CONCRETENESS: NOUNS, VERBS, AND HEMISPHERES

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The concreteness effect refers to the preferential processing of concrete over abstract words. This preferential processing has been observed in memory tasks (Clark, 1984), psycholinguistic studies of the structure of the lexicon (Bleasdale, 1987), and in lateralized paradigms investigating hemispheric specialization for language tasks (Day, 1977, 1979). However, its existence remains controversial (Chiarello, 1988; Patterson and Besner, 1984; Zaidel and Schweiger, 1984).

The concreteness effect has most often been explained in terms of the dual coding model (Paivio, 1986). The standard version of this model posits that concrete words are represented both by their semantic properties (the verbal code) and by the stored image of their referent (the imaginal code). Abstract words have no associated image, so that their forms are represented only by their semantic properties (i.e., the verbal code only). Zaidel (1978) has shown that the disconnected right hemisphere (RH) of commissurotomized patients has better access to the meanings of concrete, than of abstract words. This finding accommodates the dual coding model, suggesting that the imaginal code is available to both hemispheres, while the verbal code is subserved only by the left hemisphere (LH), which is specialized for language tasks. In a lateralized study, this hypothesis predicts an attenuation of the normal verbal/linguistic right visual field advantage (RVFA) for concrete nouns. Thus, we expect a statistically significant interaction between visual hemifield of presentation and the word class of the stimulus target. Abstract nouns are expected to result in the normal significant RVFA, while concrete nouns are expected to yield a smaller or no asymmetry of performance between the two visual fields. Zaidel (1986) has termed this kind of interaction the "processing dissociation criterion" for hemispheric independence.

Zaidel (1983, 1986) presents two limit case models of hemispheric functioning in a lateralized linguistic task. The "callosal relay" model posits that only the LH can perform the task, and that the RH functions as a relay station for stimuli presented to the LVF, shuttling them across the corpus callosum to the LH for processing. The "direct access" model posits hemispheric independence, such that each hemisphere processes the stimuli presented directly to it. The callosal relay model assumes that callosal transfer takes time (resulting in

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a RVFA for latency) and creates stimulus degradation (causing a RVFA in accuracy). In the direct access model the RH processor may be both slower and less accurate than the LH processor. If it is both, then it is not possible to distinguish between the models using these dependent measures alone. However, convergent data from other sources may help to disambiguate the results. For example, by testing commissurotomized subjects, we can directly test the abilities of the disconnected RH. If the disconnected RH can perform the task, the direct access model may be supported. If the disconnected RH cannot perform the task, then the ambiguity remains because the normal RH could participate in processing LVF stimuli even though the final decision is still made by the LH.

Additional sources of convergent data are other dissociations between left visual field (LVF) and right visual field (RVF) processing. For example, Chiarello, Nuding and Pollock (1988) used the signal detection measures d′(an index of sensitivity) and beta (an index of response bias) in a series of lateralized naming and lexical decision tasks. They found the expected RVFA with d′, indicating LH specialization of the task. However, they also found a bias to say "nonword" for stimuli in the LVF and either a "yes" bias or unbiased performance for stimuli in the RVF. They interpreted this as possible support for the direct access, or partial direct access, model, with the RH being a conservative lexical decision maker.

In the present experiment we have tried to use these two sources of convergent data to establish whether the RH can selectively process concrete words. First, we presented our stimuli to both normal subjects and four commissurotomized subjects from the California series. Second, we compared responses to words and to nonwords, in an attempt to index response bias. Here, an unbiased subject will make as many false alarms (calling a nonword a word), as misses (calling a word a nonword). If the number of false alarms is greater than the number of misses, the subject is showing a "yes" bias, if the opposite is true, then the subject is showing a "no" bias.

Within the lateralized lexical decision paradigm, the asymmetric concreteness effect has received special attention because it provides a unifying account of some of the data from acquired dyslexia due to LH damage, from commissurotomized patients, and from normal subjects (Coltheart, 1983; Zaidel, 1986; Patterson, Vargha-Khadem and Polkey, 1989). Specifically, it has been argued that some of the identifying symptoms of the syndrome of deep dyslexia (semantic errors in reading aloud, better reading of concrete than abstract nouns, better reading of nouns than of verbs, adjectives and especially function words, and the absence of grapheme-phoneme correspondence rules) reflect the contribution of the RH to reading following certain left cerebral insults. Schweiger, Zaidel, Field and Dobkin (1989) report a case study of deep dyslexia which provides evidence that semantic errors indeed originate predominantly in the RH.

Unfortunately, data on the concreteness effect in lateralized studies with normal subjects are conflicting. Patterson and Besner (1984) review these findings and claim that the only valid conclusion is that RH reading ability is widely distributed in the normal population, making generalizations about the modal RH difficult. However, as pointed out by Zaidel and Schweiger (1984), most of the studies reviewed by Patterson and Besner used response modes that are exclusively specialized in the LH (e.g., naming aloud), so that RH contribution may have been masked. In the present experiment we have attempted to solve this problem by using lexical decision and a manual response with the left hand (which is controlled by the RH), to maximize the chances of seeing RH participation in the task. Lexical decision is sensitive to semantic variables and appears to tap a relatively late stage of word processing, post-lexical access (Humphries and Evett, 1985).

We assume that if a word is "in the lexicon" of a hemisphere, then that hemisphere contains both a representation of the form of the word and (at least part) of its meaning. Here we will investigate the characteristics of lexical decisions of concrete words. One possible account of the concreteness effect has been mentioned above, that these words are usually highly imageable, so that the imaginal code is used in addition to the verbal code. The hypothesis is that the RH has access to the imaginal code which facilitates its lexical decision ability for concrete words.

We derived an alternative account of the concreteness effect from the work of Gardner based on factors contributing to word retrieval in aphasia (Gardner, 1973). We hypothesized that concrete words arouse multiple sensory representations of the objects they denote, and that the RH has access to these multisensory representations, allowing it to process concrete words. This question cannot be examined by looking at nouns, in which imageability and multisensory representation are highly correlated. We therefore decided to study verbs, while using abstract and concrete nouns as a basis for comparison. All verbs have rather low ratings on imageability, but many action verbs have strong kinesthetic associations (throw, shrug), while verbs of mental action (choose) or nonhuman action (melt) do not. If imageability is the key to the concreteness effect, all verbs should pattern like abstract nouns; if, on the other hand, multisensory representations underlie concreteness, then human action verbs should behave like concrete nouns, while other verbs should pattern like abstract nouns.

We used a lexical decision task with four classes of words: concrete and abstract nouns, "action" and "quiet" verbs. We predicted that there would be a smaller RVFA for concrete nouns than for abstract nouns. In addition, if the multisensory interpretation of concreteness is correct, action verbs should also result in a smaller RVFA than quiet verbs. For convenience, this predicted semantic dissociation for verbs will also be called a "concreteness" effect. If the imageability account of concreteness is correct, then all verbs should result in a large RVFA.

The task was designed so that it could be administered in the same way to complete commissurotomy patients and to normal subjects. Convergent findings could help separate RH competence from LH contribution, as responses to left visual field (LVF) stimuli by the commissurotomized patients are produced by the disconnected RH alone.

The prediction here is that the disconnected RH will be able to respond to concrete nouns, and possibly to active verbs, but not to abstract nouns and quiet verbs.

Materials and Method

Design

The subjects performed a lexical decision task on a list of 72 words and 72 nonwords that were presented to either the RVF or the LVF via a slide tachistoscope. The list contained 18 words in each of the following semantic/syntactic categories: concrete nouns (CN), abstract nouns (AN), action verb/nouns (AV), "quiet" or less physical verb/nouns (QV)[1]. The order and visual field in which the words were presented were counterbalanced across subjects; the items were not repeated across visual fields: each word or nonword that appeared in the RVF for half the subjects appeared in the LVF for the other half. In addition, half the subjects saw the list in a forwards order and half in a backwards order.

Subjects

The normal subjects were 21 female and 11 male undergraduate introductory psychology students at UCLA. All were right handed without sinistrality in the immediate family. None of the subjects had either spoken or understood any language except English before the age of six.

Four complete commissurotomy patients from the California series participated in the experiment. The patients varied in age from 36 to 60. All had undergone a one-stage commissural section, including the anterior commissure and the hippocampal commissure, for relief of intractable epilepsy. The operations had been performed by Drs. P.J. Vogel and J.E. Bogen of Los Angeles 22 to 17 years earlier. All of the patients had been tested pre- and postoperatively in R.W. Sperry's Psychobiology Laboratory at the California Institute of Technology. The tests for this experiment were also administered at Caltech. No other patients were available at the time of testing. A summary of the case studies is presented in Table I.

Apparatus

Within each category of word class (CN, AN, AV, QV) the words ranged across frequency levels from approximately 10/million to 200/million, and the levels for individual items were matched across category to the extent possible. The mean frequency of the stimulus words was 42.12 per million (Francis and Kucera, 1982). The nonwords for the lexical decision task were matched with the words for length in letters and phonemes, and also for the distribution of initial and final consonants and vowels. The words and nonwords, together with their frequencies and concreteness ratings, are included in the appendix.

The stimulus letter strings were presented on slides with black lettering on white background and flashed onto a rear projection screen which was placed 33.7 cm from the subject's eyes. The average length of the image was 3.5 cm with the inner edge falling 1 cm either to the right or to the left of the central fixation point. The words subtended between 1.7 and 5.9 degrees of visual angle. Exposure time of the stimuli was determined by a Gerbrands Digital Integrated Circuit Millisecond Timer model 300-6T, which was controlled by a Gerbrands Tachistoscope Logic unit model G1159. The subjects responded by pressing a key which stopped a Gerbrands digital millisecond clock, model G1270.

Procedure

The normal subjects were seated with their chin in a chin rest that kept their eyes at a constant distance from the screen. They were instructed to push a response key if the stim-

[1] One would prefer to conduct the study with words which are unambiguously verbs (e.g., "think") rather than words which are both nouns and verbs (e.g., "drink"), but in English this is not possible; there are not enough 4-6 letter words in the appropriate frequency range (over 10/million) which are unambiguously verbs. Indeed, the 18 verb/nouns that we used in the two semantic categories nearly exhaust the possibilities for a frequency-matched pair of lists; in contrast, finding appropriate category-unambiguous frequency-matched nouns was fairly easy.

TABLE I

Summary of Case Histories

Patient	Sex	Reason for Surgery	Surgery	Age at surgery	Year post-op at testing (1983)	Age at onset of symptoms	IQ history: preop	IQ history: postop
N.G.	F	Intractable epilepsy	Complete cerebral commissurotomy: Single-stage midline section of anterior commissure, corpus callosum (and presumably psalterium), massa intermedia and right fornix. Surgical approach by retraction of the right hemisphere	30	20	18	Wechsler-Bellevue 76 (79,74) at age 30	WAIS 77 (83,71) at age 35
L.B.	M	Intractable epilepsy	As above, but massa intermedia was not visualized	13	18	3:6	WISC 113 (119, 108) at age 13	WAIS 106 (110, 100) at age 16
R.Y.	M	Intractable epilepsy	As above. (Normal cerebral development until age 13)	43	17	17		WAIS 90 (99, 79) at age 45
A.A.	M	Intractable epilepsy	As above. Difficult operation	14	18	5:6		WAIS 78 (77, 82) at age 17:8

ulus was an English word, and to make no response if the string was not a word. The subjects were told that concentrating on the central fixation point increases accuracy. Fixation was monitored by the experimenter. All of the subjects responded with their left index finger. A trial sequence proceeded as follows: the experimenter would warn the subject that a trial was about to start by saying "ready", monitor fixation, and, if the subject was fixating, press a bar which exposed the stimulus for 80 ms. After the subject had responded, or 2000 ms had passed, the next trial was initiated. Subjects received 32 practice trials on which they were given feedback after each response. The subjects received no feedback on the 144 experimental trials that followed.

For the commissurotomized subjects the procedure was the same as that used with the normal subjects with three exceptions. First, the commissurotomized patients were instructed to respond on each trial with the hand homolateral to the stimulated visual hemifield. Throughout the experiment, the patient's two index fingers rested on two response buttons located at midline and placed side by side. Second, the patients received longer and more extensive training than the normal subjects. Third, the stimuli were exposed for longer periods of time in the two hemifields during the test. The exposure times were chosen for each patient in an attempt to ensure adequate perception. For N.G. and L.B. stimuli were exposed for 100 ms; for A.A. and R.Y. stimuli were exposed for 150 ms.

Results

Normal Subjects

An analysis of variance for unequal groups was performed on the accuracy scores. Sex of subject was a between-group factor, and word class and visual field of presentation were within-group factors. The analysis of variance revealed the expected RVFA ($F = 56.9$; d.f. = 1, 30; $p < .01$). There was also a significant main effect of word class, with concrete nouns being responded to significantly more accurately than other words ($F = 20.9$; d.f. = 3, 28; $p < .01$). No other effects or interactions were significant[2]. The mean accuracies for each word class in the two visual fields are shown in Table II.

Subsequent planned comparisons showed that all of the classes of words resulted in a significant RVFA ($p < .005$). There was a concreteness effect for nouns in both visual fields, but not for verbs. This pattern is illustrated in Figure 1.

TABLE II

Mean Accuracy (% error) of Responses to Each Word Class as a Function of Visual Field (Numbers in parentheses are standard deviations)

	Concrete nouns	Abstract nouns	Active verbs	Quiet verbs
LVF	18.1 (10.9)	30.1 (15.5)	29.6 (16.4)	29.02 (14.0)
RVF	5.3 (6.34)	18.3 (11.2)	13.9 (11.4)	17.5 (14.3)

[2] A separate ANOVA with percentage hits - percentage false alarms as a dependent variable revealed an identical pattern of results to that obtained with percentage hits alone. There was a main effect of visual field ($F = 22.77$; d.f. = 1, 30; $p < .001$; RVF = 63.3, LVF = 49.4), a main effect of word class ($V = 20.5$; d.f. = 3, 28; $p < .001$; AV = 54.4, QV = 53.1, CN = 65.3, AN = 52.7), and a concreteness effect for nouns ($F = 38.4$; d.f. = 1, 30; $p < .001$) but not for verbs ($p > .5$). There was no effect of sex of subject, nor did sex interact with any variable. Finally, there was also no interaction of visual field and word class ($p > .5$).

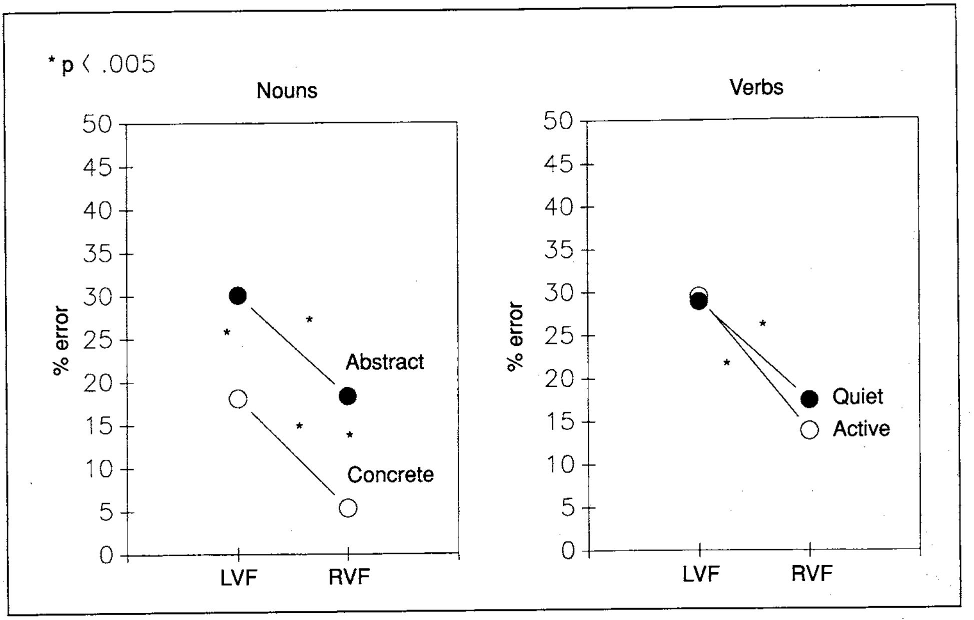

Fig. 1 - *The effect of visual field of presentation on the concreteness effect for verbs and for nouns (* = significant effect with alpha = .005).*

Response Bias

An analysis of variance was performed on the types of errors made in each visual field. Sex was a between-group factor, and visual field and error type (misses or false alarms) were within-group factors. The analysis revealed a significant sex by visual field by error type interaction (F = 5.542; d.f. = 1, 30; p < .05).

Subsequent planned comparisons revealed that the visual field × error type interaction was highly significant for males (F = 21.46; d.f. = 1, 30; p < .001) and weaker for females (F = 5.69; d.f. = 1, 30; p < .022). These patterns are illustrated in Figure 2. For females, in both visual fields, the difference between false alarms and misses is not significant (in the LVF: 24.95% misses vs. 23.79% false alarms, p < .5; in the RVF: 14.1% misses vs. 20.3% false alarms; F = 3.76; d.f. = 1, 30; p < .059). Males made significantly more misses than false alarms in the LVF (31.97% misses vs. 20.56% false alarms, F = 7.73; d.f. = 1, 30; p < .01) and somewhat more false alarms than misses in the RVF (15.3% misses vs. 23.73% false alarms, F = 3.64; d.f. = 1, 30; p = .063). Thus, both sexes show a trend for a "yes" bias in the RVF, and males show a "no" bias in the LVF.

Commissurotomized Subjects

Table III presents the performance results of the commissurotomized subjects. Four findings can be seen in these data. The first is that the disconnected

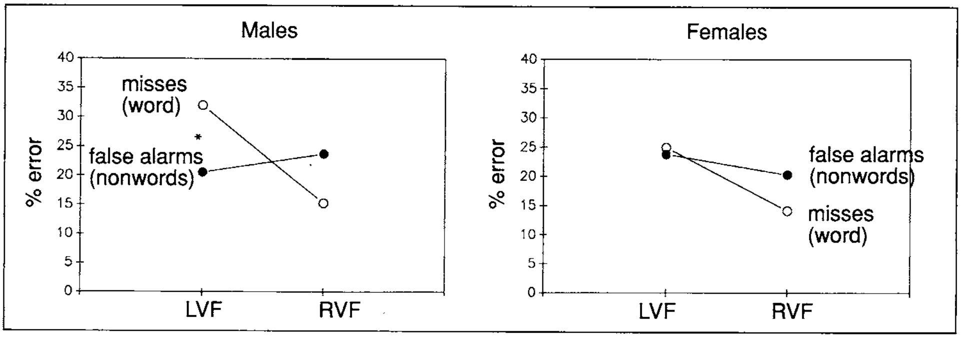

Fig. 2 – *The three way interaction between sex of subject, visual field of presentation and type of error. Males are showing a significant difference between errors with words and with nonwords in the LVF.*

LH of 3 of the 4 subjects responded with better than chance performance only to concrete nouns (with L.B. responding accurately also to quiet verbs). The second is that the disconnected RH of 2 of the 4 subjects responded accurately only to concrete nouns. The third finding is that none of the subjects evinced a concreteness effect for verbs with either hemisphere. The fourth finding has to do with response bias. It can be seen that averaged over the 4 subjects, the RH made more misses than false alarm (38 vs. 24.5), suggesting a bias to say "no". The disconnected LH made the same number of misses as false alarms (25.2 vs. 25.7), suggesting an unbiased response mode. However, individually the subjects vary widely in the direction and magnitude of bias. Chi-square tests of independence revealed a relationship between type of error and hemisphere for L.B. (with unbiased responses in the RH and a "no" bias in the LH) and N.G. (with a "no" bias in the RH and a "yes" bias in the LH). A.A. shows a general bias to say "yes" in both hemispheres, while R.Y. shows a general bias to say "no" in both hemispheres.

TABLE III

Number of Errors (out of 18) by Word Class, VF, Error Type, and Patient

	RH						LH					
Patient	CN	AN	AV	QV	total misses	false alarms	CN	AN	AV	QV	total misses	false alarms
A.A.	4*	8	6	9	27	39	6	8	8	7	29	40
R.Y.	8	11	13	12	44	13	3*	10	9	11	33	18
L.B.	1*	9	8	8	26	28	2*	5	6	2*	15	4
N.G.	14	12	15	14	55	18	2*	6	8	8	24	41
Mean	6.7	10	10.5	8.5	38	24.5	3.2*	7.2	7.7	7	25.2	25.7

* Hit rate is significantly better than chance (normal approximation, alpha = .05).
CN concrete nouns; AN abstract nouns; AV active verbs; QV quiet verbs.

Discussion

The hypothesis that there would be an analogue of the concreteness effect for verbs was not supported. As shown in Figure 1, both types of verbs resulted in a significant RVFA. Neither the normal subjects nor the commissurotomized subjects evinced preferential processing of active over quiet verbs (see Table III).

Both groups of subjects showed preferential processing of concrete over abstract nouns in both visual fields. This finding may support Bleasdale's (1987) conception of separate or separable organization for concrete and abstract words in the lexicon. The responses of the commissurotomized subjects support the hypothesis that the RH has a limited lexicon with more concrete than abstract words. Our data suggest that the concreteness effect exists in the lexical access process of both hemispheres for nouns.

In the normal data we did not find the first type of processing dissociation for nouns (Zaidel, 1986), that is, there was no interaction between noun type and visual field of presentation. However, the analysis of error types (misses and false alarms) revealed a dissociation between the response biases of males and females. For males, in accordance with the report by Chiarello et al. (1988), we found a significant "no" bias in the LVF and a trend towards a "yes" bias in the RVF. Females' responses in the LVF were unbiased (they did not make more errors on word stimuli than on nonword stimuli), and their responses in the RVF also show a trend towards a "yes" bias. It can be seen in Figure 2 that the error rate for nonwords (false alarms) does not differ between the sexes and between the visual field. However, for words, males make more errors in the LVF than females.

This finding constitutes a processing dissociation between responses to words and to nonwords in the two visual fields. Other studies in our lab (Measso and Zaidel, 1990; Kaiser and Zaidel, 1990) have also found this interaction. One possible interpretation of these findings is based on the direct access model. If the RH is processing all of the stimuli presented to the LVF, and it has a smaller lexicon than the LH, many words which are not represented in the lexicon would be categorized as nonwords, resulting in more misses than false alarms. That is, the RH is a conservative lexical decision maker because it does not have many of the stimuli in its lexicon. An alternative explanation is based on the callosal relay model, and posits that the LH uses a more conservative criterion when processing stimuli that were presented to the LVF because it is using callosally transmitted data which may be somewhat degraded. Both of these interpretations are preliminary, as the theoretical aspects of responses to words and nonwords in the lexical decision task have not been well defined. Further research on the processing components in the lexical decision task is needed.

To summarize, we were not able to verify the multisensory interpretation of concreteness by generalizing it to verbs. Neither the normal nor the commissurotomized subjects evinced a concreteness effect for active over "quiet" verbs. Therefore, our data lend support to an "imageability" rather than a "multisensory" interpretation of the basis of the concreteness effect.

Our data do show a concreteness effect for nouns in both visual fields. In addition, we found a processing dissociation between the type of stimulus (word or nonword) and visual field of presentation as a function of the types of errors made. This pattern was different for males and females. There are two implications of this interaction. The first points to the importance of unpacking the lexical decision process in a way that not only accounts for correct identifications of words, but also for correct rejections of nonwords. Our data suggest that these effects depend on the visual field of presentation. The second implication has to do with sex differences in laterality studies. Our data suggest that these differences may lie in response biases, rather than capability to perform the tasks. Since response biases are generally taken to occur post-lexically and to reflect strategic processes, we suggest that the intermittent sex differences reported in the literature are dependent on whether or not the task is sensitive to strategic control in general, and to bias in particular.

Abstract

The preferential processing of concrete versus abstract nouns, and of active versus static or "quiet" verbs, was investigated using a lateralized lexical decision task in 32 normal and 4 commissurotomized subjects. Both groups of subjects showed the concreteness effect for nouns in both visual fields. The disconnected right hemisphere of two commissurotomized subjects responded with above chance performance only to concrete nouns. Neither group showed an activeness effect for verbs in either visual field. This supports an imageability rather than a multisensory representation interpretation of the concreteness effect. A comparison of responses to words and to nonwords revealed that males had a "no" bias to stimuli in the left visual field, and both males and females showed a slight "yes" bias for stimuli in the right visual field. These data suggest that the lexical decision task is complex and that word and noword decisions constitute partly independent functional components. We interpret the sex differences as an indication of strategic rather than functional differences in lateralization patterns between males and females.

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Appendix

Stimuli for the Experiment

The 72 real-word stimuli for this experiment are listed in their four semantic/syntactic groups, along with the Francis and Kucera (1982) part-of-speech frequency (summed over inflected forms) and with Toglia and Battig (1978) concreteness and imagery ratings when available. Francis and Kucera frequency is from actual count in approximately one million words in print. Toglia and Battig ratings are on a scale from 1 to 7.

	Frequency			Concreteness	Imageability
Body/action	Total	As verb	As noun		
1. smile	178	122	56	5.19	5.96
2. throw	157	150	7	4.11	4.80
3. toss	46	41	5		
4. kick	47	34	13		
5. grab	44	37	7		
6. crawl	41	37	4	4.04	4.82
7. sigh	39	28	11		
8. thrust	34	23	11		
9. crouch	24	22	2		
10. wink	22	18	4	5.11	4.95
11. shrug	22	18	4		
12. frown	22	22	0	4.50	5.83
13. slap	18	17	1	5.07	5.36
14. shove	16	16	0		
15. chew	16	16	0	4.38	5.21
16. lick	14	14	0		
17. sniff	10	10	0		
18. wince	5	5	0		

Less physically defined verbs

	Frequency			Concreteness	Imageability
	Total	As verb	As noun		
19. wish	195	161	34	2.66	4.16
20. sell	129	121	8	3.38	4.05
21. pause	57	40	17	3.00	3.34
22. quote	50	48	2		
23. blame	43	32	11		
24. rent	37	25	12	4.13	4.24
25. shine	35	32	3		
26. gaze	28	21	7		
27. fold	28	20	8		
28. weave	23	20	3		
29. pose	22	20	2		
30. scan	20	17	3		
31. soak	18	18	0		
32. bake	16	16	0		
33. blush	13	12	1	4.59	5.59
34. thaw	11	8	3	3.40	4.07
35. spoil	11	10	1		
36. slant	11	8	3		

Concrete nouns
(x in "frequency as verb" column indicates that usage as verb appears to be ungrammatical

	Frequency			Concreteness	Imageability
	Total	As verb	As noun		
37. earth	167	x	167	5.77	5.61
38. tooth	123	x	123	6.15	6.18
39. milk	51	2	49	6.66	6.32
40. cloth	43	x	43	5.76	5.41
41. bread	41	0	41	6.18	6.38
42. fist	40	1	39		
43. leaf	34	1	33	5.89	6.02
44. shirt	29	x	29	6.05	6.12
45. sheep	24	x	24	6.18	6.09
46. bell	23	0	23	6.16	6.04
47. pill	23	0	23	6.06	5.74
48. cream	20	1	19	6.17	5.51
49. glove	18	2	16	6.14	5.89
50. stove	17	0	17	5.75	5.91
51. silk	13	x	13	5.34	5.04
52. wool	10	x	10		
53. cheese	9	x	9	6.14	5.56
54. wolf	9	0	9	5.91	6.04

Abstract nouns
(x in "frequency as verb" column indicates that usage as verb appears to be ungrammatical)

	Frequency			Concreteness	Imageability
	Total	As verb	As noun		
55. chance	156	4	152	2.71	3.98
56. choice	121	x	121		
57. pride	48	3	45	3.04	4.05
58. mood	45	x	45		
59. proof	40	0	40	3.51	3.78
60. scheme	42	3	39	3.09	3.15
61. guilt	33	x	33	2.95	3.75
62. noon	25	x	25		
63. clue	25	0	25	3.76	3.69
64. chore	23	0	23		
65. wealth	22	x	22	3.66	4.94
66. zone	20	6	14	3.88	4.56
67. width	19	x	19		
68. fame	19	0	19		
69. bulk	15	2	13		
70. plea	14	x	14	3.04	3.41
71. oath	10	x	10		
72. zeal	8	x	8	3.00	3.41

Non-words for the lexical decision task were matched with the words for length in number of letters and phonemes, and also for the distribution of initial and final consonant(s) and vowels; this was accomplished as far as possible by "grafting" the onset of one word in the above list with the rhyme of another word containing the same vowel; the non-words created were also required (1) to not have any common homophone, and (2) to differ orthographically from some fairly common real word only by the change of one or two internal letters. Each non-word is listed with the two real words of which it is a hybrid, or an approximation.

1. blan	bulk, scan	37. prine	pride, shine
2. blick	blame, lick	38. pulk	pause, bulk
3. blove	blush, glove	39. quoan	quote, zone
4. bool	bell, wool	40. rell	rent, sell
5. borth	bake, earth	41. scheal	scheme, zeal
6. brent	bread, rent	42. scown	scan, frown
7. chawl	chance, crawl	43. sealth	sell, wealth
8. cheed	chore, bread	44. shaze	sheep, gaze
9. chell	cheese, bell	45. shide	shine, pride
10. choil	choice, spoil	46. shilf	shirt, wolf
11. choof	chew, proof	47. shrab	shrug, grab
12. clort	cloth, shirt	48. shug	shove, shrug
13. clow	clue, throw	49. sidth	silk, width
14. crame	crouch, blame	50. sile	sigh, smile
15. crea	cream, plea	51. slance	slap, chance
16. croth	crawl, cloth	52. slove	slant, shove
17. earch	earth, crouch	53. snight	(smile), sigh
18. feap	fame, sheep	54. snue	sniff, clue
19. fince	fist, wince	55. sove	soak, stove
20. fote	fold, quote	56. spoice	spoil, choice
21. fraw	frown, thaw	57. stoath	stove, oath
22. gake	gaze, bake	58. tause	toss, pause
23. glush	glove, blush	59. thore	thaw, chore
24. grap	grab, slap	60. thrick	thrust, kick
25. guist	guilt, fist	61. throak	throw, soak
26. kilk	kick, milk	62. tood	tooth, mood
27. lish	lick, wish	63. waim	wince, fame
28. luss	leaf, toss	64. weaf	wealth, leaf
29. mant	milk, slant	65. weff	wink, sniff
30. mooth	mood, tooth	66. weme	weave, scheme
31. neave	noon, weave	67. wilk	width, silk
32. oase	oath, pose	68. woil	wish, pill
33. plew	plea, chew	69. wolt	wolf, guilt
34. pold	pose, fold	70. woon	wool, noon
35. ponk	pill, wink	71. zeam	zeal, cream
36. preese	proof, cheese	72. zost	zest, thrust