EFFECT OF GRAMMATICAL CATEGORIES AND SEMANTIC RELATEDNESS ON IMMEDIATE WORD PAIRS RECALL

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ABSTRACT

Huttenlocher and Lui (1979) found that semantic relatedness affected the short-term memory for both concrete nouns and verbs but the effect for nouns was stronger than the one for verbs, suggesting that there is an organizational difference between these two word categories. The present study expanded this line of research, investigating the effect of semantic relatedness on recall in combination with nouns and verbs not only as separate categories but also as interacting mental constructs. 25 university students were presented with lists of semantically related and unrelated verb-verb, noun-noun and verb-noun pairs and were asked to remember and later recall as many of the pairs as possible. The results confirmed the hypothesis that nouns are recalled better than verbs and that semantic relatedness facilitates memory, but they were inconsistent with the prediction that semantic relatedness affects more noun pairs than verb pairs. The main effects of word category and semantic relatedness were significant but there was no significant interaction between these two variables. Organizational theories of nouns and verbs as well as other theories of the verb/noun distinctions were considered as possible explanations of the results.

INTRODUCTION

Many studies have suggested that the grammatical class of words is an important dimension of lexical organization. The major grammatical categories are nouns, verbs, adjectives, adverbs and prepositions. Words from different categories not only convey different meanings but they also carry other distinctive characteristics such as "strength of imagery, distribution and frequency of occurrence" (Sommers, 1998, p. 187). Verbs and nouns are two categories, which have been extensively investigated in connection to these characteristics.

Evidence has been found that there is a neuroanatomical distinction between the processing of nouns and verbs (Daniele, Giustolisi, Silveri, Colosimo, et al., 1994). These findings suggest that the temporal lobe of the left hemisphere of the brain might be significantly involved with the processing of nouns while the frontal lobe of this hemisphere might play a crucial role in the processing of verbs.

Furthermore, a particularly strong distinction is made between the mental organization of concrete nouns and verbs. These organizational patterns are reflected in people's memory for semantically related nouns and semantically related verbs versus semantically unrelated nouns and verbs.

Huttenlocher and Lui (1979) tested this proposition and found that semantic relatedness affected the short-term memory for both concrete nouns and verbs but the effect for nouns was stronger than the one for verbs, suggesting that there is an organizational difference between these two word categories. The relation of this difference to age was also investigated. Both adults and children showed the same patterns of results - semantic relatedness affected the recall of nouns more than the recall of verbs.

One theory explains these findings with the distinctive lexical organization of verbs and nouns: nouns are hierarchically organized in domains whereas verbs have a matrix-like organization (Huttenlocher & Lui, 1979). The main difference between these two types of organization is the strength of association between the words in the structure. Nouns, being in multilevel hierarchies, are very closely related to each other because the meaning, denoted by a noun in one level of a hierarchy, is carried by nouns on lower levels of the same hierarchy. On the other hand, verbs denote actions or states and often require objects. Thus, the relation among verbs is much more loose than the one among nouns, and verbs are much more closely related to their objects than they are to other verbs.

The present experiment was designed to extend this line of research, addressing new aspects of the noun-verb organizational differences. Focusing beyond the major categorical distinction between nouns and verbs, this study investigated the relations between specific subcategories of nouns and verbs, that is action verbs and concrete nouns. The subcategory of action verbs has particular properties which tie it closely with the subcategory of concrete nouns, namely the fact that most action verbs require objects. This requirement forces a tight association between a verb and a noun. The strength of this association was to be tested against the one between noun and noun, and verb and verb.

If the strength of association between two words is reflected in the short-term memory for this pair of words, and if most verbs require objects, then people should be more likely to recall verb-noun (V-N) pairs rather than noun-noun (N-N) and verb-verb (V-V) pairs, regardless of the

presence or absence of semantic relatedness. Furthermore, if the organization of nouns exhibits more structural coherence than the one of verbs, then N-N pairs should be recalled better than V-V pairs when there is semantic relatedness between words, but this effect should not be so strong in the absence of semantic relatedness.

Semantic relatedness between two nouns, two verbs or a verb and a noun was operationally defined in two ways: first, as synonymy, and second, as complementation. Two verbs/nouns are semantically related if they are synonyms of each other, for example *murder-kill*. Furthermore, two nouns or a noun and a verb are semantically related if the noun is a pragmatically and meaningfully appropriate complement to the verb or to another noun, for example *drive-car* or *mother-father*.

In summary, this study looked at the effect of word categories and semantic relatedness on short-term memory.

METHOD

SUBJECTS

The subjects of this experiment were 25 students enrolled in a second-year research methods psychology course. While participants were informed that this was a memory study investigating short-term memory of pairs of words, they were not given any information regarding the specific variables being manipulated or the hypothesis being tested.

MATERIALS

Six different lists of word pairs were used. Half of these lists consisted of semantically related word pairs, whereas the other half consisted of semantically unrelated word pairs. Three different combinations of the noun and verb categories were investigated: Noun-Noun (N-N), Verb-Verb (V-V), and Verb-Noun (V-N). Therefore, there were semantically related N-N, V-V and V-N lists as well as semantically unrelated N-N, V-V and V-N lists.

The words, which were concrete nouns (operationally defined as nouns that depict entities or objects) and action verbs (i.e. verbs that denote actions), were taken from two lists of frequently occurring English nouns and verbs. These lists were conveniently called Alphabetical

Lists of Concrete Nouns and Action Verbs of High Frequency and are included in Appendix B. They were compiled using four different sources: <u>The use of words in context: The vocabulary of college students</u> (Black, Stratton, Nichols, & Chavez, 1985), <u>Word frequencies of spoken American English</u> (Dahl, 1979), <u>Word frequency book</u> (Carroll, Davies, & Richman, 1971), and a list of high-frequency high-concreteness nouns provided by Dr. B. Whittlesea.

Thirty nouns (randomly divided into three groups of ten) were randomly chosen from the alphabetical list of concrete nouns and thirty verbs (again three groups of ten) were randomly chosen from the alphabetical list of action verbs. The ten words from one of the noun groups were matched with ten other nouns from the alphabetical list of concrete nouns so that they formed the semantically related N-N list. The words from this same noun group were randomly combined with the words from one of the other two noun groups to form the semantically unrelated N-N list. Similarly, the ten words from one of the verb groups were matched with ten other verbs from the alphabetical list of action verbs so that they formed the semantically related V-V list. And this same verb group was randomly combined with one of the other two verb groups to form the semantically unrelated V-V list. Finally, the remaining verb and noun groups were used to form the semantically unrelated V-N list, and the verbs of this list were matched with ten other nouns from the alphabetical list of concrete nouns so that they formed the semantically related V-N list. These six lists are also included in Appendix B.

PROCEDURE

The subjects were tested in two small groups (one of 15 and one of 10 participants) in an open psychology laboratory. A mixed factorial design with combined assignment was used. Semantic relatedness was the independent groups variable and participants were randomly assigned to the two levels of this variable: present or absent. Grammatical categories in word pairs was the repeated measures variable and participants were treated with all levels of this variable: V-V, N-N, and V-N word pairs. Complete counterbalancing for the three levels of this variable was used to avoid order effects. Within each independent group, there were six different orders of the same three levels of the grammatical categories variable.

Participants were given 3 printed lists of 10 word pairs and asked to remember as many of these pairs as possible, without considering their order. They had one minute to memorize each list. After every memorization period, there was a minute-and-a-half free-recall period when participants had to write down the word pairs they remembered. After a 1-minute rest period the same procedure was repeated with the next list.

Participants were instructed about their task (i.e. memorization of word pairs) and the time periods described above. They were also told that the order of the pairs does not make a difference and single words will not be counted, but only correct pairs of words.

The number of correctly recalled word pairs was measured. Minor spelling errors were ignored and pairs, in which the position of the words was switched, were also accepted.

RESULTS

The recall scores of individual subjects are shown in Appendix A. Average scores for the V-N, N-N and V-V word-pair lists, for all subjects and for the two groups (one treated with semantically related (SR) and the other one treated with semantically unrelated (nSR) pairs) separately, are shown in Table 1. These average scores are also shown on Figure 1, where the effect of the two independent variables (grammatical categories and semantic relatedness) on the dependent variable (word pair recall score) is shown graphically. The data was further analyzed using ANOVA test for repeated measures. The results are shown in Table 4.

From Table 1 it will be seen that on average subjects recalled much better V-N and N-N pairs than V-V pairs, regardless of the presence or absence of semantic relatedness. A repeated measures analysis of variance showed this difference to be significant, $F = 12.681$, $p = 0.002$.

Furthermore, it is clear from Table 1 and Figure 1 that on average subjects recalled much better word pairs, which were semantically related, than ones, which were not. This pattern applies for all word categories: V-N, N-N and V-V. ANOVA shows also this difference to be significant, $F = 29.393$, $p < 0.001$.

Finally, as visible on Figure 1, the effect of semantic relatedness on the recall of the different word categories pairs is almost equal for all categories. The difference between the average scores for the nSR and the SR V-N lists is 1.7, while it is 2.1 for the nSR and SR N-N

lists, and it is 2.3 for the nSR and SR V-V lists. The fact that these differences are so similar to each other means that there is not interaction between the two variables. This was confirmed by the nonsignificant outcome of the analysis of variance for the variables interaction, $F = .395$, $p = .676$.

DISCUSSION

The results of the present experiment indicated a significant main effect of word categories on word-pair recall, a significant main effect of semantic relatedness on word-pair recall, and no significant interaction between word categories and semantic relatedness.

These results support the hypothesis, which predicted that subjects would recall verb-noun (V-N) pairs and noun-noun (N-N) pairs better than verb-verb (V-V) pairs, regardless of the presence or absence of semantic relatedness, and that the presence of semantic relatedness would facilitate recall. However, V-N pairs were not recalled better than N-N pairs, as was predicted in the hypothesis, and semantic relatedness did not affect N-N word recall more than V-V word recall. Possible explanations of these findings are examined below.

The results of the present experiment are partially consistent and partially inconsistent with the findings of Huttenlocher and Lui (1979). They are consistent with the previous results in that they support the hypothesis that nouns are better recalled than verbs and that semantic relatedness facilitates short-term memory for word lists. However, they are inconsistent with the findings that semantic relatedness effects the short-term memory for nouns more than the one for verbs.

As discussed previously, there is no significant interaction between the two manipulated variables, word categories and semantic relatedness. If there is no interaction between these two variables, then the theory, presented by Huttenlocher and Lui (1979), which distinguishes between nouns and verbs as having different organizational structure, has not been supported by the findings of the present experiment.

The inconsistency between the results of this experiment and the ones of previous studies can be explained by two alternative theories of noun versus verb categorical characteristics as related to memory.

Firstly, it might be that nouns are better associated with each other than verbs are, not because they have a more coherent organizational structure but because they are dominant in everyday speech.

In general, nouns and verbs are much more inflected in speech than other word categories such as adjectives, adverbs and prepositions (Sommers, 1998). Furthermore, the occurrence of nouns is more frequent than the one of verbs, making them easier to remember. The more people encounter a particular class of words, the easier it is to classify these words as belonging to a certain category, to remember them, and to associate them with one another.

Support for this proposition comes from studies like the one of Marx (1979), where subjects were presented with lists of 10 words and asked to associate freely for a minute. 3 of the words on the lists were nouns, 3 were verbs, 3 were adjectives, and the last one belonged to any of these three categories. He found that regardless of the class of the stimulus words (the ones on the list), there was a significant tendency to associate nouns with any of these words. He concluded that nouns were the dominant word category as a carrier of association. His findings support the theory that compared to verbs nouns are more stressed as a word category and are a more dominant mental construct.

This theory is also supported by the results of the present experiment, which show that there is a significant effect of word category on recall: pairs of nouns are much better remembered than pairs of verbs. Furthermore, as shown on Table 1, the average recall for V-N pairs was almost equal to the average recall for N-N pairs. This means that even if there is an organizational difference between the noun and verb categories, there is also a strong association transcending the categories' boundaries and connecting nouns and verbs with each other. This tendency fits with the suggestion that verbs are much more closely related to their objects than they are to other verbs (Huttenlocher & Lui, 1979). The reason for this might be the dominancy of nouns as a mental construct.

Secondly, nouns may not only be the word category most stressed in speech, but they may also be better imagery-encoded than verbs. When a word denotes an image apart from a verbal meaning, it is easier to remember.

Fletcher, Shallice, Frith, Frackowiak, et al. (1996) examined the effect of imagery and semantic relatedness on retrieval of word pairs and found that the recall of imaginable and non-

imaginable words were associated with activity in different areas of the brain. The recall of both types of words was associated with activation of the left dorso-lateral prefrontal cortex while only the recall of imaginable words was additionally associated with activation of the precuneus. These findings support the hypothesis that the imagery-encoding words carry effects word recall.

More importantly, findings supporting Paivio's Dual-Coding Theory (DCT), proposed in 1969, further contribute to viewing the imagery-capacity of concrete nouns as an attribute facilitating recall (Jessen, F. et al., 2000; Sadoski, M., Goetz, E. T. & Avila, E., 1995; Paivio, A., Walsh, M. & Bons, T., 1994). DCT holds that words are remembered in two ways – through verbal encoding and through image encoding. Concrete nouns, which are highly imaginable, are, therefore, more easily remembered than verbs (as well as any other word category). DCT also argues that the effect of concreteness (i.e. imaginability) and the one of semantic relatedness on word recall are independent of each other, which means that no matter whether semantic relatedness in a word pair is present or not, a pair of nouns is more easily remembered due to the concreteness effect.

There is controversial evidence for the superiority of nouns as image-carriers, but if future studies support this theory, then one possible explanation of the results of the present experiment might be that nouns are better recalled than verbs because their image-encoding facilitates short-term memory.

It should be noted that there are a number of limitations and problems of the present study.

Only 25 subjects were tested and this is absolutely unsatisfactory considering the complexity of this experiment. If more subjects were available it might be that the absent interaction between the two variables (grammatical categories and semantic relatedness) was going to surface, and in that case, the results would be fully consistent with the findings of Huttenlocher & Lui (1979).

Additionally, the sources of frequent English verbs and nouns used in the experiment were mostly from the 1970s and 1980s and the English vocabulary surely has changed in the past 20 years. Unfortunately, apart from Whittlesea's current list of high-frequency high-concreteness nouns (obtained through personal communication), no recent sources were available. This might have affected the short-term memory of the subjects (second-year university students) for these

words if they did not find them to be part of their everyday vocabulary. Therefore, one possible improvement for this study would be the use of more recent sources of frequent English words.

In summary, the present study has certain limitations connected to sample size and sources of materials, which might have affected the results. Nonetheless, the results show significant consistency with previous findings about the noun/verb categorical distinction.

In order to supplement or perhaps expand the theory of the different organizational patterns of nouns and verbs, further studies might investigate the plausible dominancy of nouns as a word category and mental construct in comparison to verbs as well as other grammatical classes. The potential status of nouns as best imagery-carriers may also be subject of further research in the field of psycholinguistics.

In conclusion, the present experiment presents additional data for the significant distinction between verbs and nouns. Whether this distinction originates in the different organizational structures of these two word categories or in some other differences between nouns and verbs as mental constructs is still to be shown by further investigation.

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