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Disentangling Context Availability and Concreteness in Lexical Decision and Word Translation

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This study examines contrasting predictions of the dual coding theory and the context availability hypothesis regarding concreteness effects in monolingual and bilingual lexical processing. In three experiments, concreteness was controlled for or confounded with rated context availability. In the first experiment, bilingual subjects performed lexical decision in their native language (Dutch, L1). In the second experiment, lexical decision performance of bilinguals in their second language (English, L2) was examined. In the third experiment, bilinguals translated words "forwards" (from L1 to L2) or "backwards" (from L2 to L1). Both monolingual and bilingual tasks showed a concreteness effect when concreteness was confounded with context availability. However, concreteness effects disappeared when abstract and concrete words were matched on context availability, and even occasionally reversed. Implications of these results for theories that account for concreteness effects, particulary in bilingual processing, are discussed.

Many people feel that abstract words like "insight" are more difficult to process than are concrete words like "skirt". This intuition has been confirmed in many experiments using a wide variety of monolingual tasks (for a review, see, e.g., Balota, Ferraro, & Connor, 1991). For instance, in word association (De Groot, 1989), lexical decision (e.g. Kroll & Merves, 1986, Experiments 1& 2; Ransdell & Fischler, 1987; Schwanenflugel, Harnishfeger, & Stowe, 1988; Schwanenflugel & Shoben, 1983), naming (de Groot, 1989; Schwanenflugel & Stowe, 1989), and free recall (Paivio, 1986; Ransdell & Fischler, 1987), it is generally found that abstract words are processed more slowly or remembered less than are concrete words (but see Kroll & Merves, 1986, Experiment 3). In addition to finding these effects for isolated words, concreteness effects are observed in connected discourse: Abstract sentences or paragraphs are more difficult to understand and recall

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than are concrete ones (e.g. Begg & Paivio, 1969; Johnson, Bransford, Nyberg, & Cleary, 1972; Marschark & Paivio, 1977; Ransdell & Fischler, 1989; Schwanenflugel & Shoben, 1983; Wattenmaker & Shoben, 1987).

The concreteness of linguistic materials not only influences monolingual processing, but it is also an important determinant of cross-language word processing. For instance, concrete words are translated faster and more accurately than are abstract words (e.g. de Groot, 1992a; de Groot, Dannenburg, & van Hell, 1994; de Groot & Hoeks, 1995). Moreover, concreteness effects have been found in interlingual word recognition and free recall (e.g. Paivio, Clark, & Lambert, 1988; Winograd, Cohen, & Barresi, 1976), interlingual priming in lexical decision (Jin, 1990), and interlingual word association (Kolers, 1963; van Hell & de Groot, 1996). Finally, in learning foreign language vocabulary, concrete words are retained better than are abstract words (van Hell & Candia Mahn, 1997).

As may be clear from the exposition above, concreteness effects are ubiquitous in monolingual and bilingual research. The source of the concreteness effect, however, remains an issue of controversy. In this study, we investigated the viability of two different accounts of concreteness effects in monolingual and bilingual memory: dual coding theory and the context availability hypothesis.

A plausible explanation for the processing advantage of concrete materials is that concrete but not abstract words have an imaginal referent. This intuitively appealing notion has been explicated by Paivio and his co-workers in their dual coding theory (e.g. Paivio, 1986). Dual coding theory assumes the existence of two functionally independent yet interconnected systems: an image system and a verbal system. The image system is a non-verbal system, specialized in representing and processing information about non-verbal objects and events. It is composed of associatively connected imaginal representations ("imagen"). The verbal system, on the other hand, represents and processes linguistic information. This system is composed of verbal associates. Dual coding theory assumes that both abstract and concrete words are represented in the verbal system. However, concrete words are more likely to have a strong cross-referential connection to the image system as well. As a consequence, presentation of a concrete word more often than that of an abstract word also arouses an imaginal representation. The arousal of verbal and imaginal memory codes are assumed to have an additive effect. Hence, concrete words have an advantage over abstract words in lexical processing.[1]

In the bilingual extension of dual coding theory, a verbal system for representing and processing words in the second language (L2) is added (e.g. Paivio & Desrochers, 1980). The (non-verbal) imagery system and the L1 and L2 verbal systems can function independently but are interconnected. As in the monolingual version, abstract and concrete words are represented differently: they both have a verbal representation in L1 and in L2, but concrete words more often have an additional imagery referent, which is shared by the L1 and L2 word of a translation pair. Therefore, the translation of abstract words is

[1] Rated word imageability and concreteness are usually highly correlated (see, e.g., Paivio, Yuille, & Madigan, 1968). In our study, word imageability and concreteness are confounded as well; hence, words rated high or low on imageability are simply referred to as concrete and abstract words, respectively.

primarily achieved via connections between the two verbal systems. Concrete words, however, can be translated directly by way of the links between the two verbal systems, or indirectly via the shared image system. This additional, indirect connection via the image system will benefit translation of concrete words over abstract words. In the bilingual memory literature, dual coding theory appears to be the prevailing framework for interpreting concreteness effects in cross-language processing (e.g. Jin, 1990; Paivio et al., 1988; Winograd et al., 1976).

The dual coding theory of Paivio and his co-workers explains concreteness effects in terms of a differential availability of imaginal codes. The context availability hypothesis, on the other hand, claims that concreteness effects emerge from a differential availability of contextual information. Building on a more general model of comprehension processes (Bransford & Johnson, 1972; Bransford & McCarrell, 1974; Johnson et al. (1972), the context availability hypothesis assumes that comprehension essentially comes about via the addition of contextual information to the material that has to be understood (Kieras, 1978; Schwanenflugel et al., 1988; Schwanenflugel & Shoben, 1983; Schwanenflugel & Stowe, 1989; Wattenmaker & Shoben, 1987). This added contexual information can either be present in the stimulus environment or may be derived from prior knowledge of the comprehender that is currently being activated. It enables the understander to derive relations among concepts that are needed for comprehension. According to the context availability model, concreteness effects arise from a differential availability of contextual information for abstract and concrete materials presented in isolation: it is more difficult to retrieve contextual information from memory for abstract than for concrete materials. As a consequence, abstract words are harder to comprehend than concrete words. These predictions of the context availability hypothesis have received support in several monolingual studies. For example, it was found that concreteness effects in lexical decision (Schwanenflugel et al., 1988; Schwanenflugel & Shoben, 1983) and in naming (Schwanenflugel & Stowe, 1989) were eliminated by presenting abstract and concrete words in a sentence context. Furthermore, embedding abstract and concrete sentences in a paragraph eliminated differences in comprehension times for (Schwanenflugel & Shoben, 1983) and recall of (Wattenmaker & Shoben, 1987) these sentences.

The context availability hypothesis was originally formulated for monolingual processing, but it can straightforwardly be extended to bilingual processing. Also, in bilingual processing the comprehensibility of an isolated word, sentence, or text fragment may be a function of the ease with which contextual information can be retrieved from memory. And as in monolingual processing, in cross-language processing adding contextual information to abstract words may be more difficult than to concrete words.

The concreteness/imageability (see Footnote 1) and context availability of words have something in common. More specifically, rated word concreteness usually has a high and positive correlation with rated context availability. In a typical rating study, subjects are asked to indicate a particular word property on a 5-point or a 7-point scale. A frequently used instruction for assessing word imageability is one in which subjects are asked to indicate how easy or difficult it is for the word to arouse a mental image (Paivio, Yuille, & Madigan, 1968). The context availability of words is often assessed by asking subjects to indicate the ease or difficulty with which they can think of a particular context or circumstance in which the word might appear (Schwanenflugel & Shoben, 1983). Using

these instructions, De Groot et al. (1994) found a correlation of .82 between rated word concreteness and context availability. Similarly, Schwanenflugel et al. (1988) reported a correlation of .69. Finally, Jones (1985) found that concreteness had a correlation of .88 with "ease of predication", operationalized in the rating instructions as the ease or difficulty of making factual statements about the word. Though this latter instruction differs somewhat from the context availability instruction, both rated context availability and ease-of-predication seem to tap the availability of stored knowledge associated with a particular word.

The correlation between rated word concreteness and context availability is high, but it is not perfect. This suggests that the addition of contextual information to some abstract concepts is relatively easy, and/or that retrieving relevant prior knowledge from memory is rather difficult for some concrete words. If concreteness effects originate from a differential availability of contextual information, as context availability theory assumes, matching abstract and concrete words on context availability should bring about equal processing times. On the other hand, dual coding theory would predict that matching abstract and concrete words on rated context availability would not make concreteness effects disappear, as the processing advantage of concrete over abstract words is due to the imaginal representation that only concrete words possess. Equating abstract and concrete words on the ease with which contextual information can be retrieved from memory would not overcome the structural difference in the representations of these words. Hence, the concreteness effect should not respond to the matching manipulation.

So, the different predictions of dual coding theory and context availability theory can be tested by experimentally dissociating the effects of concreteness from those of context availability. Using this line of reasoning, Schwanenflugel et al. (1988) found that concreteness effects in lexical decision in the native language disappeared by controlling abstract and concrete words on rated context availability. This finding supports the context availability hypothesis.

The goal of the present study was to investigate concreteness effects within a second-language processing task and in a cross-language processing task. More specifically, we seek to ascertain whether the concreteness effects observed in bilingual processing as reviewed above are due to differences in the availability of visual codes (thereby verifying the prevailing framework for explaining these effects) or to differences in the availability of contextual information. In earlier research (de Groot, 1992a; de Groot et al., 1994), we found that concreteness and context availability correlated highly (r = .82 for the Dutch words, and r = .80 for their English translations), and both variables were found to influence word translation performance in a forward (from L1 into L2) and in a backward (from L2 into L1) direction. These experiments, however, had a correlational design, and the variables concreteness and context availability were not explicitly manipulated. In addition, in these experiments concreteness and context availability were not only highly correlated, but also confounded with other word characteristics (e.g. frequency, length, or cognate status) known to be important determinants of monolingual and bilingual performance. The present studies are the first we know of that seek to nail down the exact relationship between concreteness and context availability in second-language processing and in cross-language processing. This was done by dissociating the effects of concreteness and context availability while controlling for frequency, length, and cognate status. Bilinguals performed one of the following tasks: lexical decision in the native

language (Experiment 1) or in the second language (Experiment 2), or forward or backward translation (Experiment 3). Before introducing the experiments, we describe briefly the proficiency level of the bilinguals participating in the experiments, as well as some characteristics of the lexical memory of these bilinguals.

The participants of this study were all unbalanced bilinguals, with Dutch as their native language and English as their second. They were all first-year psychology students from the University of Amsterdam. After preparatory English lessons at elementary school (starting at around the age of 10), they had been taught English at secondary school for about 3–4 hours a week, starting at around the age of 12 and continuing until their enrolment at the university. Their training at the university required them to read mainly in English. Hence, the bilinguals of our study have a fairly high level of proficiency in their second language. Nevertheless these bilinguals have less experience in their second language than in their native language. As a consequence, their second language lexicon may be smaller than the lexicon in their first language, and second-language words may have weaker connections with their meanings than do first-language words (e.g. de Groot et al., 1994; La Heij, Hooglander, Kerling, & van der Velden, 1996; Kroll & Stewart, 1994).

In brief, the predictions of dual coding theory and the context availability hypothesis were tested in three experiments. In Experiment 1, bilinguals performed lexical decision in their native language (Dutch, L1). Some data suggest that native language performance of bilinguals is somewhat less sensitive to concreteness manipulations of linguistic materials than is monolingual processing (Ransdell & Fischler, 1989). With this study we seek to test whether the results obtained by Schwanenflugel et al. (1988) will also be observed in our (bilingual) subjects and with our stimulus materials. In Experiment 2, bilinguals performed lexical decision in their second language (English, L2). In Experiment 3, cross-language performance was studied: subjects translated words in a forward (from L1 to L2), or in a backward (from L2 to L1) direction. In all experiments, concreteness and context availability were disentangled: either concrete and abstract words were matched on rated context availability or concreteness and context availability were confounded. In the former condition abstract and concrete words had equal context availability ratings. In the latter condition, concreteness and context availability were highly correlated (as is usually the case), with concrete words having high and abstract words having low context availability ratings. Dual coding theory predicts that concreteness effects will occur in lexical decision and in translation, both when abstract and concrete words are matched on context availability and when they are not. In contrast, the context availability hypothesis predicts that concreteness effects in lexical decision and in word translation will be eliminated by matching abstract and concrete words on context availability.

EXPERIMENT 1

Method

Design

A 2 (concreteness: concrete versus abstract) × 2 (context availability relation: matched versus confounded) within-subject design was used.

Subjects

Twenty fairly fluent bilinguals, drawn from the population described in the introduction, participated. After finishing 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). These ratings were collected in order to compare the proficiency in English of this group of bilinguals with that of the bilinguals participating in Experiments 2 and 3, and to verify that proficiency levels did not differ across the experiments. The mean comprehension rating was 5.35 (*SD*: 0.59). The mean production rating was 4.90 (*SD*: 0.72). All subjects received course credit for participation.

Materials

The stimuli consisted of two sets of Dutch words. In the first set 20 concrete and 20 abstract words were matched on rated context availability. In the second set 20 concrete and 20 abstract words differed in context availability—a deliberate confounding so that the concrete words had high context availability ratings and the abstract words had low context availability ratings.

The stimuli, all nouns, were derived from a set of 440 words rated for the word characteristics relevant to this study (de Groot, 1992a; de Groot et al., 1994). For all word characteristics, each Dutch word of this 440-word corpus (as well as its English translation, see Experiment 2) had been rated in separate norming studies. The word attribute concreteness was rated by using the imageability-instructions of Paivio et al. (1968) but translated into Dutch. Subjects were asked to rate words as to the ease or difficulty with which they arouse mental images. Any word that was thought to arouse a mental image very quickly and easily should be given a high imagery rating, whereas a word thought to arouse a mental image with difficulty or not at all should be given a low imagery rating. Ratings were done on a 7-point scale, with 1 indicating a very low imageability and 7 indicating a very high imageability. Similarly, in assessing the context availability of a word, subjects had been asked to indicate on a 7-point scale "how easy or difficult it is to come up with a particular context or circumstance in which the word might appear" (1 = very difficult to think of a context; 7 = very easy to think of a context). The instructions were those used by Schwanenflugel and Shoben (1983, as reported in Schwanenflugel et al., 1988), but translated into Dutch. In the norming studies underlying the above-mentioned 440-word corpus, both the concreteness and the context availability of these words had been rated by two different groups of subjects, each group rating half the words of the corpus. In order to assess the reliability of the ratings, 38 words were presented to both groups, both in the concreteness norming study and in the context availability norming study. The ratings for the 38 words presented to the two groups within each norming study correlated highly (r = .98 and r = .94 for the concreteness and context availability norming studies, respectively), suggesting that the rating procedure was reliable (see also van Hell, Oosterveld, & de Groot, 1996).

The mean values and standard deviations for the concreteness and context availability properties of the word sets are presented in the upper part of Table 1. The complete set of stimulus materials is listed in the Appendix.

The concrete and abstract words matched on context availability differed significantly in concreteness, $t(38) = 20.94$, $p < .001$, but not in context availability, $t(38) = .78$, $p > .10$. However, in the "confounded" condition concrete and abstract words differed significantly not only in concreteness, $t(38) = 19.19$, $p < .001$, but also in context availability, $t(38) = 32.37$, $p < .001$. Furthermore, across the two context availability conditions the two sets of concrete words did not differ in concreteness, $t(38) = .42$, $p > .10$, nor did the two sets of abstract words, $t(38) = 1.00$, $p > .10$. In contrast, across the two context availability conditions the two sets of concrete words differed in context availability, $t(38) = 18.60$, $p < .001$, as did the two sets of abstract words, $t(38) = 12.20$, $p < .001$.

TABLE 1
Mean Values of the Properties of the Word Sets Used in the Experiments

	Matched on CA				*Confounded with CA*			
Property	*Abstract*		*Concrete*		*Abstract*		*Concrete*	
Concreteness–D	2.75	(0.50)	6.06	(0.50)	2.57	(0.64)	6.13	(0.53)
Context availability–D	4.47	(0.33)	4.55	(0.28)	3.18	(0.34)	5.97	(0.19)
Cognate status	2.46	(1.50)	2.80	(1.81)	2.66	(1.86)	2.90	(2.09)
Length–D	5.30	(1.26)	5.10	(1.16)	5.55	(1.47)	5.60	(1.88)
Log word frequency–D	3.32	(0.56)	3.23	(0.51)	3.31	(0.57)	3.34	(0.47)
Concreteness–E	3.17	(0.42)	5.96	(0.85)	3.23	(0.87)	6.23	(0.61)
Context availability–E	4.31	(0.66)	4.59	(0.59)	3.66	(0.57)	5.73	(0.44)
Length–E	5.85	(1.63)	5.35	(1.72)	5.60	(2.04)	5.15	(1.66)
Log word frequency–E	3.51	(0.55)	3.25	(0.42)	3.40	(0.64)	3.39	(0.55)

Note: CA = Context availability; D = Dutch words; E = English words. Standard deviations are shown in parentheses.

In addition, across the two context availability conditions, the concrete and abstract words were matched on three characteristics known to influence within-language and across-language performance of bilinguals: cognate status, length in letters, and log word frequency (cf. de Groot et al., 1994; van Hell & de Groot, 1996). In earlier norming studies, ratings of these control variables had been collected (de Groot et al., 1994). Cognate status refers to the similarity in sound and spelling of the words in a translation pair. In assessing the cognate status of translation pairs, subjects had been asked to indicate on a 7-point scale "how similar they regarded the words within each translation pair" (1 = very low similarity; 7 = very high similarity). They had been told that their ratings should reflect a combined assessment of both spelling and sound of each word pair under consideration. The log frequencies of the Dutch words were derived from the frequency counts of the Centre for Lexical Information (CELEX) in Nijmegen (Burnage, 1990). The mean values and standard deviations of these variables are presented in the upper part of Table 1. Across the two levels of concreteness and of context availability, there were no significant differences on any of the control variables (all $ps > .10$).

Eighty pseudowords were constructed by changing one letter of 40 concrete and 40 abstract Dutch words, newly selected, with the constraint that the pseudowords followed the phonological and orthographic rules of Dutch. The pseudowords were not English (nor, or course, Dutch) words; absence of an entry in Dutch–English and English–Dutch dictionaries (Martin & Tops, 1984, 1986) was used as the criterion for pseudoword status. These pseudowords did not differ in length from the word stimuli ($p > .10$). Similarly, the frequencies of the original words from which the pseudowords were derived did not differ from those of the word stimuli ($p > .10$).

In addition to the test stimuli, 10 concrete and 10 abstract Dutch words, all different from any of the test stimuli, were selected as practice stimuli. Half these practice stimuli were converted into pseudowords by changing one letter.

Apparatus and Procedure

The experiment was run on an Apple Macintosh Plus computer in a normally lit room. All subjects were tested individually. Stimuli were presented in black lower-case letters on a light-grey background, at the centre of the computer screen. A PASCAL-program controlled the stimulus

presentation and the recordings of the response times. A two-button keyboard registered the responses of the subjects.

Subjects were instructed that on each trial a letter string would appear on the screen, and they were asked to determine as quickly and as accurately as possible whether or not this letter string was a Dutch word. In the case of a word, subjects were told to push the right-hand push-button with their right forefinger. In the case of a nonword, they were to push the left-hand button with their left forefinger.

The procedure for the trials was as follows. Prior to the stimulus, a fixation stimulus (an asterisk) appeared on the screen for 1 sec, slightly to the left of and above where the letter string was to appear. The letter string was then presented and remained on the screen until the subject had responded by pushing one of two buttons. Response time (RT) was measured from the onset of the stimulus. One sec after the subject had pushed either response key, the fixation stimulus for the following trial appeared. Subjects received no feedback regarding the speed and accuracy of their responses, because we wanted to equate the procedures of the lexical-decision and translation tasks (the latter to be used in Experiment 3) as much as possible.

Each subject completed 20 practice and 160 test trials. Trials were presented in random order, with a different order for each subject. The test trials, 80 words and 80 pseudowords, were divided into 8 blocks of 20 stimuli each. After each block, the subject was allowed a brief rest of at least 10 sec before the first trial of the next block began.

Results and Discussion

For each subject mean RTs were calculated for the four conditions formed by the two levels of the variables concreteness (concrete versus abstract) and context availability relation (matched versus confounded). In addition, mean RTs for all stimuli within each of the four conditions, collapsed across subjects, were calculated. Response times of incorrect responses and those shorter than 100 msec or longer than 2.5 *SD* above the subject's mean were eliminated (2.69% of all data). The pseudowords, requiring a "no" response, were regarded as fillers and are not analysed in detail; mean RTs and error rates on the pseudowords were 653 msec ($SD = 86$) and 3.7% ($SD = 2.9$), respectively.

A 2 (concreteness) × 2 (context availability relation) ANOVA was performed on the mean subject RTs, treating concreteness and the context availability relation as within-subject variables. The corresponding 2 (concreteness) × 2 (context availability relation) ANOVA was performed on the mean item RTs, treating concreteness and context availability relation as between-items variables. Given the relationship between the conditions and our a priori predictions about the direction of the effects, we take a planned comparisons approach. The crucial differences are the simple main effects of concreteness within each of the two levels of the context availability relation (matched versus confounded).

The mean subject RTs and error rates are presented in the upper half of Table 2. Simple effects analyses revealed that when concreteness was confounded with context availability, a 31-msec concreteness effect emerged, $F_1(1, 19) = 60.59$, $p < .001$, and $F_2(1, 76) = 8.57$, $p < .01$. In contrast, as predicted by the context availability hypothesis, when concrete and abstract words were matched on context availability, lexical decision for abstract words took no longer than for concrete words, $F_1(1, 19) = 2.68$, $p > .10$, and $F_2(1, 76) = 1.12$, $p > .10$.

TABLE 2
Mean Reaction Times and Error Rates for the Dutch and English Lexical Decision Tasks of Experiments 1 and 2

		Matched on CA		*Confounded with CA*	
Lexical Decision	*Concreteness*	*RT*	*Error*	*RT*	*Error*
Dutch	Abstract	541 (66)	2.0 (3.0)	554 (62)	3.0 (3.4)
	Concrete	554 (61)	4.5 (4.3)	523 (63)	2.0 (3.0)
	Effect	−13	−2.5	31	1.0
English	Abstract	623 (82)	8.2 (8.0)	641 (98)	8.0 (7.1)
	Concrete	651 (94)	8.8 (9.6)	619 (71)	5.0 (5.1)
	Effect	−28	−0.6	22	3.0

Note: CA = Context availability. Reaction times are given in msec; error rates are percentages. Standard deviations are shown in parentheses.

The error data were inspected to see whether a speed/accuracy trade-off might have occurred. As can be seen in Table 2, it appeared that this had not been the case. Therefore, the error data were not subjected to further analyses.

In sum, a concreteness effect occurred when concreteness was confounded with context availability. However, when abstract and concrete words were matched on context availability, this concreteness effect was no longer apparent. These results are in accord with the predictions of the context availability hypothesis but are difficult to explain within the framework of dual coding theory. So, the results observed by Schwanenflugel et al. (1988) in lexical decision performance in the native language by monolinguals were replicated in our bilingual subject population and with our stimulus materials. In the remainder of this paper, we focus on (within-language) performance in the second language (Experiment 2) and on forward and backward translation (Experiment 3). The issue at stake is whether concreteness effects in bilingual processing are due to differences in the availability of a visual code or to differences in the availability of (any) associated contextual information.

EXPERIMENT 2

Method

Design

The same 2 (concreteness: concrete versus abstract) × 2 (context availability relation: matched versus confounded) within-subject design was used as in Experiment 1.

Subjects

Twenty new fairly fluent Dutch-English bilinguals, drawn from the same population as those of Experiment 1, participated. The mean English comprehension and production self-ratings, performed after the experiment, were 5.50 (*SD*: 0.69) and 5.30 (*SD*: 0.57), respectively. All subjects received course credit for participation.

Materials

The English translations of the Dutch stimuli of Experiment 1 constituted the test materials of Experiment 2. As in Experiment 1, the relevant word characteristics were derived from the 440-word corpus used in earlier studies (de Groot, 1992a; de Groot et al., 1994). The instructions and procedures underlying the English words ratings in this corpus were similar to those of the corresponding Dutch translations. The reliability of the concreteness and context availability ratings of the English words in this corpus were .97 and .92, respectively (cf. Experiment 1).

The mean values and standard deviations for the concreteness and context availability properties of the two sets of English words are presented in the lower part of Table 1. The complete set of stimulus materials is listed in the Appendix. The concrete and abstract words matched on context availability differed significantly in concreteness, $t(38) = 13.14$, $p < .001$, but not in context availability, $t(38) = 1.41$, $p > .10$. In contrast, the concrete and abstract words from the "confounded" set not only differed significantly in concreteness, $t(38) = 12.64$, $p < .001$, but also in context availability, $t(38) = 12.86$, $p < .001$. In addition, across the two context availability conditions the two sets of concrete words did not differ in concreteness, $t(38) = 1.17$, $p > .10$, nor did the two sets of abstract words, $t(38) = .28$, $p > .10$. However, across the two context availability conditions the two sets of concrete words differed in context availability, $t(38) = 6.91$, $p < .001$, as did the two sets of abstract words, $t(38) = 3.32$, $p < .01$.

In addition, across the two context availability conditions, the concrete and abstract words were matched on cognate status (cf. Experiment 1), and on length and log frequency of the English words (see Table 1). As in Experiment 1, length and log frequency of the English words were derived from the 440-word corpus collected earlier (de Groot et al., 1994) and the CELEX frequency counts (Burnage, 1990). Across the two levels of concreteness and of context availability, there were no significant differences on the control variables (all ps $> .10$).

Eighty pseudowords were constructed, using the same procedure as in Experiment 1, with, of course, the exception that now the pseudowords followed the phonological and orthographic rules of English.

In addition to the test stimuli, the English translations of the Dutch practice words were selected as practice stimuli for this experiment. Of these, half were converted into pseudowords by changing one letter.

Apparatus and Procedure

The apparatus and procedure of this experiment were identical to those of Experiment 1, with the exception that subjects were instructed to determine whether or not the letter string was an English word.

Results and Discussion

Mean subject and item RTs were calculated following the procedures described for Experiment 1 (2.56% of all data was eliminated because of too fast or too slow responses). Mean RTs and error rates on the pseudowords were 759 msec ($SD = 124$) and 8.2% ($SD = 4.8$), respectively. Next, data were analysed in the same way as for Experiment 1.

The mean subject RTs and error rates are presented in the lower part of Table 2. Simple effects analyses showed that when concreteness was confounded with context availability, the 22-msec concreteness effect was marginally significant on the subject analysis, $F_1(1, 19) = 3.29$, $p = .09$, but failed to reach significance on the item analysis,

$F_2 < 1$. However, when concrete and abstract words were matched on context availability, lexical decisions on abstract and concrete words did not differ statistically, $F_2 < 1$, or were even significantly faster for abstract words, $F_1(1, 19) = 6.69$, $p < .05$.

The error data were not subjected to further analysis, as, as can be seen in Table 2, no speed/accuracy trade-off occurred.

To summarize, a slight advantage of concrete over abstract words was observed in lexical decision in the second language when concreteness was confounded with context availability. Matching concrete and abstract words on context availability eliminated this concreteness advantage; in the subject analysis this matching manipulation even resulted in a reliable advantage of abstract over concrete words. Recall that in this condition the concreteness advantage had also disappeared when bilinguals performed lexical decision in their native language.

In the design of our study, the effect of context availability was examined by matching concrete and abstract words on rated context availability. An alternative method is a post hoc, statistical control for the effect of context availability by means of an analysis of covariance, in which context availability is treated as a covariate. Therefore, we subjected the Dutch and English lexical decision times of the 20 abstract and 20 concrete words from the confounded set to an ANOVA (by items). Next, we performed an analysis of covariance on these data, treating context availability as a covariate. In agreement with the analyses above, we found that the advantage of concrete over abstract words as observed in the ANOVA, $F(1, 76) = 4.50$, $p < .05$, was no longer significant when context availability was treated as a covariate, $F(1, 75) = .49$, $p > .10$. Once again this suggests that the observed difference between concrete and abstract words in the confounded condition can be explained by differences in context availability. Note that this analysis does not allow an inference of a causal relationship between the covariate context availability and the dependent variable (see, e.g., Lord, 1969).

It is generally agreed that deciding whether or not a letter string is a word (i.e. lexical decison) goes beyond mere word identification, and many studies suggest that access to meaning is involved (see, e.g., Balota et al., 1991). This is indeed demonstrated by the present effects of concreteness, supposedly a semantic variable, and of the context availability manipulation. In the introduction we argued that our bilinguals have had less practice in their second language than in their native language, which may have resulted in a smaller second-language vocabulary and weaker links between second-language words and their meanings. This is likely to lead to higher latencies, but possibly also to a smaller effect of concreteness and of the context availability manipulation in lexical decision performance in the second language compared to that in the native language. In order to see whether such differential results were obtained, ANOVAs were performed on the combined data of Experiments 1 and 2, with language as the between-experiments factor. The overall analyses yielded a main effect of language, $F_1(1, 38) = 15.96$, $p < .001$, and $F_2(1, 152) = 88.98$, $p < .001$, reflecting the dominance of the native language over the second language: Overall mean lexical decision latencies to native and second-language words were 543 msec and 633 msec, respectively. However, none of the interactions involving the factor language was significant (all F_1s < 2, and all F_2s < 1). Hence, more practice in the native than in the second language influenced lexical decision times

but did not lead to substantial qualitative differences between native and second-language lexical decision performance.

In Experiment 3 the divergent predictions of dual coding theory and the context availability hypothesis concerning concreteness effects are again tested, but now in a cross-language-processing task. Subjects translated in a forward (from Dutch into English) or in a backward (from English into Dutch) direction.

EXPERIMENT 3

Method

Design

A 2 (concreteness: concrete versus abstract) × 2 (context availability relation: matched versus confounded) within-subject design was used. Subjects translated words either in a forward direction (from Dutch, L1, to English, L2) or in a backward direction (from L2 to L1).

Subjects

Forty new fairly fluent Dutch–English bilinguals, drawn from the same population as those in Experiments 1 and 2, participated in the experiment and were randomly assigned to one of the two translation conditions. The mean English comprehension self-ratings after the experiment were 5.25 (*SD*: 1.02) and 5.45 (*SD*: .83) for subjects translating in forward and in backward directions, respectively. The corresponding mean production self-ratings were 4.85 (*SD*: .81) and 5.05 (*SD*: .83). All subjects received course credit for participation.

Materials

The 80 Dutch word stimuli of Experiment 1 and their translations in English as used in Experiment 2 constituted the test materials of Experiment 3. In addition, the 20 Dutch practice words of Experiment 1 and their English translations that had served as practice words in Experiment 2 were used as practice materials.

Apparatus and Procedure

The apparatus was identical to that of the two foregoing experiments, with the exception that in Experiment 3 the subject's responses were registered by a microphone that activated a voice-operated switch. The experimenter typed in the subject'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 subject's response or triggering due to faltering of the subject's voice or ambient sounds were noted down.

In the forward translation condition subjects were asked to speak out loud the English translations of the Dutch stimulus words; in the backward translation condition they were asked to speak out loud the Dutch translations of the English stimulus words. The subjects were instructed to respond as quickly as they could while maintaining high accuracy. They were asked to remain silent when they could not come up with the translation of the stimulus.

The procedure for the trials in both translation conditions was similar to that of Experiments 1 and 2, up until response registration. The onset of the subject's response (or of any other sound) was registered by the voice-switch. RT was measured from the onset of the stimulus. Then, the experimenter typed in the subject's response and hit the RETURN key, effectuating the presentation of the next stimulus 1 sec afterwards. The maximum presentation duration for a stimulus was 5 sec. Whenever this period expired, the experimenter typed the word "none", and the next trial was called by pressing the RETURN key.

Subjects completed 80 test trials, preceded by 20 practice trials. Trials were presented in random order with a different order for each subject. The test trials were divided into 4 blocks of 20 stimuli each. After each block, the subject was permitted a brief rest of at least 10 sec, after which the experimenter initiated the presentation of the first trial of the next block.

Results and Discussion

For each subject in the forward and backward translation condition mean RTs were calculated for the four conditions formed by the two levels of the variables concreteness (concrete versus abstract) and context availability relation (matched versus confounded). Mean RTs for all stimuli within each of the eight conditions, collapsed across subjects, were also calculated. Response times associated with translation errors or voice-switch registration errors were excluded. Voice-switch registration errors, including false starts, made up 5.94% and 5.19% of all data of the forward and the backward translation condition, respectively. A response was considered an error when it was not mentioned as a possible translation of the stimulus in a set of Dutch–English and English–Dutch dictionaries (Martin & Tops, 1984; Martin & Tops, 1986). A response was considered an omission if the subject had not initiated a translation response within 5 sec after stimulus onset. For each subject and for each item, the mean proportion of errors and the mean proportion of omissions were calculated for each condition.

Two sets of 2 (concreteness) × 2 (context availability relation) ANOVAs were performed, one on the forward and one on the backward translation data. Within each of the two translation direction conditions, three analyses were performed: one on the mean subject RTs, one on the error scores, and one on the omission scores, treating both concreteness and context availability relation as within-subject variables. Furthermore, the corresponding 2 (concreteness) × 2 (context availability relation) ANOVAs were performed on the mean item RTs, error scores, and omission scores, treating concreteness and context availability relation as between-items variables. We report the planned comparisons as described in Experiment 1.

The mean subject RTs, error rates, and omission scores of the various conditions are presented in Table 3.

Forward Translation. Simple effects analyses of the RT data showed that when concreteness was confounded with context availability, a reliable 370-msec concreteness effect appeared, $F_1(1, 19) = 118.68, p < .001$, and $F_2(1, 76) = 21.56, p < .001$. In contrast, when concrete and abstract words were matched on context availability, the concreteness advantage disappeared and was replaced by an advantage of abstract over concrete words

TABLE 3
Mean Reaction Times, Error Rates, and Omission Scores for the Forward and Backward Translation Tasks of Experiment 3

		Matched on CA			*Confounded with CA*		
Translation	*Concreteness*	*RT*	*Error*	*Omission*	*RT*	*Error*	*Omission*
Forward	Abstract	1,207	5.8	9.0	1,374	6.8	18.5
		(215)	(4.7)	(7.9)	(167)	(5.7)	(11.0)
	Concrete	1,319	3.2	13.2	1,004	0.8	3.0
		(231)	(2.9)	(11.0)	(146)	(1.8)	(4.4)
	Effect	−112	2.6	−4.2	370	6.0	15.5
Backward	Abstract	1,204	4.0	7.0	1,306	10.0	6.8
		(230)	(4.7)	(5.9)	(213)	(7.8)	(6.5)
	Concrete	1,256	12.2	5.2	1,138	4.2	0.5
		(213)	(7.5)	(6.2)	(255)	(3.5)	(1.5)
	Effect	−52	−8.2	1.8	168	5.8	6.3

Note: CA = Context availability. Reaction times are given in msec; error rates and omission scores are percentages. Standard deviations are shown in parentheses.

significant on the subject analysis, $F_1(1, 19) = 5.57$, $p < .05$, but not on the item analysis, $F_2(1, 76) = 1.28$, $p > .10$.

Simple effects analyses of the errors in forward translation revealed that confounding concreteness with context availability yielded a reliable concreteness effect, $F_1(1, 19) = 23.59$, $p < .001$, and $F_2(1, 76) = 5.82$, $p < .05$. However, when the concrete and abstract words were matched on context availability, the concreteness advantage in the error data decreased yet remained significant in the subject analysis, $F_1(1, 19) = 5.59$, $p < .05$, but was no longer reliable in the item analysis, $F_2(1, 76) = 1.01$, $p > .10$.

Simple effects analyses of the omissions in forward translation showed that when concreteness was confounded with context availability, significantly more omissions appeared in the translation of abstract words than of concrete words, $F_1(1, 19) = 61.07$, $p < .001$, and $F_2(1, 76) = 12.98$, $p < .01$. In contrast, when concrete and abstract words were matched on concreteness, no advantage for concrete words was seen, and the difference was not significant, $F_1(1, 19) = 2.20$, $p > .10$, and $F_2(1, 76) = .98$, $p > .10$.

Finally, we subjected the RTs, error rates, and omissions for the 20 abstract and 20 concrete words from the confounded condition to analyses of covariance, treating context availability as a covariate. The effects of concreteness as observed in ANOVAs on the RT data, $F(1, 38) = 18.17$, $p < .001$, the error data, $F(1, 38) = 9.58$, $p < .01$, and the omission data, $F(1, 38) = 12.38$, $p < .01$, were no longer significant when context availability was treated as a covariate, all ps $> .25$.

Backward Translation. Simple effects analyses of the RT data indicated that when concrete and abstract words differed on context availability, the 168-msec concreteness

effect was reliable, $F_1(1, 19) = 16.28$, $p < .01$, and $F_2(1, 76) = 5.38$, $p < .05$. However, in accordance with the context availability hypothesis, when concrete and abstract words were matched on context availability, abstract words were translated no more slowly than were concrete words, $F_1(1, 19) = 2.24$, $p > .10$, and $F_2(1, 76) = .53$, $p > .10$.

Simple effects analyses of the errors made in backward translation showed a significant concreteness effect when concreteness was confounded with context availability on the subject analysis, $F_1(1, 19) = 12.39$, $p < .01$, but not on the item analysis, $F_2(1, 76) = 1.62$, $p > .10$. However, the concreteness effect not only disappeared when concrete and abstract words were matched on context availability, but it even reversed, $F_1(1, 19) = 25.51$, $p < .001$, though this contrast was only marginally significant in the item analysis, $F_2(1, 76) = 3.34$, $p = .07$.

Simple effects analyses of the omissions in backward translation yielded a significant concreteness effect when concreteness was confounded with context availability, $F_1(1, 19) = 15.73$, $p < .01$, and $F_2(1, 76) = 4.09$, $p < .05$. In accordance with the context availability hypothesis, no reliable difference between concrete and abstract words was observed when these words had similar context availability ratings, both F_1 and $F_2 < 1$.

Finally, analyses of covariance on the mean RTs and omissions for the 20 abstract and 20 concrete words from the confounded condition, treating context availability as a covariate, showed that the effects of concreteness as obtained in ANOVAs on the RT data, $F(1, 38) = 5.33$, $p < .05$, and the omission data, $F(1, 38) = 7.21$, $p < .05$, were no longer significant when context availability was treated as a covariate, both ps $> .45$.

To summarize the results of Experiment 3, the findings obtained when subjects performed a monolingual task (lexical decision in their native or second language, Experiments 1 and 2) were extended to bilingual tasks. When concreteness was confounded with context availability, abstract words took longer to translate (RT), were translated less accurately (errors), and less often (omissions) than concrete words. This finding occurred both in forward and in backward translation. However, when abstract and concrete words were matched on context availability, the general finding was that such an advantage of concrete over abstract words was no longer obtained. These findings are difficult to explain by dual coding theory and seem more in line with the context availability theory. In two cases (forward translation times and backward translation errors) this matching even resulted in a significant advantage of abstract over concrete words, a cross-over effect that is not predicted by either theory. A significant reversal of the concreteness effect was also observed in lexical decision performance in the second language (though only in the analysis by subjects). We come back to this issue in the General Discussion.

Finally, a growing body of studies suggests that forward as well as backward translation involves conceptual mediation (e.g. de Groot et al., 1994; La Heij et al., 1996; Potter, So, von Eckardt, & Feldman, 1984; Snodgrass, 1993; but see, e.g., Kroll & Stewart, 1994). That is, upon reading the presented word, its meaning is accessed in memory, and subsequently the accessed information is used in retrieving the translation response. In the introduction we argued that our bilinguals have had less practice in their second than in their native language. As a consequence, second-language words may have weaker links with their meanings than first language words. This may bring about a less effective use of word meaning in backward than in forward translation (cf. Kroll, 1993; La Heij et al., 1996). Under the assumption that concreteness and context availability are semantic

variables and that the processing of meaning is reflected in an effect of these semantic variables on performance, it can be expected that concreteness and the context availability manipulation will affect forward translation more than backward translation. Indeed, when concreteness was confounded with context availability, the concreteness effect in backward translation was smaller than the effect in forward translation (168 msec and 370 msec, respectively, see Table 3), though reliably so only in the subject analysis, $F_1(1, 38) = 14.38$, $p < .001$, $F_2(1, 76) = 2.74$, $p > .10$. However, the context availability manipulation, collapsed across abstract and concrete words, did not differentially influence forward and backward translation statistically, $F_1(1, 38) = 2.75$, $p > .10$, and $F_2 < 1$.

GENERAL DISCUSSION

The experiments described here show that when abstract and concrete words differ in context availability, as they typically do, concreteness effects arise in lexical decision in the native language and in the second language (though in the latter less strongly so), and in forward and backward translation. However, when concrete and abstract words have equal mean context availability ratings, concreteness effects were no longer significant (and occasionally even reversed). These results seem difficult to explain within the framework of dual coding theory. This theory contends that concreteness effects in monolingual and bilingual processing originate from differences in imageability between concrete and abstract words: concrete but not abstract words have an imaginal representation in addition to a verbal representation. This structural difference cannot be overcome by matching abstract and concrete words on rated context availability. Our findings seem more in line with the context availability hypothesis, which claims that concreteness effects originate from differences in the availability of contextual information. Hence, concreteness effects should disappear when abstract and concrete words have equal context availability ratings, which indeed they do.

The results of our first experiment, in which concreteness effects in lexical decision in the native language by bilinguals were no longer significant when concrete and abstract words were matched on context availability, replicated the findings of Schwanenflugel et al. (1988) with monolinguals. The cogency of the context availability hypothesis in explaining concreteness effects in native language processing is corroborated by research using a variety of tasks. (See Introduction; but see e.g. Schwanenflugel & Akin, 1994; Schwanenflugel, Akin, & Luh, 1992.)

In our second and third experiments, we found that differences in context availability also accounted for concreteness effects in lexical decision in the second language, and in forward and backward word translation. This may imply that concreteness effects observed in other cross-language studies (See the introduction for a review) were also due to differences in context availability, and not to structurally different representations in bilingual memory between abstract and concrete words, as proposed by Paivio and his colleagues in the bilingual extension of dual coding theory (e.g. Paivio, 1986). The alternative view proposed here is that concreteness effects in cross-language tasks may be caused by differences in the ease of retrieving associated contextual information: Con-

textual information may also be more readily available for concrete words than for abstract words when word processing involves the non-native language. This context availability hypothesis seems at least to provide a plausible alternative for the prevailing dual-coding account of concreteness effects in cross-language processing.

A cursory look at Tables 2 and 3 suggests that matching abstract and concrete words on context availability often brought about an advantage of abstract over concrete words. In three statistical contrasts (out of the 8 by-subject and 8 by-item analyses reported), this advantage was statistically significant. This reversal of the concreteness effect, however, is not an isolated observation, and has been reported before both in monolingual (e.g. Marschark, 1985; Smith, 1981) and in cross-language (de Groot & Hoeks, 1995; Schönpflug, 1997) studies. Furthermore, in the field of neuropsychology some patients have been described whose brain damage resulted in an impaired processing of concrete words over abstract words (e.g. Breedin, Saffran, & Coslett, 1994; Warrington, 1981); reversed concreteness effects were also obtained by Plaut and Shallice (1993) in a series of lesioning experiments on their connectionist model simulating concrete and abstract word processing. These observations, as well as the occasional reversal of the concreteness effect as obtained in our experiments, may have interesting implications for models describing concreteness effects in lexical processing, and future studies may reveal under which circumstances such a reversed concreteness effect comes about. Even so, the overall pattern in the present study appears to be that, in line with the predictions of the context availability hypothesis, the advantage of concrete words in lexical decision in the native and second language, and in forward and backward translation, was eliminated by matching concrete and abstract words on context availability.

We now turn to the question of how, when concreteness is confounded with context availability, concrete words may have an advantage over abstract words in monolingual and bilingual lexical processing. Differences in the processing of concrete and abstract words may emanate from differences in the density of their conceptual networks in memory (e.g. de Groot, 1989; Jones, 1985; Kieras, 1978; Plaut & Shallice, 1993; Schwanenflugel & Shoben, 1983; Schwanenflugel et al., 1988; but see Nelson and Schreiber, 1992). In the native-language system (and presumably in that of the second language as well), the representations of abstract words may contain fewer conceptual elements than those of concrete words. For bilingual memory, differences in the density of conceptual networks of abstract as compared to concrete words may have the consequence that abstract words and their translations share fewer conceptual elements than do concrete translation pairs (de Groot, 1992b; Taylor & Taylor, 1990; van Hell & de Groot, 1996).[2] Alternatively, the meanings of abstract words may be less consistent, and more dependent on the linguistic context in which they appear, than the meanings of concrete words (e.g. Barsalou, 1982; Breedin et al., 1994; Hampton, 1981). Because of this higher dependency on linguistic context, abstract word meanings are more language-specific

[2] This may imply that in cross-language processing abstract words are at an extra disadvantage: compared to concrete words, abstract words are not only associated to fewer conceptual elements in each of the two lexicons, but they also share fewer conceptual elements with their translations.

than those of concrete words, resulting in fewer common elements for abstract translation pairs than for concrete ones.

Differences in the density of the conceptual networks of abstract and concrete words in memory may be reflected in the context availability ratings: because concrete words possess more (or more consistent) information than do abstract words, they receive higher ratings. In this sense, concrete words are more meaningful than abstract words (cf. Balota, Ferraro, & Connor, 1991). The semantic elements comprising these conceptual networks may be of any nature, and some may be related to visual properties of (concrete) concepts (cf. Plaut & Shallice, 1993). Note, however, that this view differs from dual coding theory in the assumption that concrete and abstract words are not represented in (qualitatively) different memory structures (i.e. the image system and the verbal system).

Starting from these ideas, the results of our experiments can be explained as follows. Many studies suggest that word meaning is involved in executing the lexical decision task (see, e.g., Balota et al., 1991), and the activation and utilization of meaning is assumed to benefit performance. If indeed concrete words are generally more meaningful than are abstract words, particularly concrete words may gain an advantage in the activation of meaning. Consequently, when concreteness is confounded with context availability, a concreteness effect should emerge. Indeed, such an effect was observed in lexical decision in the native language, and, though less strongly so, in lexical decision in the second language. As pointed out in the discussion of Experiment 3, a growing body of studies suggest that word meaning is also involved in word translation, and that this conceptual information is used in retrieving the translation response. As discussed earlier, concrete words may share more conceptual elements with their translations than abstract words. Under the assumption that a higher number of shared conceptual elements between languages will facilitate the retrieval of the translation response (de Groot, 1992b; see van Hell & de Groot, 1996, for more details), shorter translation times and fewer errors and omissions should be observed for concrete than for abstract words, as was indeed the case. In the conditions where abstract and concrete words were matched on context availability, differences between abstract and concrete words in terms of the density of information in their conceptual networks were nullified. (In other words, we assume that the present matching manipulation involves a matching on the information density in the underlying representations.) As a consequence, concreteness effects in lexical decision and word translation disappeared.

In conclusion, the experiments reported here show that concreteness effects in lexical decision in the native and in the second language, as well as in forward and in backward translation, disappear (and sometimes even reverse) when concrete and abstract words no longer differ on context availability. This suggests that imagery alone cannot satisfactorily account for the occurrence of concreteness effects in the present study. The results of our experiments imply that it is at least plausible that concreteness effects in the lexical processing of isolated words, as reported in other bilingual studies, are also not simply due to differences in the imageability of the referents of concrete and abstract words. Instead, as has earlier been suggested to be the case for monolingual processing, these effects may be caused by differences in the availability of any associated contextual information.

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APPENDIX

Stimulus Materials of Experiments 1, 2, and 3

Word–D/E	*Conc–D*	*Conc–E*	*Ca–D*	*Ca–E*	*Len–D*	*Len–E*	*Freq–D*	*Freq–E*	*Cog*
Abstract words, matched on context availability									
spijt/regret	1.92	2.96	4.12	3.82	5	6	2.68	3.09	1.00
mening/opinion	2.15	2.69	4.27	4.39	6	7	3.66	3.57	1.40
belofte/promise	2.23	2.96	4.23	4.54	7	7	3.07	3.66	1.56
schandaal/scandal	2.27	3.65	4.35	4.71	9	7	2.60	2.73	5.20
bewijs/proof	2.35	2.85	4.23	3.82	6	5	3.43	3.13	1.20
steun/support	2.38	2.77	4.08	4.18	5	7	3.39	3.99	1.80
wet/law	2.46	3.31	4.42	4.61	3	3	3.90	3.94	1.63
vraag/question	2.58	3.50	4.58	4.46	5	8	4.30	4.24	1.21
leugen/lie	2.56	3.29	4.08	4.87	6	3	3.03	4.03	3.04
gevoel/feeling	2.72	3.64	4.54	4.81	6	7	4.03	3.93	2.76
rente/interest	2.73	2.50	4.69	3.57	5	8	2.62	4.19	1.48
eeuw/century	2.77	3.08	4.65	4.14	4	7	3.99	3.95	1.28
lening/loan	2.85	3.00	5.08	3.86	6	4	2.62	3.16	3.40
taal/language	2.88	3.35	4.38	5.18	4	8	3.82	4.09	1.24
taak/task	3.08	3.68	4.38	4.65	4	4	3.80	3.53	4.84
vloek/curse	3.12	3.35	4.19	3.57	5	5	2.60	2.95	1.16
stank/stench	3.23	2.65	4.88	2.39	5	6	2.82	2.25	3.52
ritme/rhythm	3.46	3.85	4.69	5.11	5	6	2.97	2.98	5.21
vrede/peace	3.64	3.68	5.31	4.94	5	5	3.34	3.54	1.53
geluk/luck	3.69	2.62	4.31	4.64	5	4	3.65	3.26	4.68
Concrete words, matched on context availability									
paar/pair	4.92	5.07	4.23	4.58	4	4	4.32	3.47	5.47
inwoner/inhabitant	5.08	3.61	4.85	4.06	7	10	2.95	2.82	2.36
ijzer/iron	5.50	5.73	3.96	4.54	5	4	2.88	3.51	3.11
land/country	5.56	5.64	4.81	5.00	4	7	4.25	4.36	1.42
koren/corn	5.65	6.08	4.65	4.00	5	4	2.36	3.03	5.21
grond/ground	5.96	6.25	4.38	5.39	5	6	4.17	3.85	5.47
staart/tail	6.00	6.23	4.88	4.54	6	4	3.14	3.24	1.63
plafond/ceiling	6.04	6.35	4.77	4.46	7	7	3.04	3.07	1.21
keel/throat	6.04	6.39	4.77	5.26	4	6	3.42	3.29	1.53
doos/box	6.08	6.38	4.88	4.21	4	3	3.22	3.63	1.37
draad/thread	6.15	3.88	4.19	3.36	5	6	3.09	2.92	3.32
driehoek/triangle	6.23	6.69	4.42	4.50	8	8	2.58	2.68	1.60
mouw/sleeve	6.31	6.00	4.62	3.54	4	6	3.02	2.86	1.16
cirkel/circle	6.31	6.50	4.12	4.64	6	6	3.05	3.50	6.37
kroon/crown	6.36	6.11	4.27	4.90	5	5	3.04	3.09	5.11
touw/rope	6.50	6.58	4.65	4.82	4	4	3.18	3.26	1.58
huid/skin	6.56	6.71	4.35	5.35	4	4	3.56	3.63	1.47
vuist/fist	6.60	6.57	4.73	5.42	5	4	3.20	3.03	4.16
druif/grape	6.68	5.96	4.81	4.10	5	5	3.00	2.60	1.42
laars/boot	6.72	6.39	4.65	5.19	5	4	3.05	3.21	1.08

Word–D/E	*Conc–D*	*Conc–E*	*Ca–D*	*Ca–E*	*Len–D*	*Len–E*	*Freq–D*	*Freq–e*	*Cog*
Abstract words, confounded with context availability									
deugd/virtue	1.31	2.52	2.42	2.89	5	6	2.84	3.17	1.24
noodlot/fate	1.69	1.96	3.15	3.36	7	4	2.71	3.13	1.16
inzicht/insight	1.92	2.42	2.88	2.89	7	7	3.63	2.83	5.40
geval/case	1.96	3.64	2.96	3.84	5	4	4.36	4.29	1.48
indruk/impression	2.12	2.68	3.35	3.90	6	10	3.82	3.38	1.96
reden/reason	2.16	2.79	3.15	4.10	5	6	3.98	4.14	4.08
zonde/sin	2.28	2.93	3.04	3.84	5	3	3.27	3.19	3.12
noodzaak/necessity	2.28	2.43	3.19	3.32	8	9	3.22	3.06	2.36
gunst/favour	2.36	3.07	3.31	4.00	5	6	2.98	3.57	1.21
zwakte/weakness	2.36	2.93	2.62	3.71	6	8	2.46	3.07	1.36
gemak/ease	2.44	2.71	3.50	3.39	5	4	3.26	3.26	1.24
ding/thing	2.65	3.46	2.88	3.29	4	5	4.20	4.68	6.12
grootte/size	3.00	3.42	3.58	4.36	7	4	3.12	3.71	1.12
daad/deed	3.04	3.07	3.65	3.32	4	4	3.39	2.68	5.28
wraak/revenge	3.12	3.50	3.54	4.42	5	7	2.88	2.69	1.24
bod/bid	3.12	2.39	3.46	2.74	3	3	2.58	2.84	4.48
deel/part	3.23	4.62	3.31	3.39	4	4	4.22	4.69	1.64
schepping/creation	3.36	4.32	3.27	4.06	9	8	2.94	3.17	1.24
domein/domain	3.36	4.39	2.85	3.39	6	6	2.80	2.66	6.24
teken/sign	3.68	5.32	3.54	5.03	5	4	3.59	3.88	1.32
Concrete words, confounded with context availability									
verjaardag/birthday	5.15	5.00	5.65	6.36	10	8	2.96	2.92	1.64
winter/winter	5.15	5.77	5.96	6.14	6	6	3.44	3.54	7.00
publiek/public	5.46	4.69	5.85	5.00	7	6	3.52	4.14	5.84
herfst/autumn	5.46	5.38	5.88	5.89	6	6	2.97	3.11	1.08
oorlog/war	5.48	5.75	5.69	6.13	6	3	3.92	4.16	1.26
paus/pope	5.85	6.42	5.92	5.18	4	4	3.05	2.91	3.28
gevangenis/jail	6.00	6.23	6.04	5.68	10	4	3.26	3.15	1.04
bakker/baker	6.12	6.46	6.19	5.71	6	5	2.74	2.80	5.58
slager/butcher	6.15	6.08	5.81	4.75	6	7	2.58	2.55	1.32
sneeuw/snow	6.23	6.19	5.92	6.00	6	4	3.22	3.46	4.89
film/movie	6.28	6.68	6.04	6.39	4	5	3.65	3.30	1.32
vuur/fire	6.35	6.62	6.12	5.82	4	4	3.64	3.92	3.58
paraplu/umbrella	6.50	6.77	6.27	5.96	7	8	2.59	2.72	1.32
boek/book	6.54	6.54	6.08	6.14	4	4	4.21	4.26	6.58
broek/trousers	6.58	6.65	5.77	5.50	5	8	3.42	3.11	1.26
koe/cow	6.62	6.58	6.04	5.61	3	3	3.18	3.22	4.68
paard/horse	6.65	6.77	5.96	5.68	5	5	3.82	3.74	1.26
kaars/candle	6.69	6.81	6.00	5.25	5	6	2.98	2.82	2.52
auto/car	6.62	6.77	6.38	5.79	4	3	3.94	4.14	1.37
boom/tree	6.73	6.46	5.77	5.64	4	4	3.76	3.89	1.26

Note: Conc = concreteness; Ca = context availability; Len = length; Freq = log word frequency; Cog = Cognate status; D = Dutch; E = English.