiment, took part. The instruction was the same as that used for De Groot et al.'s (1994) corpus.

Stimulus words were controlled for two characteristics known to influence monolingual and bilingual processing: log word frequency and length. The log frequencies of the Dutch words and their English translations were derived from the frequency counts of the Centre for Lexical Information (CELEX) in Nijmegen, Netherlands (Burnage, 1990). The length of the Dutch words and their English translations were determined simply by counting the letters of each word. Mean values and standard deviations of the properties of the critical stimulus materials are presented in Appendix B.

In addition to the test stimuli, 20 Dutch words and their English translations (10 nouns, 5 verbs, and 5 adjectives) were selected as practice stimuli, all different from any of the test stimuli. As for concreteness, cognate status, length and frequency, the practice words were comparable to the test stimuli.

Apparatus and Procedure. The experiment was run on an Apple Macintosh computer. All participants were tested individually. Stimuli were presented at the centre of the computer screen. A PASCAL-program controlled the stimulus presentation and the recording of the response times. Participants' responses were registered by a microphone that activated a voice-operated switch. The experimenter typed in the participant's responses on the computer keyboard (what was being typed in was not echoed on the screen), and monitored the workings of the voice switch. Failures of the voice-key to register the participant's response or triggering due to faltering of the participant's voice or ambient sounds were noted.

Table 1 (upper part) presents an overview of the test sessions and the experimental conditions.

In order to avoid possible repetition effects across association conditions, one month elapsed between the subsequent test sessions. In the first session, the eighty participants were randomly allocated to one of the four task conditions: stimulus presentation in Dutch and response in Dutch (DD), stimulus presentation in English and response in English (EE), stimulus presentation in Dutch and response in English (DE), and stimulus presentation in English and response in Dutch (ED). One month later, all participants took part in a second session. The language of the stimuli was the same as in the first session, but they had to respond in the other language. The 40 participants who performed the within-language association task in the first session took part in a third session, that took place one month after the second one. In the third session, they performed exactly the same task as in the first session; a comparison of first and third session responses serves as a baseline measure for the consistency of associative responses (see introduction).

In all sessions and task conditions, participants were instructed that on each trial a word would

[3] Adjectives were not considered critical in this study because many adjectives have an antonym (e.g., "cheap-expensive", "happy-unhappy"), which have been found to be the primary associate. The availability of an antonym may bias the results towards same responses within- and between-languages, above and beyond the manipulation of concreteness and cognate status, thereby interfering with the main purpose of our experiment. (See Cramer, 1968, and Deese, 1964, for more details on adjectives and word association performance.)

[4] In previous work, we found a correlation of .94 between the imageability of Dutch nouns and their English translations (De Groot et al., 1994). It is conceivable that the imageability of Dutch verbs also correlates strongly with that of their English translations. Therefore, we did not collect imageability ratings on the English verbs in a new norming study.

Table 1. *Overview of the experimental conditions, and hypothetical within- and between-language responses and their scorings (similar or dissimilar)*

Condition	Session 1 Stimulus-Response	Session 2 Stimulus-Response	Session 3 Stimulus-Response
1	Dutch-Dutch	Dutch-English	Dutch-Dutch
2	English-English	English-Dutch	English-English
3	Dutch-English	Dutch-Dutch	–
4	English-Dutch	English-English	–
	Similar Responses		
Condition	Session 1 Stimulus-Response	Session 2 Stimulus-Response	Session 3 Stimulus-Response
1	rok-jurk	rok-dress	rok-jurk
2	skirt-dress	skirt-jurk	skirt-dress
3	rok-dress	rok-jurk	–
4	skirt-jurk	skirt-dress	–
	Dissimilar Responses		
Condition	Session 1 Stimulus-Response	Session 2 Stimulus-Response	Session 3 Stimulus-Response
1	rok-jurk	rok-woman	rok-broek
2	skirt-dress	skirt-vrouw	skirt-pants
3	rok-dress	rok-vrouw	–
4	skirt-jurk	skirt-woman	–

Note: "Rok" translates into "skirt"; "jurk" translates into "dress"; "vrouw" translates into "woman"; "broek" translates into "pants".

appear on the screen. They were asked to speak out loud, as quickly as possible, the first word that came into their mind upon reading the word on the screen. Participants were told that their response had to be a single word, either in Dutch if they had to respond in Dutch, or in English if they were to respond in English. Following Kolers (1963), they were told that their response should not be a repetition (in the within-language condition) or a translation (in the between-language condition) of the presented stimulus word.

The procedure for all trials was as follows. Prior to the stimulus word a fixation stimulus (an asterisk) appeared on the screen for one second. Then the word was presented and remained on the screen until the participant responded. The onset of the participant's response (or of any other sound) was registered by the voice-switch. Reaction time (RT) was measured from the onset of the stimulus. Then, the experimenter typed in the participant's response and hit the RETURN-key, initiating the presentation of the next stimulus one second afterwards. The maximum presentation duration for a stimulus was 8 seconds. Whenever this period expired, the experimenter typed the word "none" and the next trial was called by pressing the RETURN-key.

Each participant completed 20 practice and 120 test trials. Within the practice session and within the experimental session, all trials were presented in random order, with a different order for each participant and for each session. The test trials were divided in 6 blocks of 20 stimuli each. After each block, the participant was allowed a brief rest, after which the experimenter initiated the presentation of the first trial of the next block.

Results and discussion

Association analyses: similarity of within- and between-language associations. The similarity of the within- and between-language associations was determined as follows. Each participant had been presented with the *same* set of 120 stimulus words twice: In one session he or she had associated in Dutch, and in the other session in English (see Table 1, upper part). Dutch and English associates on each critical stimulus word were compared to see if they were similar (i.e., translations) or not. Table 1 (lower parts) presents the scoring of responses of hypothetical participants, whose within- and between-language associations were all similar, or all dissimilar.

For example, if the stimulus word "rok" (meaning "skirt") evoked "jurk" in Dutch and "dress" in English, these associative responses were considered similar, because "jurk" translates into "dress". However, if "rok" evoked "jurk" in Dutch and "woman" in English, the associates were regarded as dissimilar. Translation status was determined by the first author, who, if necessary, consulted a set of Dutch-English and English-Dutch dictionaries (Martin & Tops, 1984, 1986). The plural and the diminutive of a word (in Dutch the diminutive is an affix, e.g., "*little* skirt" is "rok*je*") were equated with its generic form (i.e., lemma). Omissions were not considered responses and were excluded. After all responses were scored, the entire procedure was repeated a second time to ensure the reliability of scoring. Subsequently, the scorings were compared with an (independent) scoring of the second author, who followed the same procedures. Cohen's kappa (Cohen, 1960) for the two scorings on the nouns and verbs was .98 in both cases. Hence, our scoring procedure was highly reliable.

For each participant, mean similarity scores were calculated for each of the four concreteness (concrete

Table 2. *Mean response equivalence (in percentages) of the within-language and between-language associations upper part) and the repeated within-language associations (lower part) for the nouns and verbs, itemized for association conditions, concreteness, and cognate status. Standard errors are in parentheses*

	Cognates		Noncognates	
	Concrete	Abstract	Concrete	Abstract
	Within- and Between-language associations			
Nouns				
DD-DE	44.0 (2.0)	33.0 (3.1)	28.7 (3.0)	24.2 (4.0)
DE-DD	46.2 (2.7)	24.8 (3.4)	28.2 (3.6)	21.2 (2.2)
EE-ED	49.3 (2.9)	24.3 (2.8)	34.2 (3.3)	24.6 (2.8)
ED-EE	43.7 (3.3)	19.8 (2.2)	25.6 (3.1)	22.4 (2.8)
Mean	45.8 (1.4)	25.5 (1.5)	29.2 (1.6)	23.1 (1.5)
Verbs				
DD-DE	39.3 (3.8)	25.4 (5.0)	34.0 (3.4)	25.8 (5.9)
DE-DD	41.1 (4.5)	23.3 (2.9)	38.2 (4.0)	23.3 (5.5)
EE-ED	34.5 (5.5)	27.6 (4.0)	27.2 (3.6)	16.5 (4.8)
ED-EE	28.9 (4.8)	23.4 (3.8)	25.9 (3.3)	14.0 (4.5)
Mean	36.0 (2.4)	24.9 (2.0)	31.3 (1.8)	19.9 (2.6)
	Repeated Within-language associations			
Nouns				
DD-DD	53.9 (2.2)	43.1 (2.4)	39.6 (2.7)	42.0 (4.2)
EE-EE	52.0 (2.4)	30.2 (3.9)	42.0 (3.4)	30.8 (2.9)
Mean	53.0 (1.6)	36.6 (2.5)	40.8 (2.2)	36.4 (2.7)
Verbs				
DD-DD	48.0 (4.2)	34.0 (5.1)	44.2 (4.4)	37.7 (3.8)
EE-EE	39.2 (5.0)	31.6 (4.2)	33.7 (4.4)	26.7 (5.7)
Mean	43.6 (3.3)	32.8 (3.3)	39.0 (3.2)	32.2 (3.5)

Note: D = Dutch; E = English.

vs. abstract) by cognate status (cognates vs. noncognates) conditions; noun and verb data were treated separately. Furthermore, mean similarity scores for the items (nouns and verbs) within each concreteness by cognate status condition, collapsed across the participants within each of the four association conditions, were calculated. In calculating the mean similarity scores (both participants and items), we corrected for response omissions by subtracting these missing values from the total number of observations, N, in the denominator. A 2 (stimulus language) by 2 (response languages in first and second sessions) by 2 (grammatical class) by 2 (concreteness) by 2 (cognate status) ANOVA was performed on the mean participant similarity scores. In addition, the corresponding 2 x 2 x 2 x 2 x 2 ANOVA was performed on the mean item similarity scores.

The mean similarity scores are presented in the upper part of Table 2 (throughout this paper, all means presented are mean participant scores).

The analyses revealed that concrete words elicited 12.2 per cent more similar responses than abstract words (35.6 per cent and 23.4 per cent, respectively; $F_1(1,76) = 105.33$, $p < .0001$ and $F_2(1,328) = 54.47$, $p < .0001$). Likewise, cognates evoked 7.1 per cent more similar responses than noncognates (33.0 per cent and 25.9 per cent, respectively; $F_1(1,76) = 29.29$, $p < .0001$ and $F_2(1,328) = 15.61$, $p < .001$). The overall degree of similarity of associations was somewhat higher for nouns than for verbs (30.9 per cent and 28.0 per cent, respectively; $F_1(1,76) = 5.62$, $p < .05$ and $F_2(1,328) = 3.46$, $.05 < p < .10$). The main effect of stimulus language was marginally significant, $F_1(1,76) = 3.43$, $.05 < p < .10$ and $F_2(1,328) = 3.61$, $.05 < p < .10$; associative responses to Dutch words were slightly more similar than those to English words (31.3 per cent and 27.6 per cent, respectively). There was no significant main effect of the factor response languages.

Concreteness interacted with cognate status, $F_1(1,76) = 9.21$, $p < .01$, and $F_2(1,328) = 4.48$, $p < .05$. This interaction was qualified by a three-way interaction between grammatical class, concreteness, and cognate status, $F_1(1,76) = 9.24$, $p < .01$, and $F_2(1,328) = 4.24$, $p < .05$. The interaction between grammatical class and stimulus language was significant on the participant analysis, $F_1(1,76) = 5.65$, $p < .05$, and marginally so on the item analysis, $F_2(1,328) = 3.34$, $.05 < p < .10$. The three-way interaction between grammatical class, stimulus language, and concreteness reached significance on the analysis by participants, $F_1(1,76) = 4.42$, $p < .05$, but not on the analysis by items. None of the remaining interactions was significant.

In order to localize the source of the above three-way interaction between grammatical class, concreteness and cognate status, additional ANOVAs were performed on the noun and verb data separately. These analyses revealed that the interaction between concreteness and cognate status was only significant for the nouns, $F_1(1,76) = 29.34$, $p < .0001$, and $F_2(1,224) = 12.72$, $p < .001$, but not for the verbs. As can be seen in Table 2, the degree of equivalence of associations is particularly large for the concrete cognate nouns (45.8 per cent).

In sum, across all four association conditions, concrete nouns and verbs evoked a higher proportion of equivalent responses than abstract nouns and verbs. Likewise, the within- and between-language associations for cognate nouns and verbs were more often translations than those for noncognate nouns and verbs. Concreteness was found to interact with cognate status in the nouns, but not in the verbs; this interaction was caused by the high proportion of similar responses to concrete cognate nouns. Finally, the overall degree of similarity of associations was somewhat higher for nouns than for verbs.

The overall pattern of results (i.e., irrespective of concreteness and cognate status) obtained in our study is similar to that of Kolers (1963) and Taylor (1976). Collapsed across all task conditions and word types, 31 per cent of the nouns and 28 per cent of the verbs evoked the same within- and between-language associations (see Table 2). Remarkably, the 31 per cent similarity of responses to the nouns is exactly the same degree of similarity as Kolers (1963) obtained in his study (using all nouns). This finding prompted Kolers to conclude that the meanings of words in the two languages of bilinguals are stored separately. However, as discussed in the introduction, before drawing any conclusions pertaining to the organization of conceptual representation in bilingual memory, one first has to know how consistent the associative responses are when participants perform the same task twice within the same language.

Association analyses: similarity of repeated within-language associations. In order to ascertain the consistency of associative responses, the responses of participants who had performed the within-language association task twice, in the first and in the third session, were compared. These participants had either associated twice from Dutch into Dutch, or twice from English into English. In judging the similarity of responses, the same procedure as described above was followed. Responses were considered similar if they were repetitions (e.g., "skirt" and "skirt"), or, as occasionally occurred, synonyms (e.g., "jail" and "prison"). Again, the plural and the diminutive of a word were equated with its generic form. Cohen's kappa for the scorings of the first and second author was .99 and .98 for the nouns and verbs, respectively, indicating that the scoring procedure was highly reliable.

For each participant, and separately so for the nouns and verbs, a mean similarity score was calculated for the four conditions formed by the two levels of the variables concreteness (concrete vs. abstract) and cognate status (cognates vs. noncognates). Furthermore, mean similarity scores for all stimuli within each condition, collapsed across participants, were calculated. In calculating these mean similarity scores, we corrected for response omissions as was done in the foregoing analysis.

In the lower part of Table 2 the mean similarity scores of the two association conditions are presented. The most important finding is that participants do not consistently produce the same associations when they have to perform the same task twice within the same language. It was found that, across all conditions, only 45 per cent of the associates to Dutch nouns and 39 per cent of the associates to English nouns were produced twice. In addition, 41 per cent and 33 per cent of the associations to the Dutch and English verbs were given twice. At best, 53.9 per cent of the associations are produced a second time (for Dutch concrete cognate nouns). Hence, our data do not support the implicit assumption of Kolers (1963) and Taylor (1976) that people typically come up with the same responses when they perform the within-language association task twice. The present within-language comparisons qualify our findings of the within- and between-language comparisons, as well as the results obtained by Kolers (1963) and Taylor (1976), and the concomitant conclusions on conceptual representation in bilingual memory. This point will be elaborated upon in the discussion.

Moreover, Table 2 suggests that the degree of similarity of the repeated within-language associations (lower part) is higher than that of the within- and between-language associations (upper part). To substantiate this we performed the following ANOVA on the mean participant similarity scores: 2 (comparison: within- and between-language associations versus repeated within-language associations) by 2 (stimulus language) by 2 (grammatical class) by 2 (concreteness) by 2 (cognate status). The corresponding 2 x 2 x 2 x 2 x 2 ANOVA was performed on the mean item similarity scores. (In these analyses only the data of participants who associated in all three sessions were used.)

The main effect of comparison was significant, $F_1(1,38) = 60.15$, $p < .0001$ and $F_2(1,328) = 21.74$, $p < .0001$, indicating that the overall similarity of the repeated within-language associations (39.3 per cent) was higher than that of the within- and between-language associations (30.8 per cent). In addition, the following main effects were found: concreteness, $F_1(1,38) = 44.26$, $p < .0001$ and $F_2(1,328) = 41.22$, $p < .0001$; cognate status, $F_1(1,38) = 22.32$, $p < .0001$ and $F_2(1,328) = 9.81$, $p < .01$; grammatical class, $F_1(1,38) = 9.52$, $p < .01$ and $F_2(1,328) = 6.04$, $p < .05$; and a weaker effect of stimulus language, $F_1(1,38) = 3.00$, $.05 < p < .10$ and $F_2(1,328) = 5.70$, $p < .05$.

Concreteness interacted with cognate status, $F_1(1,38) = 6.52$, $p < .05$ and $F_2(1,328) = 4.81$, $p < .05$; the similarity of the associative responses was particularly high on the concrete cognates (45 per cent). The interaction between comparison and stimulus language was significant on the participant analysis,

$F_1(1,38) = 5.20$, $p < .05$, but not on the item analysis. Likewise, the three-way interaction between stimulus language, concreteness, and grammatical class was significant on the participant analysis, $F_1(1,38) = 4.80$, $p < .05$, but not on the item analysis. None of the remaining interactions reached significance.

In conclusion, for each type of word, the similarity of the repeated within-language associations was higher than that of the within- and between-language associations.

Association analyses: dissimilar within- and between-language associations. In the foregoing analyses, we compared the within- and between-language associations to see whether they were the same or not. However, dissimilar responses, though not exact translations, may still reflect some degree of semantic resemblance. For example, the word "skirt" may elicit "dress" and "vrouw" (translation of "woman") as within- and between-language associations, respectively (see Table 1). Though these responses are dissimilar, they nevertheless are somewhat related in meaning, and possibly add to our understanding of the organization of bilingual conceptual memory representation.

Therefore, four fluent Dutch-English bilinguals scored all dissimilar within- and between-language responses on the degree of semantic relatedness. Judges were instructed to assign a 2 to clearly related, a 1 to somewhat related, and a 0 to unrelated response pairs. Some examples of related response pairs were given, in which the relations reflected (near) synonymy, hyponymy, membership of a common semantic category, antonymy, meronymy, attributes, functions, and entailment (see, e.g., Miller & Fellbaum, 1991, for more details; pilot testing had indicated the need to include some examples in the instructions, as semantic relatedness appeared to be a vague notion for lay persons). The reliability of the ratings of the four judges was high: intraclass correlations (for more details, see Guilford, 1954, pp. 395–7) for the responses on the nouns and verbs were .93 and .91, respectively. Next, mean ratings of all response pairs were calculated, averaged across the four judges. Following the procedures of the similarity analyses described above, mean semantic relatedness ratings of the dissimilar responses were then calculated for each of the cells of our design, for each participant and for each item. The data were subjected to ANOVAs that were identical in design to those of the foregoing similarity analyses. The mean semantic relatedness ratings are presented in Table 3. It should be mentioned that these data only provide a gross indication of semantic relatedness, as in some cells only a few dissimilar responses were observed, and could be scored.

Table 3. *Mean semantic relatedness ratings of the dissimilar within-language and between-language associations for the nouns and verbs. Standard errors are in parentheses*

	Cognates		Noncognates	
	Concrete	Abstract	Concrete	Abstract
Nouns				
DD-DE	1.10 (.07)	.50 (.06)	1.16 (.08)	.67 (.10)
DE-DD	1.03 (.08)	.51 (.06)	1.16 (.06)	.51 (.06)
EE-ED	.87 (.08)	.40 (.04)	.97 (.08)	.42 (.06)
ED-EE	.97 (.08)	.37 (.06)	1.09 (.06)	.50 (.05)
Mean	.99 (.04)	.45 (.03)	1.10 (.03)	.52 (.04)
Verbs				
DD-DE	1.17 (.09)	.64 (.07)	1.02 (.06)	.36 (.05)
DE-DD	1.08 (.09)	.44 (.07)	.84 (.09)	.49 (.08)
EE-ED	1.08 (.10)	.54 (.07)	.66 (.08)	.31 (.06)
ED-EE	.78 (.08)	.45 (.07)	.60 (.05)	.23 (.04)
Mean	1.03 (.05)	.52 (.04)	.78 (.04)	.35 (.03)

Note: D = Dutch; E = English.

The analyses revealed a large effect of concreteness, $F_1(1,76) = 472.60$, $p < .0001$, and $F_2(1,328) = 174.46$, $p < .0001$: semantic relatedness ratings of the dissimilar responses were higher for concrete words than for abstract words (.97 and .46, respectively). Cognates received somewhat higher ratings than noncognates, .75 and .69, respectively, $F_1(1,76) = 6.23$, $p < .05$, and $F_2(1,328) = 2.80$, $.05 < p < .10$. Semantic relatedness ratings were higher for nouns than for verbs, .77 and .67, respectively, $F_1(1,76) = 15.71$, $p < .001$, and $F_2(1,328) = 4.99$, $p < .05$. The main effect of stimulus language was significant, $F_1(1,76) = 20.07$, $p < .0001$, and $F_2(1,328) = 14.80$, $p < .001$; the semantic relatedness of the dissimilar responses to L1 (Dutch) stimulus words was higher than that to L2 (English) stimulus words, .79 and .64, respectively. There was no significant main effect of the factor response languages.

Cognate status interacted with grammatical class, $F_1(1,76) = 36.45$, $p < .0001$, and $F_2(1,328) = 11.08$, $p < .01$; the semantic relatedness of the dissimilar associations to cognates was higher than that to noncognates in the verbs, but not in the nouns. The three-way interaction between stimulus language, response languages, and grammatical class was significant on the participant analysis, $F_1(1,76) = 4.98$, $p < .05$, and marginally so in the item analysis, $F_2(1,328) = 2.85$, $.05 < p < .10$. The four-way interaction between response languages, grammatical class, concreteness, and cognate status reached significance on the participant analysis, $F_1(1,76) = 9.92$, $p < .01$, but not on the item analysis. None of the remaining interactions reached significance.

In sum, semantic relatedness ratings of the dissimilar within- and between-language associations substantiate our main conclusion that association performance varies as a function of concreteness, cognate status, and grammatical class. Analogous to the analyses on the similar within- and between-language responses, the dissimilar responses to concrete words were more related in meaning than those to abstract words. Likewise, the dissimilar responses to cognate verbs (but not nouns) shared more meaning than those to noncognate verbs. Dissimilar responses to nouns were more alike in meaning than those to verbs.

Response Times and Omissions Analyses. The analyses of reaction times and omissions centered around two main questions. First, is it easier to associate to some types of words than to others? Second, is it more difficult to associate between languages than within languages? To answer these questions, RTs and omission data of the *first* session were analyzed. Responses measured in the first session were deemed a purer measure of word association performance, and provided a better comparison with earlier word association studies, than would responses in any of the subsequent sessions.

For each participant in the DD, EE, DE, and ED conditions, and separately so for the nouns and verbs, mean RTs were calculated for the four word types. Furthermore, mean RTs for all stimuli (nouns and verbs) within each of the four association conditions, collapsed across participants, were calculated. False registrations due to voice switch registration errors and voice catches were excluded in calculating the means. In addition, for each stimulus word an omission score was calculated, which was the number of times participants did not come up with an association within 8 seconds after stimulus onset.

A set of 2 (stimulus language) by 2 (response language) by 2 (grammatical class) by 2 (concreteness) by 2 (cognate status) ANOVAs was performed, one on the mean participant RTs and one on the omission scores. In addition, the corresponding 2 x 2 x 2 x 2 x 2 ANOVAs were performed on the mean item RTs and omission scores.

Response times. Mean RTs are presented in Table 4.

The analyses of the RT data yielded a significant effect of concreteness, $F_1(1,76) = 273.92$, $p < .0001$ and $F_2(1,328) = 228.80$, $p < .0001$: coming up with an associate to concrete words took 681 ms less than to abstract words (1934 ms and 2615 ms, respectively). Participants were 286 ms faster in retrieving an associate to cognates than to noncognates (2131 ms and 2417 ms, respectively); $F_1(1,76) = 88.42$, $p < .0001$ and $F_2(1,328) = 38.73$, $p < .0001$. The effect of grammatical class was marginally significant on the analysis by participants (2252 ms and 2296 ms for the nouns and verbs, respectively), $F_1(1,76) = 3.05$, $.05 < p < .10$, and was not significant on the analysis by items. The main effect of stimulus language was significant on the analysis by items, $F_2(1,328) = 5.77$, $p < .05$, but not on the analysis by participants. The effect of response language was significant, $F_1(1,76) = 9.24$, $p < .01$ and $F_2(1,328) = 43.36$, $p < .0001$.

Table 4. *Mean reaction times (in milliseconds) of the associations to nouns and verbs, itemized for association conditions, concreteness, and cognate status. Data are from the first session. Standard errors are in parentheses*

	Cognates		Noncognates	
	Concrete	Abstract	Concrete	Abstract
	Nouns			
Dutch-Dutch	1471 (56)	1983 (127)	1661 (94)	2397 (135)
Dutch-English	1925 (96)	2848 (143)	2330 (115)	3052 (130)
English-English	1813 (87)	2571 (136)	2070 (105)	2730 (153)
English-Dutch	1742 (119)	2569 (150)	2063 (100)	2815 (151)
Mean	1738 (49)	2492 (77)	2031 (58)	2749 (75)
	Verbs			
Dutch-Dutch	1541 (77)	2077 (106)	1591 (65)	2615 (165)
Dutch-English	2054 (118)	2732 (166)	2224 (141)	3002 (146)
English-English	1958 (77)	2467 (150)	2301 (146)	2687 (152)
English-Dutch	1915 (99)	2438 (126)	2284 (146)	2852 (172)
Mean	1867 (51)	2428 (73)	2100 (72)	2789 (80)

The latter two main effects were qualified by an interaction between stimulus language and response language, $F_1(1,76) = 9.87$, $p < .01$ and $F_2(1,328) = 52.09$, $p < .0001$; mean RTs in the DD, EE, DE, and ED conditions were 1917, 2325, 2521, and 2335, respectively – see Table 4. Post-hoc analyses showed that participants were fastest in associating from their native language into the native language (in the participant analysis, only the differences between DD and each of the three remaining conditions were significant; in addition to these differences, DE also differed from ED and EE in the item analysis).[5] The

[5] This result points to potentially interesting differences between within-language processing and cross-language processing, and between cross-language processing from L1 to L2 and vice versa. An elaborate discussion of this issue is beyond the scope of the present paper however; see Kroll and De Groot (1997) for more details on differences in cross-language processing in the two directions.

Table 5. *Mean omission scores (in percentages) of the associations to nouns and verbs, itemized for association conditions, concreteness, and cognate status. Data are from the first session. Standard errors are in parentheses*

	Cognates		Noncognates	
	Concrete	Abstract	Concrete	Abstract
	Nouns			
Dutch-Dutch	0.3 (0.3)	6.3 (2.3)	1.3 (0.8)	9.3 (2.6)
Dutch-English	0.0 (0.0)	5.0 (1.6)	1.0 (0.5)	9.3 (2.3)
English-English	1.7 (0.7)	8.0 (2.6)	1.7 (0.7)	6.3 (2.3)
English-Dutch	1.0 (0.7)	4.0 (1.6)	1.3 (0.8)	8.3 (2.3)
Mean	0.8 (0.3)	5.8 (1.0)	1.3 (0.3)	8.3 (1.2)
	Verbs			
Dutch-Dutch	0.7 (0.7)	3.8 (1.6)	0.0 (0.0)	8.6 (3.0)
Dutch-English	2.2 (1.2)	5.0 (2.1)	1.2 (0.9)	10.7 (4.3)
English-English	5.0 (2.6)	11.2 (3.6)	7.5 (2.9)	10.0 (2.9)
English-Dutch	2.2 (1.6)	5.6 (2.3)	3.8 (2.0)	8.6 (2.8)
Mean	2.5 (0.8)	6.4 (1.3)	3.1 (1.0)	9.5 (1.6)

three-way interaction between stimulus language, grammatical class, and concreteness reached significance on the analysis by participants, $F_1(1,76) = 6.18$, $p < .05$, but not on the analysis by items. The three-way interaction between response language, concreteness, and cognate status was also significant on the analysis by participants, $F_1(1,76) = 4.20$, $p < .05$, but not on the analysis by items. None of the remaining interactions reached significance.

In brief, as in the similarity analyses, word-type effects were observed in the speed of associative responses. Across all four association conditions, retrieving an associate was faster to concrete words than to abstract words, to cognates than to noncognates, and it was marginally faster to nouns than to verbs in the participant analysis. Furthermore, participants who associated in Dutch to a Dutch stimulus word (the DD condition) were faster than participants in any of the other conditions; this result corroborates the findings of Gekoski (1980).

Omissions. Mean omission data are presented in Table 5.

The effect of concreteness was significant, $F_1(1,76) = 45.02$, $p < .0001$ and $F_2(1,328) = 82.81$, $p < .0001$: fewer omissions occurred on concrete words (1.9 per cent) than on abstract words (7.5 per cent). Likewise, participants less often failed in retrieving an associate on cognates than on noncognates, 3.9 per cent and 5.6 per cent, respectively, $F_1(1,76) = 8.68$, $p < .01$ and $F_2(1,328) = 7.60$, $p < .01$. They remained silent somewhat less often on nouns than on verbs, 4.1 per cent and 5.4 per cent, respectively, $F_1(1,76) = 3.63$, $.05 < p < .10$ and $F_2(1,328) = 4.57$, $p < .05$. The effect of stimulus language was significant on the item analysis, $F_2(1,328) = 4.74$, $p < .05$, but not on the participant analysis. Likewise, the effect of response language reached significance on the item analysis, $F_2(1,328) = 4.46$, $p < .05$, but not on the participant analysis.

Grammatical class interacted with stimulus language, $F_1(1,76) = 4.03$, $p < .05$ and $F_2(1,328) = 5.04$, $p < .05$; post hoc analyses revealed that participants remained silent relatively often on the English verbs. None of the remaining interactions reached significance.

In brief, the pattern of results of the omission analyses substantiates that of the RT analyses (and both analyses reveal a pattern similar to that obtained in the similarity analyses). Participants remained silent less often on concrete words than on abstract words, and fewer omissions were observed on cognates than on noncognates. Likewise, somewhat fewer omissions were observed for the nouns than for the verbs.

An interesting aspect of the omission and response times analyses concerns the influence of cognate status on within-language association performance, particularly in the native language. When participants associated in their native language on a stimulus presented in their native language, they were 302 ms and 294 ms faster in finding an associate to cognates than to noncognates in the case of nouns and verbs, respectively. Likewise, fewer omissions occurred on cognates compared with noncognates. Importantly, at this stage of the experiment (i.e., first session), participants presumably were not aware of the fact that they were participating in a bilingual experiment. That is, they were only presented with Dutch stimulus materials, they did not know they were being tested as bilinguals, and no mention had been made of the between-language association task in the second session (in which they had to associate in English). Furthermore, when participants were recruited for this experiment (via sign-up lists), no reference had been made to their bilingualism. Hence, neither the experimental task nor the conditions in the laboratory required explicit activation of their second language, yet cognates were responded to faster than noncognates. This suggests that when processing in the mother tongue, the second language remains nonetheless active. Moreover, at least in word association, this activation of the second language lexicon facilitates native language performance.

Recently, we replicated this advantage of cognates over noncognates in associating in the native language, using a different group of bilinguals (in fact, trilinguals) and another set of stimuli. Moreover, we also obtained a facilitative effect of cognates in lexical decision in the native language (Van Hell, 1998b). The finding that performance in one language is affected by knowledge of another language is not an isolated effect and has been found, for example, in studies using interlexical homographs (e.g., Beauvillain & Grainger, 1987; Dijkstra, Van Jaarsveld & Ten Brinke, 1998; but see Grosjean, 1998), in studies manipulating the number of interlexical orthographic neighbors (e.g., Grainger & Dijkstra, 1992), as well as in Stroop interference paradigms (e.g., Chen & Ho, 1986). Furthermore, in natural discourse of bilingual speakers in one language, intrusions from the other language sometimes occur (e.g., Grosjean, 1995). Interestingly, these code-switches are more likely to occur after processing a cognate than after processing a noncognate (Clyne, 1980).

General discussion

The aim of this study was to gain insight into the organization of conceptual memory of bilinguals by comparing within- and between-language associations. We hypothesized that conceptual representations in bilingual memory are different for concrete versus abstract words, for cognates versus noncognates, and for verbs versus nouns, as would be demonstrated by different association patterns for these different types of words. Such differences were indeed obtained. It was found that the within- and between-language associative responses on concrete words were more often translations than those on abstract words. Cognates more often evoked equivalent responses than noncognates, and responses to nouns were similar more often than those to verbs. Moreover, concrete cognate nouns elicited relatively many similar within- and between-language associative responses. The observed effects were highly consistent, and were further bolstered by the semantic relatedness ratings on the dissimilar within- and between-language responses. The effects of concreteness, cognate status, and grammatical class obtained in the similarity analyses were corroborated by the RT and omission data. In all four within- and between-language association conditions, longer association times and more omissions were observed with abstract than with concrete words, with noncognates than with cognates, and with verbs than with nouns.

The pattern of associative responses obtained in this study replicates and extends the results of earlier bilingual word association studies (Kolers, 1963; Taylor, 1976). One of the new aspects of our study was the inclusion of a base-line consistency measure for repeated within-language associations. As Kolers (1963) we found that the overall similarity of within- and between-language responses on nouns was 31 per cent (and 28 per cent on verbs), a finding that prompted Kolers to conclude that the meanings of words in the two languages of a bilingual are represented in two separate stores. This result, however, was qualified by our finding that when bilinguals perform the within-language association task twice, also a relatively small percentage of the associations were repeated, namely 45 per cent, 41 per cent, 39 per cent, and 33 per cent on the Dutch nouns and verbs, and English nouns and verbs, respectively. So, even when meanings are retrieved from one and the same memory store, which is supposedly the case in the within-language association task, responses are more often not repeated than repeated. Hence, Kolers' (1963) conclusion has been too strong: conceptual representations in bilingual memory are not purely language-specific.

However, our data indicate that these conceptual representations are not purely shared either. Overall analyses revealed that the degree of similarity of within- and between-language associations is lower than that of repeated within-language associations (see Table 2). More importantly, the word-type effects we obtained suggest that conceptual representations in bilingual memory are different for concrete versus abstract words, for cognates versus noncognates, and for nouns versus verbs. We will explain these results in terms of two different views on the representation of word meanings in (bilingual) memory, one assuming local conceptual representations and the other assuming distributed conceptual representations. But first we will raise a critical note concerning the role of conceptual memory in between-language word association.

As discussed in the introduction, the word association task is assumed to involve conceptual memory. It might be argued, however, that the bilingual version of this task not only reflects conceptual processing, but lexical processing as well. In retrieving an associate in the other language, bilinguals may first associate within-language to the stimulus word and then translate the retrieved association, or they may first translate the stimulus and then associate to the translation. Under the assumption that translation occurs entirely at the lexical level in memory, between-language association thus at least partly involves lexical processing. However, the assumption that translation is an entirely lexical process is at variance with many findings in the word

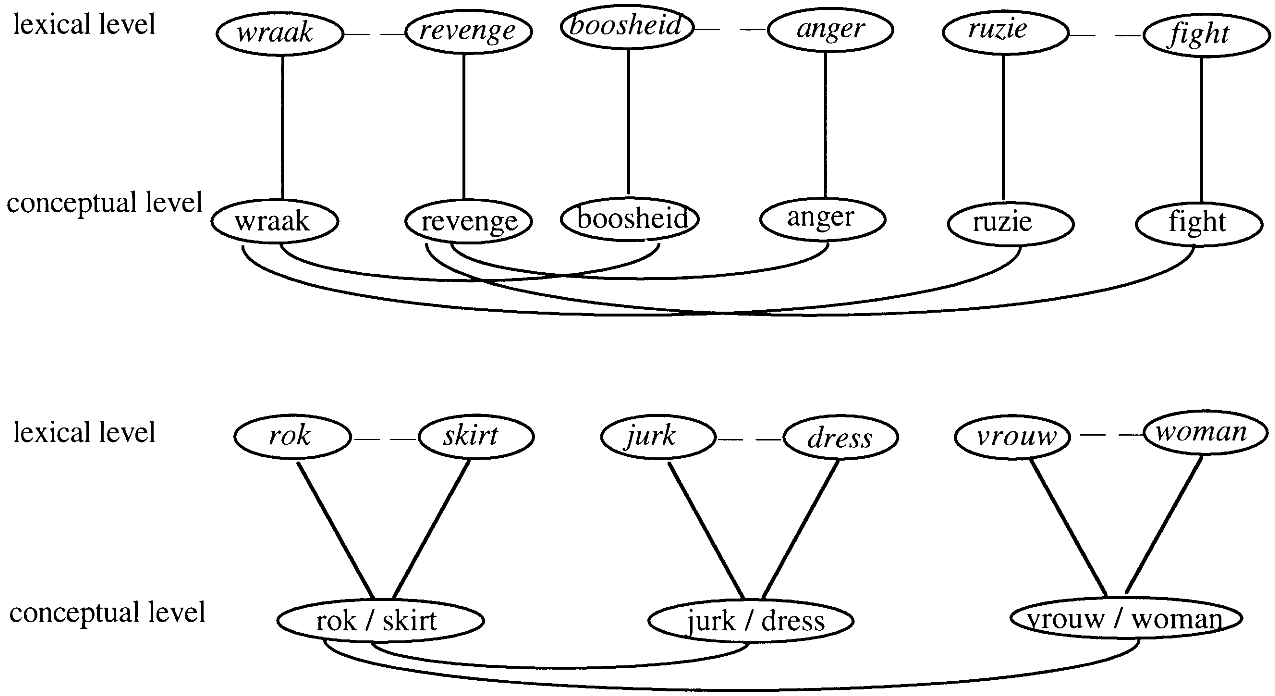

Figure 1. Local representations of related abstract noncognate translation pairs (upper part) and related concrete noncognate translation pairs (lower part).

translation literature (e.g., De Groot et al., 1994; La Heij, Hooglander, Kerling & Van der Velden, 1996; Potter, So, Von Eckardt & Feldman, 1984). These studies all converge on the conclusion that word translation involves conceptual processing, and particularly so in quite proficient bilinguals (such as our bilinguals). So, switching towards the other language (either before or after retrieving an associate) does not preclude the activation of meaning.

We will briefly outline how the localist view could explain the main results of our study, and will elaborate in more detail on the distributed view. Theories assuming local representations typically distinguish two representational systems in memory: a word's form is represented in a single node at the lexical level, and its meaning is represented in a single node at the conceptual level. (See, e.g., Collins & Loftus, 1975; Potter et al., 1984, for monolingual and bilingual memory representation, respectively). Upon activation of a node, activation spreads via links to connected nodes in the network. In bilingual memory, illustrated in Figure 1, the meanings of the two words in a translation pair are assumed to share a conceptual representation (that is, are connected to conceptual representations of associatively related words; see bottom part of figure), or they are represented in language-specific conceptual nodes (each being only connected to conceptual nodes of associatively related words in the same language; see top part of figure).

The localist view can explain the effects obtained in our study by assuming that the effects of word type reflect how many members of a particular group of words share a conceptual representation between languages: word types of which many members share a conceptual representation between languages (i.e., concrete noncognate nouns such as "rok–skirt") will give rise to high degrees of within- and between-language associative similarity, whereas word types of which few members share a conceptual representation between languages will result in low degrees of within- and between-language associative similarity (e.g., abstract noncognate nouns such as "wraak–revenge"). In a similar vein, the RT data can be explained by assuming that more links must be traversed in retrieving an associate to translations with language-specific conceptual representations than to translations with a shared conceptual node (most notably so in between-language association – see Figure 1), bringing about longer association times in the former case than in the latter. In addition, assuming that activation decreases over links (see, e.g., Collins & Loftus, 1975), the number of omissions will increase with the distance between the critical nodes in the network. Indeed, as translations are more likely to share a conceptual node (as

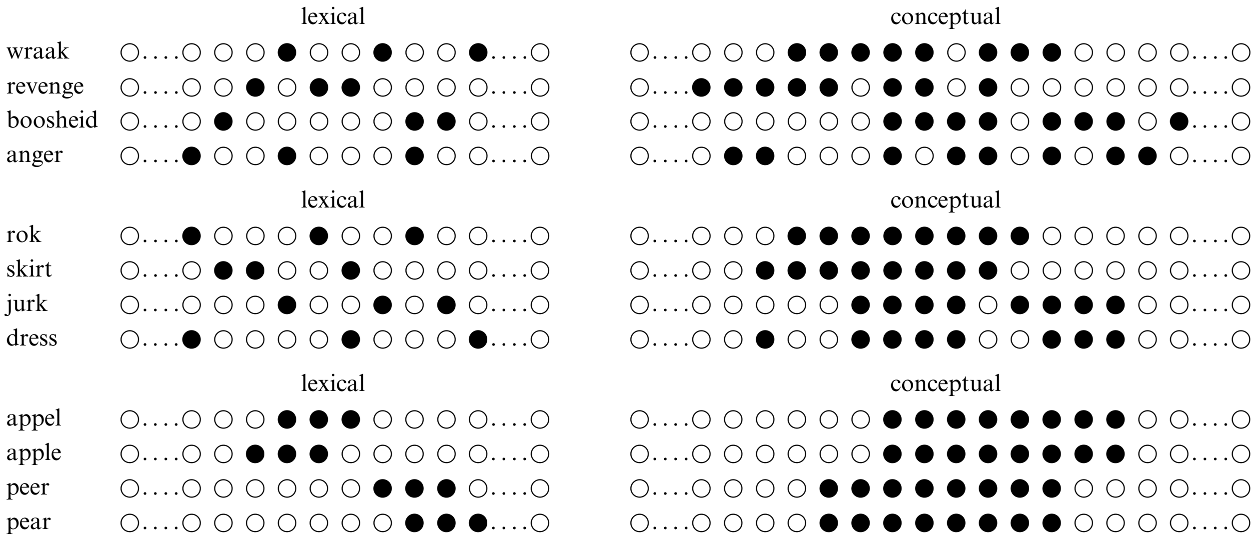

Figure 2. Distributed representations of two related abstract noncognate translation pairs (upper part), two related concrete noncognate translation pairs (middle part), and two related concrete cognate translation pairs (lower part). Units are interconnected within and between subsets.

suggested by the similarity data), association times and the number of omissions were found to decrease.

A different account which we will discuss in more detail is provided by theories based on distributed representations (e.g., Hinton et al., 1986; Kawamoto, 1993; Masson, 1991; Van Orden, Pennington & Stone, 1990). In general, these models assume that a word is not represented by a single node, but as a pattern of activation across an entire network of interconnected units or features. One unit can be involved in the representation of different words. Knowledge is encoded by the weights on connections between units. In Figure 2 some examples of distributed representations are presented, in which the orthography/phonology and the meaning of a word correspond to a pattern of activation across the lexical and conceptual units, respectively.[6] Different patterns of activation denote different words. Typically, distributed memory models assume that units are completely interconnected, hence, they assume full connectivity within each subset of units (here: lexical units and conceptual units) as well as between different subsets of units (see, e.g., Kawamoto, 1993). A key property of distributed memory models is that when a fragment of a (previously learned) activation pattern is presented, the activation in the network gradually changes (via recurrent connections between the units) until the whole pattern is reproduced and the system has reached a stable state (i.e., reached the minimum of a basin of attraction). So, presentation of a word (e.g., "skirt") activates the corresponding pattern of lexical units, after which the entire pattern of activation of this word, including the conceptual units, is re-created (indicating that the pattern is "recognized").

Important for our present purpose is the notion that activation patterns of different words can partially overlap (see Figure 2). Words related in meaning (e.g., "skirt" and "dress") are assumed to share conceptual features. Similarly, words related in spelling and/or pronunciation (e.g., homophones such as "dear" and "deer") can share orthographic and/or phonological features. The overlap in activation patterns of words is not restricted to the native language memory system, but may extend to that of the second language. For example, to the extent that translation pairs have similar meanings, the conceptual features of a word and its translation may (partially) overlap. When the system proceeds from one state to another, it will most likely be attracted to the activation pattern that has most overlap with the initial pattern. As activation patterns share more features (hence, the lexical distance between the patterns is smaller), this movement from one pattern to another will take less time, and will be more often successful (for more details, see, e.g., the simulation studies of Kawamoto, 1993; Masson, 1991).

[6] Some models based on distributed memory representation do not specify the precise information entailed by each of the lexical (i.e., phonological and orthographic) or conceptual features (e.g., Kawamoto, 1993; Masson, 1991), whereas in other models each feature is assigned to capture a specific piece of information. For example, in some models a set of labeled conceptual features (e.g., "has-legs", "pleasant", "container") is employed, denoting empirically derived (McRae, De Sa, & Seidenberg, 1997) or intuitive (Plaut & Shallice, 1993) semantic distinctions.

Within this theoretical framework, how may word association come about? Presentation of the stimulus word (e.g., "skirt") activates lexical features, after which the entire activation pattern (entailing lexical and conceptual features) is re-created. Activation in memory then moves further towards partially overlapping patterns, representing related words (e.g., its translation "rok", the semantically related word "dress", and the latter's translation "jurk" – see Figure 2). These related words are all potential associative responses, though, in this experiment, participants were instructed not to give the translation of a word as associative response (see Method, above). The more features an activation pattern of a word shares with that of the stimulus, the more likely it is that this word will be the ultimate associative response given by the participant (conceptual features conceivably play a stronger role in determining the response than do lexical features, as adults' word associations are typically related in meaning to the stimulus). Furthermore, the more the activation pattern of the stimulus resembles that of the (potential) associative response, the less time will be needed to move towards this pattern (bringing about shorter latencies), and the more frequently the association process will be successful within a particular amount of time (bringing about fewer omissions; see, e.g., Sharkey & Sharkey (1992) for a more detailed explanation of effects of lexical distance between related words).

The word-type effects obtained in the present study may stem from differences in overlap of conceptual features. (In the introduction we discussed why such differences may exist.) This is depicted in Figure 2, in which activation patterns of abstract words share fewer conceptual elements with semantically related words and with the latter's translations than those of concrete words. As a result, with abstract words such as "revenge" chances are higher that in within-language association the system is attracted towards a pattern that is different from that of between-language association. In addition, more time will be needed to move from the activated pattern of an abstract stimulus word towards that of an associative response, and chances are higher that no such pattern will be reached eventually. On the other hand, because a concrete word such as "skirt" shares many elements with the related word "dress" and the latter's translation "jurk", it is fairly likely that both these words will be produced as within- and between-language associations, respectively. Due to the close resemblance in activation patterns, the speed and success with which these associations are produced will be relatively high.[7] Likewise, if activation patterns of concrete words share more conceptual units with semantically related words in the same language than the patterns of abstract words do, chances are higher that when the within-language association task is repeated, the system will move towards the same pattern as before. Indeed, we observed a higher number of repeated within-language associations for concrete than for abstract words.[8] This notion may also imply that if the system is attracted towards a different pattern upon repetition of the association task (now in the other language), the activation patterns of dissimilar associations will share fewer conceptual features in the case of abstract stimulus words than with concrete words. We indeed observed that the semantic relatedness ratings of the dissimilar within- and between-language associations for abstract words were less similar in meaning than those for concrete words.

Differences obtained between cognates and noncognates and between nouns and verbs may originate from similar differences in conceptual overlap: cognates may share more conceptual units than noncognates, and nouns may share more conceptual units than verbs.[9] Moreover, we observed that concrete

[7] One could argue that if concrete words share more conceptual features with semantically related words and with their translations than abstract words do, the former may lead to *less* consistent associations: words with many closely related concepts may generate less consistent associations due to competition among potential associates. Previous word association studies contradict this view (e.g., De Groot, 1989; Taylor, 1976). De Groot (1989) found that concrete words elicited a greater number of associations in a continued association task than did abstract words. In a recent study, these results were replicated, and extended to continued word association in the second language in bilinguals (Van Hell, 1998a). Because of the higher number of associations, the alleged competition among potential associates should be higher for concrete than for abstract words. Nevertheless, the present study showed that the former evoked more consistent (and faster) responses. Hence, the lexical distance from a word to a potential associate appears to determine the consistency of associations above and beyond a role that the competition among potential associates may play.

[8] This proposal implicitly assumes that associative responses to words with a high (low) overlap of conceptual features, such as concrete (abstract) translation pairs, evoke associative responses with a relatively high (low) overlap of conceptual features. To see whether our data fit these assumptions, we looked in more detail at the nature of the associations produced to nouns. For each association condition (i.e., DD, EE, DE, and ED), we combined the associations given in the first and second session, and, for each of the 60 nouns, took the most frequently produced association. It appeared that, across all four conditions, *all* associations to concrete nouns were concrete themselves. Furthermore, of the associations to abstract nouns, 70 per cent, 72 per cent, 57 per cent, and 69 per cent were abstract themselves in the DD, EE, DE, and ED conditions, respectively.

[9] Relatively few studies on bilingual memory have studied effects of grammatical class, and more research is needed to test this notion.

cognate nouns such as "appel–apple" evoked a particularly high degree of similar within- and between-language associations. Within the framework of distributed memory representations, this is to be expected due to the joint effects of concreteness, cognate status, and grammatical class: conceptual features of concrete cognate noun translations overlap more than either concrete, cognate, or noun translations alone. In fact, the activation patterns of the two words in a concrete cognate noun translation pair may be nearly identical due to the high overlap in conceptual, as well as orthographic and phonological elements (see lower part of Figure 2). This near identity of activation patterns conceivably benefits concrete cognate noun translations such as "appel–apple" over and above the summed effect of being concrete, cognate, and noun.

Finally, the finding of shorter association times and fewer omissions for cognates than for noncognates in the within-language association task fits within the above framework. One asset of this framework is that it allows for high interaction between the two language systems. Conceivably, of the patterns sharing features with the pattern of the stimulus word, the pattern of its translation overlaps most, and this will be the pattern to which the system is first attracted after stimulus recognition.[10] Because cognate translation pairs such as "appel–apple" share more features than those of noncognates such as "rok–skirt" (see Figure 2), a cognate translation will become activated sooner than a noncognate translation. Because of the earlier convergence of activation of an L1 cognate and its L2 translation, the ultimate associative response will be reached earlier for cognates than for noncognates, resulting in shorter association times and fewer omissions for cognates than for noncognates.

In brief, explanations based on local and distributed memory representations can both explain the data of this study. One merit of an account based on distributed memory representations is that we no longer need a notion of bilingual memory comprising qualitatively different representations, depending on word-type. Word-type effects in bilingual, and, for that matter, in monolingual processing may stem from differences in the amount of conceptual, and/or orthographic, and/or phonological features shared. As such, the distributed memory view is more parsimonious than views based on local representations (see Van Hell, 1998a, for a discussion on how the above attractor model may describe other findings in the bilingual literature).

In conclusion, the present study revealed different patterns of association performance for concrete vs. abstract words, for cognates vs. noncognates, and for nouns vs. verbs. The framework of distributed memory representation seems to provide a parsimonious account of these results by attributing these differences to one and the same underlying cause: effects of word type and word class originate from differences in the amount of conceptual features shared between languages.

[10] This is supported by translation data we recently collected for the 60 nouns of the present study: translation times for the four groups of nouns were shorter than the corresponding association times (see Table 4). Mean forward translation times (from L1 to L2) for the concrete and abstract cognates, and concrete and abstract noncognates were 864 ms, 996 ms, 1030 ms, and 1523 ms, respectively. Mean backward translation times were, in the above order, 844 ms, 993 ms, 1032 ms, and 1354 ms.

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Appendix A: Critical Stimuli of the Experiment

Abstract nouns

Noncognates		Cognates	
Dutch	English	Dutch	English
plicht	duty	inzicht	insight
gelegenheid	opportunity	schaamte	shame
gunst	favour	plan	plan
poging	attempt	motief	motive
voordeel	advantage	kwaliteit	quality
gemak	ease	hel	hell
wraak	revenge	blok	block
waarheid	truth	methode	method
geweten	conscience	kans	chance
oorzaak	cause	principe	principle
geheugen	memory	informatie	information
eis	demand	metaal	metal
zorg	care	cirkel	circle
geloof	faith	paniek	panic
bezit	property	figuur	figure

Concrete nouns

Noncognates		Cognates	
Dutch	English	Dutch	English
winkel	shop	schouder	shoulder
spiegel	mirror	seizoen	season
geweer	gun	vinger	finger
aardappel	potato	kapitein	captain
mes	knife	dochter	daughter
fles	bottle	peper	pepper
rok	skirt	slaaf	slave
bloem	flower	appel	apple
boom	tree	sneeuw	snow
ziekenhuis	hospital	winter	winter
broek	trousers	koffie	coffee
boerderij	farm	roos	rose
vogel	bird	politie	police
fiets	bike	trein	train
gevangenis	jail	dokter	doctor

Abstract verbs

Noncognates		Cognates	
Dutch	English	Dutch	English
weigeren	refuse	vergeten	forget
toegeven	admit	buigen	bend
storen	disturb	durven	dare
slagen	succeed	arresteren	arrest
raden	guess	haten	hate
beloven	promise	hopen	hope
begrijpen	understand	spreiden	spread
		irriteren	irritate

Concrete verbs

Noncognates		Cognates	
Dutch	English	Dutch	English
beven	tremble	niezen	sneeze
bewegen	move	klimmen	climb
dopen	baptize	fronsen	frown
gooien	throw	zwemmen	swim
rekenen	calculate	luisteren	listen
trouwen	marry	stelen	steal
huilen	cry	zingen	sing
schilderen	paint		

Appendix B: Mean Values (and Standard Deviations) of the Properties of the Critical Stimuli

	Cognates		Noncognates	
	Concrete	Abstract	Concrete	Abstract
	Nouns			
Word property				
Concreteness-D	6.09 (.63)	3.44 (1.44)	6.44 (.26)	2.46 (.49)
Concreteness-E	6.43 (.49)	3.95 (1.42)	6.58 (.47)	2.92 (.39)
Cognate Status	5.89 (.52)	5.89 (.73)	1.23 (.08)	1.23 (.09)
Log Frequency-D	3.43 (.35)	3.38 (.36)	3.39 (.21)	3.40 (.27)
Log Frequency-E	3.50 (.34)	3.53 (.34)	3.39 (.36)	3.56 (.42)
Length-D	6.07 (1.16)	6.27 (1.98)	6.07 (2.40)	6.27 (1.98)
Length-E	5.87 (1.19)	6.13 (1.85)	5.27 (1.39)	6.60 (2.35)
	Verbs			
Concreteness-D	6.29 (.41)	4.23 (.89)	6.26 (.41)	4.01 (.60)
Cognate Status	4.58 (.61)	5.04 (1.02)	1.56 (.39)	1.62 (.49)
Log Frequency-D	3.18 (.58)	3.34 (.39)	3.43 (.37)	3.48 (.40)
Log Frequency-E	3.21 (.58)	3.46 (.35)	3.41 (.62)	3.57 (.26)
Length-D	6.86 (1.07)	7.12 (1.89)	6.62 (1.60)	7.00 (1.41)
Length-E	5.00 (.82)	5.25 (1.49)	5.62 (1.92)	6.71 (1.70)

Note: D = Dutch. E = English. Concreteness ratings in English for the verbs are not available (see text for further details).

Received February 12, 1998 Revision accepted August 7, 1998