

Storage and recall of verbal and pictorial information

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A modified paired associate incidental and intentional learning task was used to train subjects to associate pairs of highly imageable stimuli, presented either as words or pictures. When later testing of learning was accomplished in a congruent stimulus mode, as on training, then reconstruction of associate pairs of items was more complete than for disparate learning recall conditions (picture-words or words-pictures). This effect was particularly marked for incidentally learned pairs of items. The findings are used to relate state-dependent learning, encoding-retrieval specificity, and lateralization of brain function in the storage and retrieval of to-be-remembered information.

A variety of theoretical models have been used to account for the storage and retrieval of information in memory. These have included theories emphasizing discrete storage and retrieval stages as well as approaches that stress systematic transformations of input determined by context or relational factors linking input stimuli with previous learning, organized in long-term memory. The more recent of these transformation theories of memory has postulated specific encoding strategies that operate at the time of storage and retrieval strategies used in searching storage as key determinants in accounting for recall processes (Tulving & Thomson, 1973). This view of memory is particularly useful in examining effects of systematic changes in the contextual conditions present at the time of learning and independently at the time memory is tested.

The contextual conditions studied to date have included not only typical informational variables used in most verbal learning paradigms, but have also included systematic alterations in brain state, usually drug induced, at the time of storage and, independently, at the time of retrieval. Such research was first pursued in animal learning studies and labeled dissociative or state-dependent learning. More recently, similar effects have been demonstrated in man. For some drugs, such as alcohol and marijuana, learning that had taken place while in a drugged state could be more effectively retrieved when tested under similar drug conditions in contrast to tests of previous learning in an undrugged, disparate, recall state. That is, learning that had taken place while drugged appears to be state dependent. Furthermore, the effect appears directly related to

systematic encoding and retrieval changes associated with discrete brain states (Henry, Weingartner, & Murphy, 1973; Weingartner & Faillace, 1971). It has also been shown that information which appears "dissociated" or "forgotten" when recall is attempted in some disparate recall state is, nevertheless, available although temporarily inaccessible (Eich, Weingartner, Stillman, & Gillin, 1975). Recall fails because subjects are unable to self-generate cues with which to effectively access memory. These studies show that the same stimulus is encoded in a context-specific manner, where context can be defined as a brain state, set, instructions, stimulus context, etc., and that retrieval strategies which mediate access of uniquely encoded stimuli may also be retrieval context or brain state specific.

In this study we attempted to extend findings relating informational or neurochemical contextual effects as determinants of specific encoding and retrieval of information by varying the mode of presentation of simple stimuli and independently altering the stimulus mode in which memory store is later tested. That is, instead of pharmacologically inducing congruent and disparate learning-recall conditions, common random noun stimuli were presented either as words or their schematic pictorial representations in a modified paired associate learning task. Recall was later tested in some congruent or disparate stimulus mode, in the form of words or pictures. We hypothesized that the same stimulus presented in a different form would be encoded, represented in memory, quite differently. The success of retrieving information stored in memory was therefore hypothesized to be more a function of the relative congruence in storage and retrieval mode than the particular mode, verbal or pictorial, of the stored information. Furthermore, congruence vs. disparity of storage and retrieval mode was expected to

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particularly affect the recall of more "weakly" stored input (e.g., incidentally learned information), as has recently been shown in recall of input in disparate brain state conditions.

METHOD AND PROCEDURE

A sample of 60 very common English nouns (AA frequencies as determined by Thorndike and Lorge word count norms, 1944) and highly imageable (imagery ratings of greater than 5.0 according to Paivio, Yuille, and Madigan norms, 1968) were used as stimuli. These were presented to subjects either as words printed on 3 x 5 in. index cards or in the form of highly stereotyped simple line drawings of these stimuli, again printed on 3 x 5 in. index cards. Subjects were presented with 20 of the 60 words, chosen at random, as stimuli with which to pair an associated response. The remaining 40 words served as responses to be paired with the 20 stimuli, either in the form of a word or picture. That is, stimuli were each presented, one at a time, along with two other randomly chosen stimuli, one of which was to be chosen by the subject as a response to be paired with the presented stimulus for later recall. Subjects were told that they would later be asked to reconstruct all 20 of the pairings. This effectively required them to process but reject an alternate response for each stimulus. Each of the 20 stimuli and alternative response pairs were presented for 10 sec and, during this time, responses had to be chosen and studied as in a paired associate learning task.

Thirty minutes later subjects were presented all of the stimuli, one at a time, in the same sequential order as on initial presentation. They were also presented with a random sort of their previously chosen responses and were required to reconstruct the pairings (intentional learning). The same stimuli were then presented again and subjects were required to reconstruct the pairings of stimuli with associated but previously rejected responses (incidental learning).

Each subject was presented with stimuli in either word or pictorial form. The mode of presentation of stimuli and alternative response pairs and the mode of testing intentional and incidental learning was systematically varied in four independent conditions. In two of the conditions, subjects reconstructed pairs of items, and these were in the same form, word (W) or picture (P), as on initial presentation (congruent conditions W-W, P-P). The remaining two conditions required that learning occur using one form of the stimuli, while recall was tested in the other mode (disparate conditions W-P and P-W). No time limit was placed on subjects in the recall phase of the study. However, all completed both intentionally and incidentally learned stimulus-response reconstructions in less than 10 min.

Forty introductory psychology students from the University of Maryland, Baltimore County were used as subjects in the experiment. They were initially familiarized and practiced in the learning phase of the procedure. Ten subjects were tested in each of the four experimental conditions, which included the congruent W-W and P-P and disparate W-P and P-W learn-recall procedures.

RESULTS

The number of intentionally and incidentally stored pairs which were successfully reconstructed in the four experimental conditions was examined in a three-way analysis of variance in which a .01 level of significance was set as a criterion for rejecting the null hypothesis. Results showed that for intentionally learned stimulus-response pairings, mode congruence on storage and

Number Of Correct Pairings Of Intentionally And Incidentally Learned Pairs Of Stimuli, (words or pictures), And Recall In The Same Or Different Modality

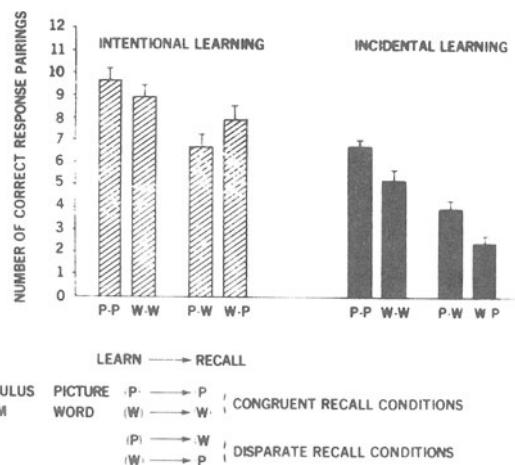


Figure 1. Number of correct pairings of intentionally and incidentally learned pairs of stimuli (words or pictures) and recall in the same or different modality.

retrieval (W-W and P-P) produced a greater number of correct reconstructions than were produced under W-P or P-W conditions, $F(3,36) = 4.04$. There was no significant difference in the number of paired associate reconstructions produced by P-P and W-W conditions or between the two disparate conditions, W-P and P-W. The effect was simply one of storage and retrieval congruence producing more effective recall and reconstruction of S-R pairs than disparate storage-retrieval mode conditions. For all conditions, fewer correct stimulus-response reconstructions were produced with previously rejected, incidentally learned, compared to intentionally studied responses, $F(3,36) = 13.61$. The effect of congruence vs. disparity in storage and recall conditions was, however, amplified in the incidental learning condition. That is, the interaction of experimental condition and type of learning (incidental vs. intentional) had a marked effect on recall, $F(3,36) = 8.74$. These results are displayed in Figure 1.

DISCUSSION

Generally, pictures are retrieved from memory more effectively than words, except when words are quite concrete and highly imageable, as was the case in this study (Paivio, 1969). Here we found no difference between the two congruent learning/paired associate recall conditions (W-W and P-P) nor between disparate conditions (W-P and P-W) for both intentional or incidental learning. If the words had been less imageable, with primarily ideational or linguistic representation in memory, then pictorial information might have been expected to be stored more effectively, as measured, than comparable verbal information. Successful recall was, however, determined by the congruence vs. disparity of storage-retrieval conditions. A conceptual framework that emphasizes the specificity of encoding and related specific retrieval schemes seems particularly

useful in accounting for these effects. Aside from contextual manipulations of information fields on storage or retrieval, altering the form of a stimulus on input seems to change its representation in memory store and, consequently, determines the kinds of cues and retrieval strategies that most effectively access memory. The same nominal stimulus in some other form is presumably encoded differently and these findings are consistent with theories of memory emphasizing distinctions between language vs. pattern processing.

The intentionally learned word or picture responses were more successfully re-paired with appropriate stimuli than were rejected responses which were presumably incidentally learned in relation to the target stimuli. This was the case for all four of the conditions, but particularly in disparate learn-recall conditions. It seems reasonable to assume that issues of "incidental" vs. "intentional" learning involve a continuum defined by the depth or effectiveness in processing rather than discretely different kinds of learning (Hyde & Jenkins, 1973; Postman, 1964). If the extent to which an event can be retrieved depends on the "depth" to which that event was processed—where depth here refers to the number and/or quality of dimensions along which the event was encoded (Craik & Lockhart, 1972)—and if recall further depends on an effective interface or match between the retrieval environment and features of the encoded event in memory, then it is reasonable to expect incidentally learned material to be more readily forgotten. More precisely, incidentally stored input may be less accessible on recall because fewer potential interface encoding-retrieval structures can be generated with which to cue back memory store.

These results also lend further support, albeit indirect, to notions of lateralization of brain function in the processing of language vs. pattern information. That is, specific asymmetrical neural mechanisms seem to be involved in the storage and representation in memory of linguistic as compared to pattern information. Processing words, even when they elicit vivid images, may involve dominant rather than nondominant neocortex, while storage of these seemingly equivalent stimuli as pictorial representations may be mediated by nondominant hemispheres (Milner, 1967; Milner & Taylor, 1972; Seamon & Gazzaniga, 1973). The stimuli can be viewed as being encoded differently and represented in memory differently precisely because of differences in processing in brain of words and pictures.

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