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Concreteness and Semantic Repetition Effects in Free Recall: Evidence for Dual-coding Theory*

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ABSTRACT Dual-coding theory asserts that semantic equivalents are encoded as a combination of separate verbal representations for all words and common imaginal representations for concrete equivalents. The model predicts that semantic repetition will enhance memory for concrete but not abstract synonyms. Models that emphasize only abstract or only verbal representations do not predict an interaction between concreteness and semantic repetition. Ninety-six subjects recalled a list that contained no repetition, synonym repetition, and identical repetition items, half of which were concrete and half abstract. For concrete words, recall of synonym and identical repetition items did not differ significantly, and both conditions facilitated recall relative to no repetition items. For abstract words, however, recall of synonym and no repetition items did not differ significantly, whereas identical repetition facilitated recall relative to both of these conditions. These findings demonstrate the importance of concreteness in semantic-repetition effects and are especially problematic for conceptual models of meaning and memory.

RÉSUMÉ La théorie du double-encodage stipule que les équivalents sémantiques sont encodés comme une combinaison de représentations verbales séparées pour tous les mots et de représentations imagées communes pour les équivalents de mots concrets. Le modèle prédit que la répétition sémantique améliorera la mémoire dans le cas des synonymes concrets, mais non dans celui des abstraits. Les modèles qui mettent l'emphase seulement sur les représentations abstraites ou seulement sur les représentations verbales ne prédisent pas d'interaction entre la concrétude et la répétition sémantique. Quatre vingt seize sujets se rappellent une liste de mots qui contient des items dont certains sont répétés par synonymes, d'autres par des items identiques et d'autres qui ne sont pas répétés. La moitié de ces items est de nature abstraite et l'autre de nature concréte. Dans le cas des mots concrets, il n'y a pas de différence significative entre le rappel des mots répétés par synonyme et par items identiques. Ces deux conditions produisent des meilleurs rappels que la condition de non répétition. Dans le cas des mots abstraits cependant, la condition de répétition identique favorise un meilleur rappel que les deux autres conditions qui, elles, produisent des résultats équivalents. Ces résultats montrent l'importance du facteur concrétude dans les effets de répétition sémantique et posent spécialement problème dans le cas des modèles conceptuels de la mémoire et de la signification.

Dual-coding theory (Paivio, 1971, 1976a, b) maintains that cognition is based on functionally distinct verbal and imaginal systems. Verbal representations are arbitrary symbols for concepts, whereas images are nonarbitrary representations of the objects to which words refer. Although distinct, the verbal and imaginal

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systems are functionally interconnected. Thus, Paivio (1971) proposed that a word activates, first, its own corresponding verbal representation and, subsequently, representations that are connected to it in semantic memory. Activation of other verbal representations was termed associative meaning, whereas activation of images was termed referential meaning. Referential meaning is less universal than is associative meaning. In particular, concrete words are more likely to elicit images than are abstract words.

The differential availability of images has implications for the representation of semantic equivalents such as synonyms and translations. All words have verbal associative networks that contribute in some way to the shared meanings of semantic equivalents. In addition to these associative connections, however, concrete equivalents are likely to have convergent referential connections to common images. Abstract synonyms lack such referential meaning and, therefore, are more dependent upon separate verbal representations with their distinct associative networks.

Alternative models of cognition do not implicate concreteness in the representation of semantic equivalence. Conceptual views emphasize the role of abstract representations in word meaning (Collins & Loftus, 1975; Frijda, 1972; Kiss, 1973; MacLeod, 1976; Miller, 1972). According to this view, "synonymous words are represented by the same idea node" (Anderson & Bower, 1973, pp. 207–208), an interpretation that many theorists have endorsed (e.g., Collins & Quillian, 1972, p. 317; Norman & Rumelhart, 1975, p. 39; Rosenberg & Simon, 1977, p. 307; Schank, 1976, pp. 171–173). Other scholars have suggested a single verbal coding system to account for word meaning. For example, Hayes-Roth and Hayes-Roth (1977) demonstrated that word-based models could handle phenomena thought to support conceptual theories. Semantic-equivalents have distinct representational identities according to verbal theories, and neither synonyms nor translation-equivalents would converge on a single node. Thus, conceptual and verbal theories differ radically, but agree that a single characterization of semantic equivalence applies to both concrete and abstract words.

Semantic repetition effects in free recall offer one test of the hypothesis that concrete equivalents, but not abstract ones, converge upon a common underlying representation. In free recall, subjects remember more repeated words than once-presented words, possibly because a common representation is activated or replicated on each occasion, and whatever mechanism mediates recall is thereby strengthened. If synonyms or translation-equivalents activate a shared underlying representation, then recall following semantic repetition should be facilitated to the same extent as literal repetition. However, if semantic-equivalents activate different memorial representations, recall should not differ from once-presented items in the semantic repetition condition or at least should be less than recall in the identical repetition condition.

According to dual-coding theory, only concrete synonyms share common referents that would be activated repeatedly in a semantic repetition paradigm. Abstract synonyms are encoded as separate words. Thus, dual-coding theory predicts that semantic and literal repetition effects in free recall should be more

similar for concrete than for abstract synonyms. Indeed, on the basis of structure alone, abstract synonyms should be remembered no better than once-presented abstract words. The conceptual theory predicts semantic repetition effects for both concrete and abstract equivalents, whereas the verbal theory predicts little or no effect of semantic repetition, again for both types of material. These predictions are idealized ones based upon very impoverished models. More realistic models that incorporate additional mechanisms such as associative processes, for example, are considered in the discussion.

Previous research has shown that, in general, recall following semantic repetition surpasses recall of once-presented items and is approximately equivalent to recall following identical repetition (Glanzer & Duarte, 1971; Kolers, 1966; Kolers & Gonzales, 1980). Indeed, Glanzer and Duarte (1971) found that, with a token scoring procedure, translation repetitions produced levels of recall even higher than identical repetitions at short lags. Kolers (1966) and Kolers and Gonzales (1980) found that translation repetition effects were equivalent to identical repetition effects. The latter also showed that recall of synonyms far surpassed recall of once-presented items, although literal repetitions produced significantly better recall than did synonym repetitions. However, the absolute difference between these conditions was modest.

These results are clearly consistent with the conceptual coding view of convergent representations and are an embarrassment to purely verbal theories, at least as characterized to this point. The case is indeterminant for dual-coding theory because none of the studies manipulated or controlled concreteness. Conceptual and dual-coding theories make identical predictions for concrete semantic-equivalents. The words in previous studies may have been concrete, given the criteria used to select items, especially for those experiments showing semantic repetitions to be as good as or superior to literal repetitions. For example, Kolers and Gonzales (1980, p. 57) required that translations have a common referent, while Glanzer and Duarte (1971, p. 627) used only very common short words. The inferiority of synonym repetitions in Kolers and Gonzales may have been due to a mixture of concrete and abstract items and/or to variation in the similarity of items. The present study explicitly tested these possibilities.

Subjects were exposed to a single list that contained half concrete and half abstract items. Within each item type, some of the items were presented once, some were presented twice, and others were presented with their synonyms. This design provided a test of the prediction from dual-coding theory that semantic repetition effects would be obtained for concrete but not abstract words. By way of contrast, conceptual and verbal theories predict semantic repetition effects or the absence of semantic repetition effects, respectively, for both concrete and abstract words.

METHOD

Materials and Procedure

Synonyms were selected from unpublished ratings of 150 concrete and 150 abstract pairs on a 7-point scale of synonymity. The ratings were obtained in 1971 from 28 subjects instructed to

rate pairs of words on "synonymity or similarity of meaning." Words considered "identical or very similar in meaning" were to be rated 7 and words of "low similarity" were to be rated 1. Subjects were "free to use the entire range of numbers" and received concrete and abstract pairs in a random order. With the exception of one apparently unfamiliar pair, ratings were obtained from at least 26 subjects for each pair. Internal reliability measures were not available, but the average ratings correlated .82 (36 pairs) with Wilding and Mohindra (1981) and .91 (40 pairs) with Whitten, Suter, and Frank (1979). Thus, the ratings seem stable.

Thirty synonym pairs were selected such that concrete and abstract sets were equated for rated synonymity, rated familiarity where available, and length. The mean rated synonymity was 5.64 (SD = .31) and 5.63 (SD = .43) for the concrete and abstract pairs, respectively. The difference between means was not significant, $t(28) = .04$, $p > .10$, even though the standard error (.14) was sufficiently small to ensure adequate power (Winer, 1971, p. 34). A difference between population means of 0.5 units would be detected over 95% of the time.

Each list contained 40 target words: 10 presented once, 10 presented twice, and 10 synonym pairs. The repeated items were separated by 0, 2, 4, 6, or 8 intervening items. Three semi-random orders of the conditions were generated with the stipulation that all items would occur within 50 serial positions. Word pair was nested within this factor such that three randomly formed sets of five concrete pairs and three sets of five abstract pairs acted successively as a single presentation set, an exact repetition set, and a synonym repetition set for one of the three orders of conditions. For each of these orders, eight lists were generated by counterbalancing the concreteness of the item (2), the type of repetition (2), and the member of the pair (2) that was presented at a given serial position.

The 24 lists with 10 buffer items at the beginning and 10 at the end were videotaped from the CRT of a PDP-12 at a rate of four seconds per item. Lists were presented to small groups of subjects (never more than four) on a television monitor. Standard free recall instructions were given with the additional admonishment to avoid guessing. Immediately after the 3-minute written recall interval, subjects had 30 seconds to indicate which of the recalled words had been presented twice.

Subjects

Subjects were drawn from Introductory Psychology classes at the University of Western Ontario and participated for course credit. Five subjects were discarded for failure to follow instructions, and additional subjects were tested to obtain the 96 subjects called for by the design.

RESULTS

Recall performance in semantic repetition conditions can be assessed in two ways. Token scoring is the number or proportion of words recalled; each synonym pair contributes two observations. Type scoring is the number of pairs from which one or both words were recalled; each pair contributes only one observation. Although type scoring is a common practice in semantic repetition studies, token scoring was adopted because it requires no assumptions about the underlying number of types actually presented. Note that, according to conceptual models, synonym repetitions constitute only one type (underlying representation) per pair. According to verbal models, on the other hand, synonym repetitions constitute two types per pair.

Separate analyses of variance were performed on the proportion of words recalled by each of the 96 subjects and the proportion of subjects who recalled each word for the 15 concrete and 15 abstract pairs. The F ratios for these analyses were combined to assess the reliability of the effects across subjects and items simultaneously (Clark, 1973). The concreteness effect was significant, min F' (1,

37) = 5.32, $p < .05$, $MSe = 0.026$, for both the subject and item analyses, and will not be mentioned further.

The hypotheses of interest were tested by four orthogonal comparisons within levels of concreteness, $MSe = 0.032$ (pooled) and 0.006 for the subject and item analyses, respectively. The respective degrees of freedom were 375 (based on Satterthwaite formula) and 56.

For concrete words, both identical repetition ($M = 0.38$) and synonym repetition ($M = 0.32$) conditions were clearly superior to non-repetitions ($M = 0.15$); in fact, synonym repetitions were recalled at a level near that achieved by the actual repetition of a concrete word. Once-presented items were contrasted with the combined synonym and identical repetition items, a comparison that was significant, min $F'(1, 175) = 38.01$, $p < .001$. The difference between synonym and identical repetitions was not significant by the combined test, min $F'(1, 175) = 2.40$, $p > .10$, although both the item and subject analyses were significant at the .05 level. The contrast between once-presented and repeated items accounted for 94% of the variability among the three concrete means.

In the case of abstract words, only identical repetition ($M = 0.29$) facilitated recall in comparison to once-presented items ($M = 0.13$), whereas abstract synonym repetitions ($M = 0.18$) were recalled at a level close to that of non-repetitions. Within abstract words, once-presented items and synonyms were contrasted with identical repetitions, a comparison that was significant, min $F'(1, 175) = 17.74$, $p < .001$. The difference between once-presented items and synonyms was not significant, min $F'(1, 193) = 1.70$, $p > .10$, although the subject and item analyses produced somewhat improbable Fs, $p < .08$. The contrast between identical repetitions and the other conditions accounted for 92% of the variability among the three abstract means.

These results can be summarized succinctly. Repeated concrete words were recalled better than once-presented words, whether the repetition was literal or semantic. Only 6% of the variability among the concrete means could be attributed to the difference between identical and synonym repetitions. For abstract materials, on the other hand, identical repetitions were superior to both synonym repetitions and once-presented items. Only 8% of the variability among means was due to differences between the latter conditions.

The synonym repetition results were examined for evidence of differential memory of words in the pairs. There was slightly better recall of the second member than the first ($M = .26$ and .24, respectively), since the percentage of recalled words identified (wrongly) as being twice-presented was slightly higher for the first than the second member of each pair (7.4% vs. 4.8%, respectively), and, when both members of a pair were recalled, the first member was recalled first 65% of the time. In general, concrete and abstract words behaved similarly on these measures.

Another analysis concerned pair recall and lag effects. Each subject saw just one pair at each lag by condition combination, and items were not completely counterbalanced across lags. Thus, the results should be viewed with caution. The conditional probability that one member of a pair was recalled given the other

member was recalled varied with concreteness and lag. For concrete words, these conditional probabilities were consistently high: .76, .80, .71, .70, and .71 across the five lags. Chi-square tests of independence were significant at all lags for concrete pairs. However, the conditional probabilities declined sharply with lag for abstract pairs: .63, .59, .48, .30, and .32. Chi-square tests were significant only at the three shorter lags for abstract words.

DISCUSSION

The results confirm that concreteness is an important variable in semantic-repetition effects. Concrete synonyms yielded evidence for a common underlying code, whereas abstract words did not, an interaction that was predicted by dual-coding theory. According to the theory, images constitute the shared representations for semantic equivalents and are available primarily for concrete words. Thus, semantic repetition facilitates memory for concrete but not abstract words. The findings qualify previous studies that have neither controlled nor manipulated concreteness. Semantic repetition effects that were thought to be universal may have been due to the use of concrete words, while less than perfect semantic repetition effects, such as those reported by Kolers and Gonzales (1980), may have been due to the use of a mixture of concrete and abstract words.

The verbal view appears to have difficulty not only with the present findings, but also with previous semantic repetition effects. However, associative facilitation effects without semantic equivalence have been reported in the free recall paradigm (Deese, 1965; Jenkins & Russell, 1952), and synonyms may have associative connections such that presentation of one member of the pair results in activation of the other member or of some shared associate. Such mechanisms could result in the double activation of synonyms or their common associates, accounting for both the semantic repetition effect and the superiority of semantic repetition over literal repetition at short lags (Glanzer & Duarte, 1971). An additional assumption that concrete synonyms are more strongly associated than abstract synonyms would still be required to account for the present findings.

The analysis of synonym recall and lag offers some modest evidence with respect to this associative hypothesis. In general, memory for associates is negatively related to the distance between the related items (Glanzer, 1969; Greitzer, 1976). On the other hand, identical or semantic repetition generally demonstrates positive or flat relationships with lag (Glanzer, 1969; Glanzer & Duarte, 1971; Glenberg, 1977). In the present study, conditional recall of concrete synonyms was unaffected by lag, whereas conditional recall of abstract synonyms showed the negative function characteristic of associative repetition effects. Interestingly, Stern and Hintzman (1979) reported decreases in recognition memory with increased lags between synonymous adjectives or adverbs, relatively abstract materials. These results suggest that the semantic effect for concrete words is not due to associative processes, but that such processes may operate for abstract words at short lags.

Consider next the conceptual models. It is not immediately apparent how these models can account for the absence of semantic repetition effects or their

interaction with concreteness. One possibility is that the abstract synonyms were less equivalent than the concrete. However, this argument is weakened by the fact that the concrete and abstract pairs were rated as being equally synonymous, admittedly only one of many possible measures of synonymity (see below). If the relationship between concreteness and semantic equivalence is shown to be real, conceptual models of mental representation would require some radical change. The proponents of such views would need to find some mechanism that distinguishes between identical and semantic repetitions, is associated with concreteness, and does not render superfluous the common underlying semantic representations.

The case for dual-coding theory also has problems. Both verbal and imaginal codes are repeated in the identical repetition condition, whereas only imaginal codes are repeated in the semantic repetition condition. Despite this difference, semantic repetition produced levels of recall comparable to identical repetition. Subjects also tended to recall pairs in order of presentation, an effect presumably mediated by word-specific memory traces. These issues complicate but do not change the general results. In fact, concrete synonyms were slightly less well remembered than identical repetitions, although not significantly so. This difference and the order of recall results may be due to separate verbal traces that are present in the semantic condition but not in the identity condition.

Irrespective of theoretical orientation, a major difficulty in the study of semantic repetition effects is the lack of an ultimate definition of synonymity that is independent of the psychological processes of interest. Semantic equivalence was defined as rated synonymity, an operation that appeared reliable and did not distinguish concrete from abstract words. As one reviewer noted, however, many alternative operations could be used to measure synonymity, and the concrete and abstract materials could differ on these other operations. One might even argue that true synonyms should demonstrate semantic repetition effects in free recall, a definition that would preclude differential memory effects of concreteness. Thus, the most neutral characterization of the present results is that two measures of semantic similarity, rated synonymity and semantic repetition effects, do not show equivalent concreteness effects.

In conclusion, concrete synonyms display repetition effects comparable to identical word repetitions, a finding that suggests some common component to their meaning. Abstract synonyms show little or no evidence for a common code. These results were predicted from dual-coding theory and, at the very least, demonstrate the importance of concreteness in the semantic repetition effect. Stronger conclusions must be tempered by the fact that certainly the verbal model and perhaps even the conceptual coding view may be able to account for the findings, albeit in a post hoc fashion. Stronger tests of alternative characterizations of semantic equivalence remain to be done.

REFERENCES

Anderson, J.R., & Bower, G.H. (1973). *Human associative memory*. New York: Wiley.

Clark, H.H. (1973). The language-as-fixed-effect fallacy: A critique of language statistics in psychological research. *Journal of Verbal Learning and Verbal Behavior*, **12**, 335–359.

Collins, A.M., & Loftus, E.F. (1975). A spreading-activation theory of semantic processing. *Psychological Review*, **82**, 407–428.

Collins, A.M., & Quillian, M.R. (1972). How to make a language user. In E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp. 309–351). New York: Academic Press.

Deese, J. (1965). *The structure of associations in language and thought*. Baltimore: Johns Hopkins Press.

Frijda, N.H. (1972). The simulation of human long-term memory. *Psychological Bulletin*, **77**, 1–31.

Glanzer, M. (1969). Distance between related words in free recall: Trace of the STS. *Journal of Verbal Learning and Verbal Behavior*, **8**, 105–111.

Glanzer, M., & Duarte, A. (1971). Repetition between and within languages in free recall. *Journal of Verbal Learning and Verbal Behavior*, **10**, 625–630.

Glenberg, A.M. (1977). Influences of retrieval processes on the spacing effect in free recall. *Journal of Experimental Psychology: Human Learning and Memory*, **3**, 282–294.

Greitzer, F.L. (1976). Intracategory rehearsal in list learning. *Journal of Verbal Learning and Verbal Behavior*, **15**, 641–654.

Hayes-Roth, B., & Hayes-Roth, F. (1977). The prominence of lexical information in memory representations of meaning. *Journal of Verbal Learning and Verbal Behavior*, **16**, 261–275.

Jenkins, J.J., & Russell, W.A. (1952). Associative clustering during recall. *Journal of Abnormal and Social Psychology*, **47**, 818–821.

Kiss, G.R. (1973, July). *An associative thesaurus of English: Structural analysis of a large relevance network*. Paper presented at the Conference on Current Research in Aspects of Long-term Memory, University of Dundee, Scotland.

Kolers, P.A. (1966). Interlingual facilitation of short-term memory. *Journal of Verbal Learning and Verbal Behavior*, **5**, 314–319.

Kolers, P.A., & Gonzales, E. (1980). Memory for words, synonyms, and translations. *Journal of Experimental Psychology: Human Learning and Memory*, **6**, 53–65.

MacLeod, C.M. (1976). Bilingual episodic memory: Acquisition and forgetting. *Journal of Verbal Learning and Verbal Behavior*, **15**, 347–364.

Miller, G.A. (1972). English verbs of motion: A case study in semantics and lexical memory. In A.W. Melton & E. Martin (Eds.), *Coding processes in human memory* (pp. 335–372). New York: Wiley.

Norman, D.A., & Rumelhart, D.E. (1975). *Explorations in cognition*. San Francisco: Freeman.

Paivio, A. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart, & Winston. (Reprinted in 1979 by Lawrence Erlbaum Associates, Hillsdale, NJ.)

Paivio, A. (1976a). The relationship between verbal and perceptual codes. In E.C. Carterette & M.P. Friedman (Eds.), *Handbook of perception. Vol. IX: Perceptual processing* (pp. 375–397). New York: Academic Press.

Paivio, A. (1976b). *Imagery, language, and semantic memory*. Paper presented at Symposium on Semantic Aspects of Memory, 21st International Congress of Psychology, Paris.

Rosenberg, S., & Simon, H.A. (1977). Modeling semantic memory: Effects of presenting semantic information in different modalities. *Cognitive Psychology*, **9**, 293–325.

Schank, R.C. (1976). The role of memory in language processing. In C.N. Cofer (Ed.), *The structure of human memory* (pp. 162–189). San Francisco: Freeman.

Stern, L.D., & Hintzman, D.L. (1979). Spacing and the retention of synonyms. *Bulletin of the Psychonomic Society*, **13**, 363–366.

Whitten, W.B., Suter, W.N., & Frank, M.L. (1979). Bidirectional synonym ratings of 464 noun pairs. *Journal of Verbal Learning and Verbal Behavior*, **18**, 109–127.

Wilding, J., & Mohindra, N. (1981). Ratings of the degree of synonymity of 279 noun pairs. *British Journal of Psychology*, **72**, 231–240.

Winer, B.J. (1971). *Statistical principles in experimental design* (2nd ed.). New York: McGraw-Hill.

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