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Some psychological attributes of potential computer command names

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Abstract. One of the major difficulties that users may experience when interacting with computer systems is remembering the system functions that relate to particular command names. This paper considers the problem by evaluating various semantic attributes of a set of verbs in relation to the underlying psychological processes involved in a naming task.

An initial investigation carried out to obtain imagery and concrete–abstractness ratings for the verbs (most of which were also existing computer commands) showed not only a wide range of ratings for attributes of the stimuli, but also that the majority of 'command' verbs were rated as being highly abstract and low in imagery. A second experiment investigated the factors of imagery and word frequency as a function of the ease with which 'command' verbs were elicited from an appropriate verbal description. The results demonstrated a complex interaction, in so far as low frequency, high imagery verbs were elicited more easily than those which have high frequency and low imagery attributes.

The findings of these two investigation were discussed in relation to the ways in which imagery associations for verbs may influence user performance in memory tasks involving computer systems.

1. Introduction

One of the difficulties which novice users of computer systems often complain about is an initial difficulty in learning and subsequently remembering command names (see, for example, Long *et al.* 1983). The vocabulary selected for them is frequently described as being unfamiliar jargon, confusing, and lacking in meaningfulness. Furthermore, having learned a command set users often experience difficulty in remembering which command names relate to which system functions and *vice versa.*

Recently a number of investigations have attempted to evaluate aspects of human–computer dialogue that are related to these problems. These investigations have included studies which have looked at the relationship between attributes of computer command name sets and such performance features as the learning and recall of computer oriented words (Scapin 1981), the suggestiveness of command names (Rosenberg 1982), and characteristics of the relationships between command names within a set such as congruence and hierarchy (Carroll 1980). The extent to which computer command languages should resemble the terminology and structure of natural languages has also been considered a major area of concern (Treu 1975). In particular, studies have evaluated the use of natural English words (Ledgard *et al.* 1981), the memorability of user generated commands (Scapin 1982, Landauer *et al.* 1983) and designer's naming behaviour of command names (Jorgensen *et al.* 1983). Findings from these studies, however, have been varied and, at times, inconsistent. For instance, whilst Scapin (1982) found that user-generated commands were easier to

recall than language imposed, when learning a text-editing task Landauer *et al.* (1983) showed that there was no significant difference in user's preference for names generated by the two methods.

One of the problems that exists in this research area is an inadequate knowledge of the underlying psychological processes involved in the mapping between command names and their functions. Central to this is the fundamental issue of establishing which are the most salient command name variables in relation to their ease of learning and remembering. Although characteristics such as naturalness, suggestiveness and congruence are variables which are operationally definable and have been shown to influence user's performance, their formal properties are difficult to elucidate.

There is a need, therefore, for a more systematic approach in which the evaluation of such command name variables is considered in relation to the underlying psychological processes involved in users' behaviour. Furthermore, the scientific knowledge and theoretical models which have been developed in the field of psycholinguistics and cognitive psychology ought, wherever possible, to be applied. One study which has taken this approach was carried out by Barnard *et al.* (1982) who investigated how task and vocabulary differences affect initial learning and subsequent memory for commands used in a simple editing task. In their study they looked at the effects of semantically general terms (i.e. those which cover a whole range of potential actions and operations, e.g. ADD) and specific terms (i.e. those which refer to the precise nature of a movement or change, e.g. INSERT) used for command names. They found that when users were required to learn the general commands they used a 'help' facility, provided by the system, more often than when required to learn the specific commands. Furthermore, they found that memory for the meanings of command names was more accurate with the specific terms than with the general terms. This study is important to the present discussion in so far as the hypotheses were based on empirical research of memory tasks. The results, for example, can be compared with a study such as that by Thios (1975) who has demonstrated that cued recall for sentences containing specific verbs (e.g. 'scratch') was better than cued recall for equivalent sentences containing general verbs (e.g. 'injure').

The finding that different learning strategies are adopted depending on the type of word is also consistent with current theories on how the meanings of words are learned. For example, Johnson-Laird (1983) has proposed that there are at least two different ways in which words and their meanings can be learned. This depends on whether they are definable (such as intentional verbs (e.g. 'search') or indefinable (such as primary verbs, e.g. 'move') (Johnson-Laird and Quinn 1976, Miller and Johnson-Laird 1976).

Word imagery is another semantic attribute which does not appear to have been considered in human–computer dialogue but which has been suggested in the memory literature as playing an important role in the mental representation of word meaning and memorability. In his seminal work on verbal processing and imagery, Paivio (1971) found that words with high imagery values showed a generally superior performance in a wide assortment of memory tasks over those with low imagery values. He also showed that imagery is highly related to linguistic abstract–concreteness and that, likewise, recognition and recall of concrete words were greater than for abstract words. More recently, concrete concepts have been found to be more easily attained than abstract concepts (Katz and Paivio 1975, Katz and Denny 1977). In an extensive unit-analysis of verbal behaviour Rubin (1980) demonstrated that out of 51 properties of a set of words, imagery was one of the main factors which emerged as being important in verbal processing. Furthermore, it had a drastic effect on what words were able to be recalled.

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1. Introduction

One of the difficulties which novice users of computer systems often complain about is an initial difficulty in learning and subsequently remembering command names (see, for example, Long *et al.* 1983). The vocabulary selected for them is frequently described as being unfamiliar jargon, confusing, and lacking in meaningfulness. Furthermore, having learned a command set users often experience difficulty in remembering which command names relate to which system functions and *vice versa.*

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An obvious implication from these findings for human–computer dialogue is that a cause of problems both of learning and remembering command names may be related to the abstract–concreteness of the words selected for the name sets. Most could be considered as being abstract in the sense that they do not refer to concrete objects but are verbs that denote actions. This suggests, therefore, that it may be difficult for them to evoke functional mental images that are readily generated by more concrete words. Nevertheless, it may be that within a domain of more abstract words, there are some which are able to evoke images by means of association. Paivio (1971) in his research on imagery mnemonics has suggested that the mental representation of an abstract concept is executed by a process of 'concretisation', whereby a link is made to a concrete situation or object by means of associative chaining. For example the word 'religion' commonly evokes a concrete image of a church as an associative reaction. Moreover, he suggests the directness of the link could be a result of idiosyncratic associative frequency in experience. The word 'liberty', for example, may immediately evoke an image of the Statue of Liberty. This suggests, therefore, that although abstract terms do not directly correspond to objects, some of them may have a strong enough association with an image for that image to act as a memory aid. The implication from this, therefore, is that because of their imagery associations, certain command names may have a richer mental representation than others and so may prove to be functional in memory tasks.

How command names are internally represented in terms of imagery and linguistic concrete–abstractness is unknown. As yet, there appear to be no published data for these attributes for the equivalent verbs. An initial aim of this investigation, therefore, was to obtain ratings of these variables for a set of verbs of which the majority are computer command names. With such data it should then be possible to consider their effect on the relationship between the normal meaning of a command word and its meaning in interactive computer dialogue. Additionally, the variables of word frequency, familiarity and meaningfulness were also considered since these, too, have been shown to be important in verbal behaviour (Rubin 1980).

This paper will report two studies. The first was designed to produce a data-base of a set of verbs with the associated rating values for the attributes suggested above. The rating technique was based on that used by Paivio *et al.* (1968). Most of the words were selected from a range of existing command name sets but, in addition, an arbitrary selection of other verbs which might be considered as suitable for the development of future systems was included. It was decided also to include some other verbs which had definite concrete associations e.g. 'kick', 'cuddle', and 'swim' to provide a more balanced range of stimuli. On the basis of Paivio's theory it was hypothesized that the attributes of imagery and concrete–abstractness would be highly correlated since both should be defining the same underlying dimension of the word.

Having established a data-base the second experiment was designed to produce a measure of the ease with which people can derive words from an appropriate semantic description. It also investigated the effects of word frequency and imagery. The task used was based on the Object and Function Questionnaire used by Barnard *et al.* (1982). They suggest that this type of task is particularly relevant to the similar problem of mapping the meaning of a command operation onto a required name.

The types of command names which were investigated were systematically selected for word frequency and imagery. It was hypothesized that high-imagery and high-frequency names would be more easily elicited than low-imagery and low-frequency names.

2. Experiments

2.1. *The establishment of a normative data-base of a set of verbs and their semantic correlates*

As discussed above, the aim of this experiment was to obtain ratings of the variables of concrete–abstractness, imagery, familiarity and understanding for a set of 150 verbs, most of which were also computer command names.

Method

Subjects

The subjects were 64 unpaid, first-year undergraduates studying psychology at University College of Swansea. There were 46 females and 18 males, whose ages ranged between 18 and 22.

Materials

Stimuli. Initially a set of 150 verbs were chosen from a number of sources. These included reference guides for computer commands which were written for high level languages, and for statistical and word processing packages. In addition a number of words were taken from Thorndyke and Lorge's (1944) book of word frequencies. This followed a semi-random procedure with the restriction that the words selected covered a distribution of several frequency ranges and had concrete associations.

Each word was typed twice in upper-case letters at both ends of an A5 sheet of paper. Two of the four rating scales were them printed beneath the words.

Rating scales. Four different rating scales were used to evaluate the set of words. These were 'concrete–abstractness' (high concrete–high abstract), 'imagery' (high imagery–low imagery), 'familiarity' (very familiar–not familiar) and 'understanding' (good understanding–not good understanding).

For each set of words, two scales were used, providing four conditions:

Condition A	Imagery and understanding
Condition B	Imagery and familiarity
Condition C	Concrete–abstractness and understanding
Condition D	Concrete–abstractness and familiarity

Seven-point rating scales were used for all four scales. In addition to having the labels at either end of the scales the positioning of the scales was also alternated so that for each condition there were eight different combinations. For example, for Condition A the imagery scales were presented on four occasions above the 'understanding' scale and for the other four occasions beneath it. Thus 32 different types of rating scales were used for each word. The words and scales were assembled into booklets so that their order was completely randomized for each booklet.

At the beginning of each booklet a definition of a verb was presented which emphasized either the attribute of imagery or concrete–abstractness. Following this was a set of instructions which explained the purpose of the experiment. The wording of the instructions differed according to the type of rating scales presented.

Procedure

The booklets were randomly distributed to two groups of 32 subjects. No additional verbal instructions were given other than to tell the subjects not to think too long about each word and not to refer to words which they had previously rated. No

time limit was set and subjects were told to work at their own pace. The average time taken to complete the task was about 25 minutes.

Results

Three of the words used had to be discarded as a result of missing data. The remaining 147 words are presented in alphabetical order in the Appendix, together with the medians and the interquartile range of the imagery (I), concrete–abstractness (C), familiarity (F) and understanding (U) ratings.

The range of I ratings (1, high imagery; 7, low imagery) for the median scores was 1·14–6·66. A similar range of 1·20–6·12 was found for the C ratings (1, highly concrete; 7, highly abstract). The frequency distributions of the two attributes were both found to be negatively skewed, but exhibiting different patterns. As shown in figure 1 the modal I ratings lie in the range of 1–2 ($n=56$), whereas most C ratings are in the ranges of 2–3 ($n=59$) and 3–4 ($n=42$).

The correlation between I and C attributes for all words, however, was to be very high ($\rho=0{\cdot}80$, $P<0{\cdot}001$), which would seem to suggest that the two parameters are, in fact, defining the same dimension of word meaning. Figure 2 presents a scattergram for these two variables, illustrating the nature of this relationship.

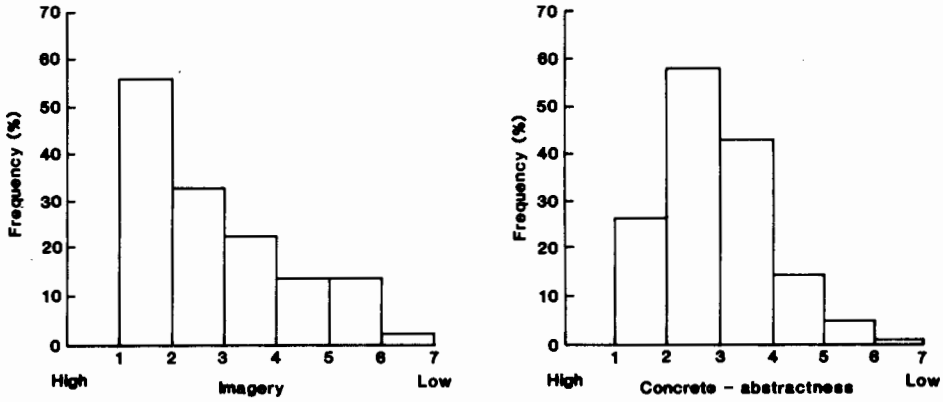

Figure 1. Frequency distributions for imagery and concrete–abstractness ratings.

The frequency distributions for the two other parameters (familiarity and understanding) were found to be extremely negatively skewed, with the majority of ratings for both being in the range 1–2. The full range for U was between 1·13 and 4·10, with 96 per cent of the words falling in the 1–2 range. For the F scale the range was found to be larger (1·05–6·0) but still with 80 per cent of the ratings falling in the 1–2 range. A smaller, but still significant, correlation was found between the two parameters ($\rho=0{\cdot}58$, $P<0{\cdot}001$).

The correlations between understanding and concrete–abstractness ($\rho=0{\cdot}52$) and imagery ($\rho=0{\cdot}48$), however, were found to be lower than those for familiarty with concrete–abstractness ($\rho=0{\cdot}63$) and imagery ($\rho=0{\cdot}61$), respectively. This would seem to suggest that familiarity is a more relevant attribute.

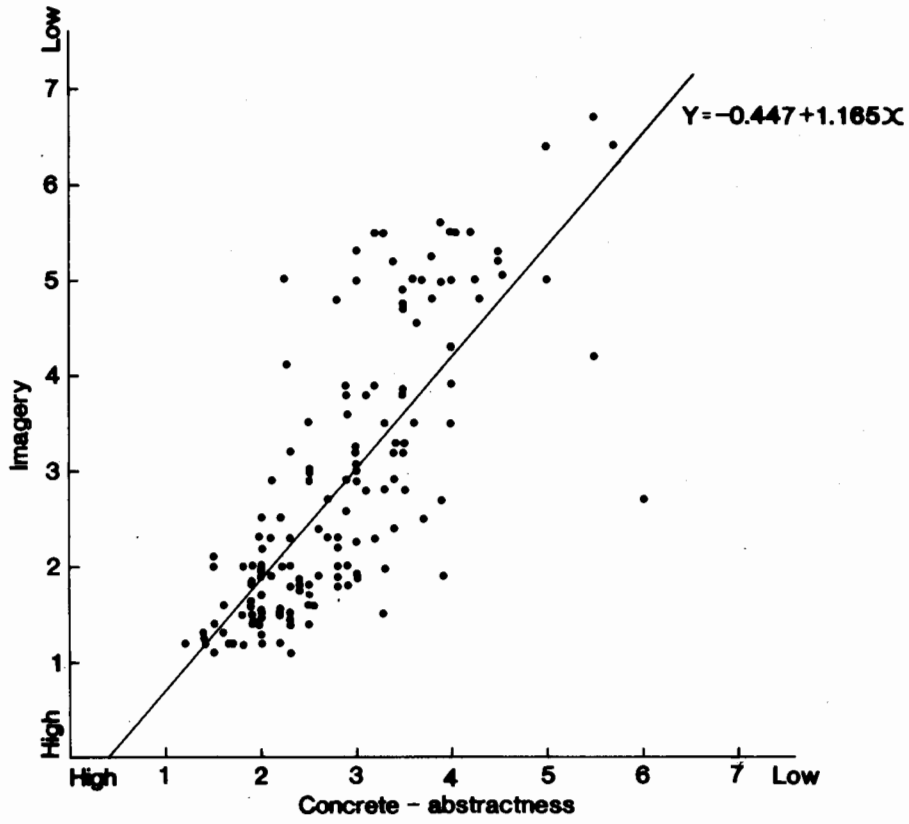

Figure 2. The relationship between ratings of imagery and concrete–abstractness. (Points represent median ratings.

Discussion

The wide range of ratings obtained for the imagery and concrete–abstractness scales indicate that, for a set of verbs, there are some which can be classified as highly concrete and associated with high imagery, whilst there are others which are classified as highly abstract and associated with low imagery. The implications of these observations suggest that systematic normative rating data of the attributes of imagery and concrete–abstractness can be produced for a set of verbs. The results for the understanding and familiarity scales, on the other hand, were biased in that the majority of ratings were at the extreme end of the 'good understanding' and the 'highly familiar' scales, respectively.

An interesting finding which emerged from the data was that high abstract, low imagery ratings were given for the majority of existing computer-related command names that has been included in the data-base. In particular, the words ASSIGN, EVALUATE, APPEND and QUIT were given the lowest ratings for I and C. They were also, incidentally, associated with low U and F values. On the other hand, the few commands which were in the higher end of the range for I and C, such as RUN, WRITE, BREAK, and OPEN were given relatively high F and U values. This observation would seem to suggest that, although the F and U scales, were considered inadequate, there may be an interaction between these variables which is influencing the linguistic representation of the stimulus words.

The validity of I and C as two measures that define a common dimension of word meaning, in terms of the word's associations with concrete objects and events, may be evaluated by examining the correlations between I and C and also between F and I and C, respectively. Since all the correlations were found to be highly significant this would seem to suggest that there is a general unifying dimension and that further research in this area may use either measure. However, the results also show that there is a group of verbs which, although highly correlated, exhibit contrasting frequency patterns. Interestingly, these words, which have different I and C ratings, are also rated as being highly abstract or having low imagery. Of the 35 stimuli where there was a difference of greater than 1 between the values of I and C, twenty-three were computer command names such as ADD, ASSIGN, COPY, DELETE and REPEAT. Furthermore, the nature of the relationship for most of these was such that the C ratings were higher than the I ratings. This would seem to suggest that such abstract verbs are unable to arouse sensory images although they were not considered as being totally abstract. On the other hand, verbs which were given high ratings for C and I could also be considered as having strong sensory connotations and refer directly to bodily experiences, e.g. CUDDLE, KISS, WINK, LAUGH, SWIM, EAT and WALK. For this group of verbs, therefore, it appears that, as well as having the common property of being associated with sensory experience (they are also likely to have affective connotations), they are implicitly associated with specific objects (especially parts of the body) and the physical actions they perform. Another group of verbs which were given ratings in the 1–2 range of I but had lower C ratings appear also to be associated with physical bodily actions, e.g. PLAY, FIGHT and DRAW but not necessarily with specific actions. This could possibly explain why these words have relatively high I ratings but lower C ratings.

It is interesting to note, too, that a number of the verbs which have high C and I ratings are intransitive, i.e. they do not have objects when used in verb phrases, for example, 'she laughs'. Verbs with low C and I ratings, however, are nearly all transitive, that is, they require objects in verb phrases (e.g. she compiles the book). This seems to suggest, therefore, that the mental representation of intransitive verbs may be associated with a more explicit meaning. For transitive verbs, the meaning of the verb will depend on the object specified in the verb phrase. Thus such verbs may have a more general mental representation, that is dependent on the context in which they are used. It could be proposed, therefore, that the way verbs are semantically structured in sentences may also be related to their ability to evoke images.

This initial inspection of the data would seem to suggest that a verb's linguistic concrete–abstractness and imagery associations may have functional properties for verbal behaviour and memory tasks. The aim of the next experiment, therefore, was to evaluate whether a set of words which had been given high and low imagery ratings differed significantly in the ease with which they could be elicited from an appropriate verbal description. The variable of word frequency was also investigated, and it was hypothesized that the words which had high frequency and imagery ratings would be elicited more easily.

2.2. *To explore the effects of imagery and word frequency in a task involving the mapping of verb actions and their referents*

Procedure and method

The experimental task was designed as a questionnaire and consisted of a sequence of 32 definitions from which target verbs had to be derived. For example the definition,

'to make discontinuous, to disconnect by cutting' requires the word 'to break'. 'To ascertain amount of, to assess' was the definition given to the verb 'to evaluate'. The target verbs selected from the data-base derived in Experiment 2.1 were categorized so that eight words were used in each of the following conditions:

(1) High frequency and high imagery.
(2) Low frequency and high imagery.
(3) High frequency and low imagery.
(4) Low frequency and low imagery.

The criteria for these categories were that high imagery words were classified as having a median rating of $\leqslant 2{\cdot}5$ (1-high imagery and 7-low imagery) and low imagery words as having a median rating of $\geqslant 4{\cdot}5$. Word frequencies were taken from Thorndyke and Lorge's (1944) word book. Low and high-frequency words were classified as having a frequency less than 50 and greater than 100 occurrences per million printed words, respectively. For each target word a definition with two semantic descriptions having equivalent meanings were taken from the Concise Oxford Dictionary. The order of presentation of the definitions was completely randomized.

The instructions given at the beginning of the questionnaire were as follows:

> Below is a set of definitions for a group of verbs. What we want you to do is to write down the verb which you think each definition is referring to.

The definition, 'to restore to sound condition, to repair' with its target 'to mend' was provided as an example.

The questionnaire was given to 10 subjects who were not told of the nature of the target words but simply that they were verbs. No time constraint was given but subjects were asked not to spend too much time on each definition and also not to refer back to previous answers.

Results

The data were initially analysed quantitatively using a 'strict' and a 'lenient' scoring method. For the former the number of subjects giving the exact target word for each definition was scored. For the lenient scoring method, words which were considered as having a very similar meaning to the target word were also scored as being correct. Table 1 presents the number of target words obtained for the two types of scoring for the 10 subjects.

A two-way analysis of variance (ANOVA) performed on the 'strict scoring' data revealed a large main effect of word frequency ($F = 44{\cdot}04$, $P < 0{\cdot}001$). This effect was also found for the 'lenient scoring' data but was not as great ($F = 10{\cdot}62$, $P < 0{\cdot}001$). The ANOVA summary tables for these are presented below in tables 2(*a*) and 2(*b*). Although no main effect was found for imagery, an interaction between word frequency and imagery was revealed for both 'strict scoring' ($F = 11{\cdot}01$, $P < 0{\cdot}001$) and 'lenient scoring' ($F = 69{\cdot}33$, $P < 0{\cdot}001$).

The complex nature of the interaction is illustrated in figure 3, which shows profiles of the mean total correct scores as a function of imagery and word frequency, for both methods of scoring the data. From the profiles it can be seen that the number of target words correctly derived was higher for high-frequency words, but that more correct high-frequency–low-imagery words were elicited than high-frequency–high-imagery words. These results suggest, therefore, a rather complex interaction: high-frequency words are modified by imagery whilst the effect of imagery on low-frequency words is

Table 1. Correct number of target words derived from definitions.

Set	Target word	Rating I (med)	Frequency	Scoring ($N = 10$ subjects) Strict	Lenient
High I	BREAK	1·82	>100	2	2
and	OPEN	2·00	>100	4	4
high F	WRITE	1·44	>100	4	4
	CLOSE	2·50	>100	10	10
	READ	2·33	>100	1	5
	STOP	2·33	>100	9	9
	CALL	2·40	>100	7	7
	RUN	1·20	>100	0	1
High I	POKE	2·30	12	0	7
and	DEMOLISH	1·44	3	6	8
low F	SKIP	2·19	17	1	8
	FREEZE	1·83	32	1	6
	PUNCH	1·55	17	0	8
	CHOP	1·70	29	3	3
	CHASE	1·64	48	5	7
	SCRIBBLE	1·64	3	7	9
Low I	END	5·50	>100	3	8
and	GET	5·17	>100	6	6
high F	REPORT	5·25	>100	4	8
	BEGIN	5·00	>100	8	10
	REMOVE	5·00	>100	10	10
	RETURN	5·00	>100	10	10
	INCREASE	5·00	>100	5	7
	START	4·83	>100	9	9
Low I	QUIT	5·64	49	0	4
and	APPEND	6·66	1	1	4
low F	ASSIGN	6·38	24	1	6
	EVALUATE	6·39	1	2	3
	COMPILE	5·50	5	3	4
	SUBSTITUTE	5·00	29	0	7
	SCAN	5·00	8	4	4
	TRANSFER	5·17	28	3	4

minimal. Furthermore, as figure 3 (*b*) illustrates, this modifying effect of imagery on high-frequency words is contrary to expectations since low-imagery, rather than high-imagery, words were derived more easily.

Figure 3 also demonstrates that the two types of scoring also produced different effects. Whereas the lenient scoring increased the number of correct words scored for both low imagery conditions, it had a differential effect on the high-imagery conditions. Instead, more high-imagery–low-frequency words were scored as correct, whereas very little change resulted for the interaction of high imagery and high frequency. The implications from these findings, therefore, seem to suggest that the relationship between these two variables is very complex.

The data were also analysed with respect to the between-subjects agreement on the same names. Very similar patterns of effect were obtained as found with the within-

Table 2. Analysis of variance of verbs correctly derived for imagery (I) and frequency (F).

Source	SS	d.f.	MS	F
(*a*) *Using 'strict' scoring data*				
(1) *Within subjects*				
Imagery (I)	2·5	1	2·5	1·41
Frequency (F)	78·4	1	78·4	44·29**
I × F	19·6	1	19·6	11·07**
Subjects	31	9	3·44	
Residual	48	27	1·77	
(2) *Between subjects*				
Imagery (I)	33·5	1	33·5	2·77
Frequency (F)	94·5	1	94·5	7·81**
I × F	22·8	1	22·8	1·88
Error	339·0	28	12·1	
(*b*) *Using 'lenient' scoring data*				
(1) *Within subjects*				
Imagery (I)	0·9	1	0·9	1·18
Frequency (F)	8·1	1	8·1	10·66**
I × F	52·9	1	52·9	69·60**
Subjects	61·4	9	6·81	
Residual	20·6	27	0·76	
(2) *Between subjects*				
Imagery (I)	1·1	1	1·1	0·26
Frequency (F)	10·1	1	10·1	2·30
I × F	66·1	1	66·1	14·99**
Error	123·5	28	4·4	

** $P < 0.001$.

subject analysis (see figure 3). Some slight differences were observed, however. Whereas an interaction was found for the within-subjects' 'strict' scoring data, it was not found to be significant for the between-subjects' data (see table 2). Similarly, word frequency which was found to be significant for the between-subjects' data did not reach significance in the within-subjects 'lenient' scoring data.

Taken together, these results seem to suggest, therefore, that the complex interaction between word frequency and imagery is consistent for both an individual's response and intersubject agreement for the same verbs.

To assess the qualitative nature of these results, a frequency matrix of the alternative words was constructed as in table 3. In total 130 other words were produced: 20 for the high imagery–high frequency set, 42 for the high imagery–low frequency set, 21 for the low imagery–high frequency set and 47 for the low imagery–low frequency set. It can be seen that the conditions which produced the greatest variability of different words were the two which included low frequency word sets.

Most of the other words given can be considered as close, if not equivalent, alternatives for the particular semantic descriptions. Furthermore, several definitions occurred in which a large number of appropriate alternatives were given. These findings seem to suggest, therefore, that some of the target words have a number of synonyms, which can be equally associated with the definition provided.

Table 3. Matrix of alternative words given for definitions.

Set	Target word	Alternative words given
High I and high F	BREAK	HALT, SPLIT, SEPARATE, SNIP, CHOP, RUPTURE, TEAR
	OPEN	ADMIT
	WRITE	STRESS, SYLLABISE
	CLOSE,	—
	READ	COMPREHEND(4), ASCERTAIN, EXPLAIN
	STOP	—
	CALL	DEMAND
	RUN	GO, LIVE, FORWARD
High I and low F	POKE	PRESSURE, BUTT, SHOVE(4), SHUNT, BARGE
	DEMOLISH	CRUSH, DISMANTLE
	SKIP	HOP(5), FLIT(2), RUSH
	FREEZE	STOP(2), HALT(3), STABILIZE, HOLD
	PUNCH	PUNCTURE(5), DRILL, PRICK, PERFORATE
	CHOP	PUNCH, SMASH, JAB, HIT
	CHASE	FOLLOW(2), PERSEVERE, ATTEMPT
	SCRIBBLE	SCRAWL
Low I and high F	END	COMPLETE(4), ACHIEVE, REACH, TERMINATE
	GET	RECEIVE, ACQUIRE
	REPORT	RECOUNT, RELATE(3), INFORM
	BEGIN	INITIATE(2)
	REMOVE	—
	RETURN	—
	INCREASE	MULTIPLY(2), ENLARGE(2)
	START	INITIATE
Low I and low F	QUIT	GIVE UP, DISSASSOCIATE, LEAVE(3), FORGET, CAST OUT, DIVEST
	APPEND	SUPPLEMENT, APPROPRIATE, INCREASE(2), CONNECT, SUM, INCLUDE
	ASSIGN	IMPLY, INDICATE(2), MENTION(2), DEFINE, DELINEATE
	EVALUATE	WEIGH, ESTIMATE, SIZE, CALCULATE, JUDGE
	COMPILE	FORM(2), COMPOSE, GATHER, COLLATE
	SUBSTITUTE	REPLACE(4), SWAP(3)
	SCAN	INSPECT, OVERLOOK, SKIM(2), PERUSE
	TRANSFER	EXCHANGE, SURRENDER, PASS

The number in brackets refers to the frequency of occurrence. If no number is given, the word occurred once.

The relative contributions of the two factors to the task of mapping a description to a name, obviously needs further clarification. The general pattern which has emerged from the data, however, suggests that it is profitable to consider that both verbal and imaginal processing are involved in this task, although the extent of the role of imagery is difficult to ascertain. As found in this experiment, it can produce quite unexpected results. The large word-frequency effect, on the other hand, suggests that verbal processing may take precedence in this task. In particular, it could be speculated that frequency may play a more significant role in the mental representation of a verb, depending on the strength of its imagery association.

The finding that fewer high-imagery relative to low-imagery words were correctly elicited, however, would appear to be inconsistent with previous research on memory

Appendix

Listed below, in alphabetical order, are the 147 verbs with each word's median (M) and interquartile range (IQ) for the imagery, concrete–abstractness, understanding and familiarity attributes. Also shown are Thorndyke and Lorge's frequencies of the number of times each word appears per million words.

	Imagery		Concrete		Understand		Familiar		
Verb	M	IQ	M	IQ	M	IQ	M	IQ	Freq.
ADD	4·64	4·07	3·64	3·65	1·44	1·31	1·34	1·08	>100
AIM	3·90	4·29	4·00	3·00	1·50	1·28	1·31	1·47	50–100
ALTER	5·00	3·97	3·63	2·94	1·41	1·43	1·83	1·33	26
APPEND	6·66	1·08	5·50	3·27	4·10	3·80	6·00	2·76	1
ASSIGN	6·38	1·72	5·00	2·83	1·95	2·38	2·94	2·50	24
BAKE	2·50	2·96	2·20	1·65	1·57	1·37	1·67	1·29	50–100
BANG	1·77	1·21	2·75	1·29	1·31	1·29	1·43	1·62	14
BEGIN	5·00	4·19	5·00	4·18	1·32	1·44	1·32	1·12	>100
BEND	2·07	2·16	2·83	2·40	1·30	1·13	1·44	1·73	48
BLAST	2·25	2·09	3·17	3·92	1·67	1·04	2·00	2·21	31
BOIL	1·50	1·50	2·21	2·03	1·23	0·97	1·26	1·12	50–100
BREAK	1·82	1·39	2·50	2·11	1·30	1·17	1·47	1·33	>100
BURN	1·77	1·38	2·25	1·78	1·32	1·20	1·34	1·21	>100
CALL	2·40	2·30	2·70	2·19	1·34	1·29	1·23	0·97	>100
CARVE	1·83	2·06	1·90	1·83	1·39	1·56	1·81	1·25	26
CHANGE	4·27	2·60	4·00	2·25	1·83	1·93	1·44	1·17	>100
CHASE	1·64	1·72	2·50	2·00	1·21	1·05	1·44	1·31	48
CHOP	1·70	1·43	2·10	2·20	1·68	1·34	1·30	1·40	29
CLEAR	3·50	3·67	4·13	3·40	1·44	1·78	1·50	1·23	>100
CLOSE	2·50	3·61	3·67	2·50	1·44	1·70	1·34	1·29	>100
CODE	5·33	2·71	4·50	3·12	1·44	2·03	2·17	2·20	21
COMPILE	5·50	2·00	4·00	2·83	2·14	2·05	2·71	2·16	5
COOK	1·90	1·73	2·10	1·87	1·34	1·03	1·20	0·85	>100
COPY	4·06	2·67	2·25	2·52	1·30	1·04	1·79	1·86	50–100
COUNT	3·81	2·87	3·50	2·83	1·26	1·05	1·41	1·11	>100
CREATE	4·30	3·67	5·50	3·70	1·44	1·67	1·77	1·36	50–100
CRY	1·20	0·79	2·20	2·11	1·20	0·82	1·23	1·04	>100
CUDDLE	1·14	0·62	1·50	1·90	1·14	0·64	1·12	0·61	5
CUT	2·00	2·13	2·07	1·78	1·22	0·97	1·50	1·79	>100
DECORATE	2·00	2·00	2·88	3·43	1·39	1·76	1·55	1·79	17
DELETE	5·25	3·88	3·83	3·00	1·83	1·78	2·00	2·33	—
DEMOLISH	1·44	1·17	3·25	2·69	1·32	1·12	1·93	2·38	3
DIG	1·81	1·85	1·89	2·41	1·41	1·32	1·47	1·43	43
DINE	2·00	2·83	1·90	2·43	1·39	1·56	1·64	1·76	50–100
DONATE	3·80	3·77	3·10	3·02	1·39	1·31	1·95	1·68	2
DRAW	1·83	2·23	2·41	2·78	1·30	1·27	1·24	1·20	>100
DUPLICATE	3·93	3·12	3·17	3·32	1·44	1·25	2·13	1·98	8
EAT	1·23	0·97	1·20	0·79	1·14	0·64	1·05	0·55	>100
EDIT	5·50	2·71	3·33	3·93	1·63	2·09	2·79	2·50	7
EMBRACE	1·50	1·23	2·08	2·11	1·30	1·10	1·39	1·42	34
END	5·50	3·56	4·21	3·37	1·22	0·97	1·39	1·31	>100
ERASE	2·83	3·37	3·06	2·17	1·30	1·27	1·61	1·47	2
ESCAPE	2·93	2·68	2·88	3·20	1·30	1·10	2·17	2·45	>100
EVALUATE	6·39	1·35	5·73	3·55	1·95	1·60	2·35	1·90	1
EXCHANGE	5·07	3·30	4·50	3·90	1·83	1·67	2·17	2·45	50–100
EXECUTE	3·25	3·27	3·00	4·06	1·83	1·33	2·10	1·77	20
EXPAND	3·50	2·85	3·62	3·39	1·47	1·33	1·72	1·68	15

	Imagery		Concrete		Understand		Familiar		
Verb	M	IQ	M	IQ	M	IQ	M	IQ	Freq.
FETCH	3·14	2·42	3·00	2·50	1·44	1·23	1·44	1·41	32
FIGHT	1·39	1·42	2·30	2·00	1·34	1·14	1·44	1·31	>100
FILE	3·83	3·50	3·50	2·20	1·63	1·64	1·50	1·83	43
FINISH	3·50	3·94	3·33	2·87	1·20	0·90	1·32	1·30	>100
FIRE	1·14	0·64	2·25	2·67	1·20	0·82	1·38	1·48	>100
FRACTURE	3·21	2·93	2·30	1·94	1·44	1·17	2·00	2·13	7
FREEZE	1·83	1·88	2·39	2·33	1·30	1·40	1·34	1·58	32
FRY	1·44	2·03	2·00	1·77	1·34	1·08	1·34	1·29	11
GET	5·17	3·25	4·50	2·56	1·70	1·43	1·34	1·20	>100
GIVE	3·17	3·42	3·50	3·62	1·30	1·27	1·34	1·21	>100
GLOW	1·94	2·33	3·86	2·00	1·50	1·88	1·80	1·52	50–100
GRAZE	2·36	3·45	2·64	2·37	1·50	1·75	1·70	2·47	16
GROWL	2·50	3·31	2·67	2·71	1·60	1·31	2·13	2·72	23
HELP	2·75	3·94	3·28	2·75	1·20	0·82	1·32	1·12	>100
HIT	1·59	1·28	1·61	1·47	1·30	1·27	1·26	1·05	50–100
INCREASE	5·00	3·80	4·17	3·63	1·30	1·80	1·50	1·39	>100
INSERT	4·70	3·20	2·83	2·62	1·44	1·23	1·88	1·98	14
JAB	1·94	1·93	3·00	3·25	1·90	2·33	2·17	2·20	2
JOG	1·39	1·31	1·86	1·07	1·34	1·08	1·26	1·00	4
KICK	1·34	1·03	1·59	1·29	1·23	0·93	1·20	0·90	47
KISS	1·17	0·67	1·44	2·20	1·19	0·79	1·09	0·59	>100
KNIT	2·17	2·58	1·50	1·39	1·34	1·21	1·30	1·17	30
LABEL	3·17	2·87	3·06	2·07	1·44	1·23	1·67	2·22	7
LAUGH	1·18	0·79	1·64	2·47	1·12	0·63	1·14	0·64	>100
LIST	3·50	3·85	2·50	2·94	1·44	1·16	1·39	1·42	50–100
LOAD	2·90	3·52	3·36	2·76	1·50	2·30	1·75	1·42	50–100
LOCK	1·94	1·93	2·10	2·00	1·26	1·05	1·58	1·16	1
LOOK	3·21	3·78	2·50	3·00	1·39	1·31	1·23	0·97	>100
MAIL	2·88	1·97	2·17	3·20	1·47	1·18	1·44	1·41	50–100
MELT	2·29	2·00	2·75	2·27	1·34	1·14	1·63	1·22	50–100
MEND	3·19	2·88	3·40	2·39	1·71	1·10	1·45	1·31	26
MIX	2·64	3·37	2·93	2·63	1·50	1·50	1·44	1·41	50–100
MOVE	3·79	3·50	2·93	2·27	1·26	1·22	1·50	1·50	>100
OPEN	2·00	2·21	2·30	2·50	1·34	1·08	1·23	0·93	>100
OVERTAKE	1·86	2·05	2·64	1·80	1·32	1·09	1·41	1·32	>100
PEEP	2·28	1·97	2·95	2·37	1·68	1·34	1·79	1·93	27
PERISH	4·90	4·21	3·50	3·54	2·10	1·80	2·25	1·92	32
PLAY	1·44	1·78	2·32	1·90	1·26	1·22	1·23	0·93	>100
PLOT	4·67	4·35	3·50	3·27	1·77	1·38	1·95	1·61	36
POKE	2·30	2·25	1·96	1·20	1·32	1·20	1·75	1·72	12
POP	2·35	2·26	3·44	2·67	2·05	2·52	1·94	1·74	21
POUR	1·36	1·45	2·50	2·89	1·38	1·42	1·34	1·21	50–100
PULL	2·14	2·18	1·50	2·00	1·23	0·89	1·24	1·01	>100
PUNCH	1·55	1·23	1·85	1·66	1·46	1·25	1·36	1·45	17
PUSH	2·50	2·61	2·00	1·49	1·58	1·22	1·34	1·58	50–100
QUIT	5·64	3·70	3·93	2·80	1·34	1·08	2·67	2·25	49
READ	2·33	2·67	2·13	2·27	1·22	0·97	1·12	0·61	>100
REMOVE	5·00	3·17	2·50	2·56	1·30	1·27	1·61	1·47	>100
REPEAT	5·50	3·40	3·20	3·06	1·30	1·10	1·63	1·22	50–100
REPLACE	4·70	3·27	3·50	3·00	1·39	1·73	1·75	2·10	28
REPORT	5·25	3·04	3·00	3·32	1·67	1·97	1·73	1·29	>100
RESTORE	4·80	3·60	4·33	2·60	1·92	2·25	2·10	2·20	49
RETURN	5·00	3·67	3·17	2·12	1·20	0·85	1·59	1·29	>100

	Imagery		Concrete		Understand		Familiar		
Verb	M	IQ	M	IQ	M	IQ	M	IQ	Freq.
RIDE	1·86	1·18	1·77	1·65	1·20	0·98	1·31	1·35	>100
ROAST	1·75	1·93	2·38	2·11	1·50	1·23	1·63	1·61	31
ROLL	2·21	2·44	2·25	2·19	1·44	1·33	1·32	1·44	>100
RUN	1·20	0·85	1·73	1·23	1·14	0·62	1·14	0·64	>100
SAVE	3·30	3·90	3·50	3·58	1·39	1·31	1·39	1·56	>100
SCAN	5·00	3·42	3·94	2·17	2·17	2·33	2·36	2·87	8
SCRATCH	1·47	1·56	2·00	1·28	1·39	1·16	1·32	1·19	30
SCRIBBLE	1·64	1·76	2·50	3·20	1·23	1·04	1·65	1·20	3
SEARCH	3·33	3·32	3·40	2·20	1·26	1·05	1·75	1·45	50–100
SELECT	5·00	3·43	3·70	3·12	1·61	1·47	1·64	1·67	50–100
SELL	3·28	2·50	3·13	2·60	1·30	1·10	1·60	1·37	>100
SEW	1·88	2·38	1·93	2·88	1·30	1·10	1·39	1·42	34
SHIFT	5·50	2·90	4·08	3·20	1·46	1·41	2·13	1·89	35
SHOOT	1·39	1·42	1·88	1·77	1·30	1·27	1·44	1·70	50–100
SHOUT	1·61	1·46	1·92	1·60	1·23	0·86	1·20	0·82	>100
SIMMER	2·17	2·03	2·79	2·60	1·63	1·80	1·50	1·50	4
SING	1·50	1·90	1·94	1·76	1·34	1·03	1·17	0·67	>100
SKIP	2·19	1·88	2·19	1·72	1·50	1·70	1·69	1·66	17
SLEEP	1·28	1·26	2·11	2·12	1·15	0·64	1·15	0·65	>100
SPEED	2·75	2·61	3·50	3·44	1·39	1·31	1·70	1·97	50–100
SPIN	1·72	1·68	2·50	2·70	1·50	1·23	1·44	1·53	24
SPLIT	2·93	2·50	3·05	2·10	1·44	1·53	1·92	1·44	26
SPREAD	1·95	1·86	3·30	2·83	1·63	1·67	1·41	1·23	>100
SQUEAK	1·94	2·33	2·79	3·00	1·63	1·67	1·85	1·98	11
START	4·83	3·62	3·75	4·00	1·39	1·42	1·23	1·31	>100
STEP	2·88	3·44	2·50	2·20	1·50	1·75	1·50	1·39	>100
STIR	1·94	2·08	2·17	2·03	1·60	1·37	1·30	1·17	50–100
STOP	2·33	2·94	2·29	3·03	1·17	0·72	1·26	1·05	>100
STORE	3·94	2·32	2·94	2·32	1·50	1·50	1·50	1·93	>100
SUBSTITUTE	5·00	2·61	4·25	3·33	1·50	1·39	2·06	2·47	29
SUCK	1·86	2·33	2·04	1·80	1·30	1·17	1·50	1·50	15
SWEAR	3·55	2·14	2·93	2·73	1·36	1·23	1·50	1·23	21
SWIM	1·20	0·82	1·44	1·34	1·12	0·62	1·14	0·64	50–100
SWITCH	3·17	3·86	3·36	2·17	1·44	1·73	1·94	1·93	15
TALK	1·39	1·42	1·88	1·88	1·29	1·19	1·09	0·59	>100
TEAR	1·64	1·67	2·28	1·62	1·80	1·71	1·23	1·14	>100
TOUCH	1·50	1·09	1·75	2·47	1·44	1·17	1·17	0·67	>100
TRANSFER	5·17	2·86	3·41	2·82	1·80	1·72	1·90	2·33	28
TREAD	3·00	2·22	2·50	2·40	1·60	1·37	2·00	1·84	26
VIEW	2·70	2·37	3·88	2·80	1·44	1·31	1·50	1·39	>100
WALK	1·34	1·41	1·36	1·45	1·15	0·64	1·17	0·67	>100
WINK	1·17	0·70	1·82	1·43	1·18	0·76	1·50	1·50	20
WHISPER	1·50	2·10	2·17	1·83	1·44	1·31	1·26	0·99	50–100
WHISTLE	1·83	1·87	1·86	1·20	1·59	1·29	1·23	1·04	50–100
WRITE	1·44	2·03	1·50	2·00	1·20	0·78	1·20	0·79	>100
YAWN	1·20	0·96	2·06	2·07	1·22	0·97	1·23	1·04	15
ZAP	2·70	4·44	6·13	2·20	2·80	4·20	3·90	3·25	—

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