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Effects of concreteness and semantic relatedness on composite imagery ratings and cued recall

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Day and Bellezza (1983) rejected a dual coding imagery explanation for the superior recall of concrete words because unrelated concrete pairs were rated lower in composite imagery but were still remembered better than related abstract pairs. We show that dual coding theory explains their results and our new findings using the same paradigm. In Experiment 1, 120 subjects rated imagery or relatedness for 108 pairs that varied in concreteness, pair relatedness, and associative strength. Incidental cued recall followed. Relatedness and strength affected imagery ratings, as did concreteness, and very low relatedness partly accounted for the low composite imagery ratings for unrelated concrete pairs. Concreteness and relatedness also affected recall, and superior recall for unrelated concrete pairs occurred consistently under imagery but not under relatedness instructions. In Experiment 2, 40 subjects rated imagery value and recalled 24 pairs. Subsequent questioning indicated that composite images were retrieved better given stimuli from unrelated concrete than from related abstract pairs. These findings and Day and Bellezza's original results are explained in terms of (1) imaginal and verbal associative processes, which jointly influence composite imagery ratings and recall, and (2) the critical role of stimulus concreteness during image retrieval and recall (i.e., the conceptual peg hypothesis).

Dual coding theory (Paivio, 1971, 1986) explains cued recall in terms of the joint activity of independent verbal and nonverbal (imaginal) cognitive systems. Recall depends partly on the capacity of the nonverbal system to generate composite images to pairs during study trials and to reintegrate those images to cue words during test trials (cf. the conceptual peg hypothesis, Paivio, 1969). The ease with which such images are generated and reintegrated depends partly on verbal to imaginal referential connections, which are more available for concrete than for abstract words, and partly on associative connections between units within the verbal and imaginal systems. This theoretical account has been supported by positive effects on associative memory of noun concreteness and imagery instructions (see Paivio, 1969), and of associative relatedness (e.g., Kuszyszyn & Paivio, 1966). Recently, however, Day and Bellezza (1983) obtained results that they took as evidence against the theory's imagery explanation for concreteness effects in cued recall.

Day and Bellezza (1983) had subjects form composite images to pairs of words that varied orthogonally in concreteness and pair relatedness. Subjects rated the vividness of their interactive images and were later tested for cued recall. The critical findings were that subjects rated images to related abstract pairs (e.g., *democracy-liberty*)

as more vivid than images to unrelated concrete pairs (e.g., *cheese-fur*), but they nonetheless recalled more unrelated concrete than related abstract words. According to Day and Bellezza, such findings contradict dual coding theory and other imagery explanations for the effects of concreteness and imagery instructions on cued recall. They proposed an alternative explanation, based on "organized generic knowledge structures" (i.e., schemata), that emphasized "relations among objects in the physical world rather than their mode of representation in memory" (pp. 256-257).

Day and Bellezza's results are novel and interesting, but we will show that they do not contradict dual coding theory. We first clarify several oversimplifications and omissions in their interpretation of the theory, and then present a more complete dual coding account of their findings, along with experimental tests of implications of the theory that were not considered by Day and Bellezza.

Day and Bellezza (1983) stated that in "dual coding theory, abstract nouns are represented only in the linguistic-verbal system, whereas concrete nouns are represented both in the verbal-linguistic and in the pictorial-imagery system" (p. 256). They also asserted that "the emphasis in dual coding theory is on ... the representation of individual nouns" (p. 256). From this view, they inferred that word pairs or letter-word pairs with high imagery ratings should always be recalled better than word pairs with lower imagery ratings. Since the predictions were not upheld, they rejected the theory.

These predictions were based, however, on an interpretation of dual coding theory that was too extreme or incomplete in several respects. First, abstract nouns are not assumed to be represented only in the verbal system. The

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theory states, instead, that individual abstract nouns are less likely to arouse images or they do so with greater difficulty than concrete nouns (e.g., Paivio, 1971, pp. 179, 367). Consistent with this assumption, subjects can image to abstract words or pairs, but generally do so more slowly than to concrete materials (Paivio, 1966; Paivio & Foth, 1970; Yuille, 1973; Yuille & Paivio, 1967). Second, dual coding theory has not been restricted to individual words. The earliest versions of the theory emphasized imaginal associations that encode spatial relations among objects, and also gave a central role to the integrative properties of composite imagery (Paivio, 1971, pp. 247-248). Third, the theory does not assume that imagery is only visual, or "pictorial," but includes other sensorimotor modalities (Paivio, 1972), such as the tactual dimension cited by Day and Bellezza (1983) as evidence for schema. Moreover, along with auditory-articulatory representations, the verbal system is assumed to contain visual representations (Paivio, 1971, p. 56), so that one can have visual images of printed letters and words that are useful in many tasks. In memory tasks, however, the emphasis has always been on the importance of *nonverbal*, concrete imagery as a recall mediator (Paivio, 1969, p. 243). Letters, for example, become more memorable when imaged as objects similar in shape to the letters (Clark & Paivio, 1987, p. 19). That the effective variable in associative tasks is imagery as a "mode of representation in memory" rather than concreteness per se, or some other correlate of concreteness, has been supported in numerous studies (e.g., Paivio, 1971, pp. 266-268; Richardson, 1980, p. 93).

Two additional features of dual coding theory were not sufficiently emphasized by Day and Bellezza. First, dual coding theory explains cognition in terms of the joint contribution of independent verbal and imaginal processes, rather than imagery alone (e.g., Paivio, 1969, p. 248). Intraverbal associations contribute to context effects on image arousal (Begg & Clark, 1975; Paivio, 1971, p. 61) and to recall independent of imagery (e.g., Kusyszyn & Paivio, 1966). Second, Day and Bellezza did not take account of the conceptual peg hypothesis, which states that stimulus concreteness is especially critical for the retrieval of composite images during the test phase of cued recall (Paivio, 1965, 1969, p. 244). We elaborate on these points in the relevant contexts.

These clarifications suggest that Day and Bellezza were too strong in their rejection of dual coding theory. Nonetheless, their dramatic findings raise important questions concerning the complex mechanisms that underlie concreteness, pair relatedness, interactive imagery, and cued recall. We turn now to two experiments that investigated several implications of our analysis of those mechanisms. Experiment 1 examined composite imagery ratings and recall as a function of concreteness and pair relatedness, as well as the qualifying effects of imagery instructions on recall effects. Experiment 2 directly tested the conceptual peg hypothesis of image formation and retrieval using the Day and Bellezza paradigm.

EXPERIMENT 1

Imagery Ratings and Recall

The following analysis is based on assumptions that were part of the original version of dual coding theory (Paivio, 1971) and that have been amplified in recent descriptions of the theory (e.g., Paivio, 1986, chaps. 4 and 8). From the dual coding perspective, the generation of composite images entails a combination of referential, verbal associative, and transformational processing. Referential translation from the verbal to nonverbal system depends largely on concreteness, so that concrete words such as *student*, *book*, and *pickle* more easily activate images than do individual abstract words such as *joy*, *victory*, and *history*. Once activated, separate images can be transformed into an integrated whole by nonverbal organizational processes. The generation of composite images is also aided by the preexperimental relatedness of the words or their referents. That is, integrated images may be more easily or directly generated for such related pairs as *joy-victory* and *student-book* than for unrelated pairs such as *joy-history* and *student-pickle*. Related words may, for example, jointly activate a composite image already available in memory, or mutually prime access to each other's images.

This analysis suggests that both item concreteness and pair relatedness affect composite imagery ratings, as Day and Bellezza demonstrated. Also consistent with this view, word concreteness predicts imagery use and latency for unrelated pairs (e.g., Yuille, 1973; Yuille & Paivio, 1967), and relatedness ratings for metaphor topics and vehicles predict their composite imagery ratings (Katz, Paivio, Marschark, & Clark, in press). It does not follow directly from our dual coding analysis that composite imagery ratings should be higher for related abstract than unrelated concrete pairs, any more than it follows from Day and Bellezza's schema theory. Nonetheless, dual coding theory provides a plausible interpretation of this finding because several features of Day and Bellezza's paradigm could have induced pair relatedness to affect imagery ratings more than concreteness did. Their instructions stressed interactive images, the lists contained extremely related and unrelated pairs (perfectly confounded with concreteness in one study), and subjects had sufficient time to form images even to abstract pairs. Consistent with a diminished sensitivity to concreteness, Day and Bellezza found a larger statistical effect of pair relatedness than of concreteness (p. 254) and imagery ratings that were only slightly higher for concrete ($M = 3.87$) than for abstract ($M = 3.68$) unrelated pairs.

The relatively low imagery ratings for unrelated concrete pairs also suggest that those pairs may have been less related than unrelated abstract pairs. The reasoning is as follows: Random abstract pairs tend to be more associatively related than are random concrete pairs, at least as measured by associative overlap (Paivio & Begg, 1971) and confusability (O'Neill & Paivio, 1978). If pair relatedness affects composite imagery ratings, uncontrolled

differences in relatedness that favor abstract pairs would operate against the positive effect of word concreteness and reduce imagery differences between concrete and abstract unrelated pairs. This confounding would also increase Day and Bellezza's rating effect, which compares unrelated concrete to related abstract pairs.

We accordingly sought evidence in Experiment 1 for independent effects of concreteness and pair relatedness on imagery ratings in general, and their possible counteracting effects on ratings of unrelated pairs in particular. The effect of concreteness on imagery ratings should be most apparent when concrete and abstract pairs are equal in measured relatedness, and somewhat obscured if confounded differences in relatedness favor the abstract pairs. To test the hypothesis that concreteness effects on recall depend on imagery, we examined whether the recall advantage for concrete unrelated over abstract related pairs would be weaker or perhaps even reversed under instructions to rate pair relatedness as compared with rating vividness of imagery. The reversal is not predicted by nonimagery interpretations of concreteness effects.

We also varied imagery instructions so that some subjects rated vividness and others rated ease of interactive imagery, which has been emphasized in dual coding theory (Paivio, 1965; Paivio, Yuille, & Madigan, 1968), and added a larger and less selective sample of concrete and abstract word pairs to Day and Bellezza's pairs. The new pairs varied in interitem associative strength, which permitted a further test of the influence of associative factors on composite imagery ratings, and the words in the new abstract pairs had lower imagery ratings than Day and Bellezza's abstract words (see our Method).

Method

Subjects. As a course requirement, 120 introductory psychology students from the University of Western Ontario participated in the study. Two subjects were replaced because of incomplete booklets. Forty additional subjects from the same population rated ease of imagery for the individual words.

Materials. We obtained 54 concrete and 54 abstract pairs of related words. Of these, 12 concrete and 12 abstract pairs were selected or adapted from the words used by Day and Bellezza (hereafter called DB items).¹ A new set of 42 concrete and 42 abstract pairs was constructed from unpublished free associations of 100 subjects to 50 concrete and 50 abstract words from Paivio et al.'s (1968) norms. The pairs were stimuli and responses judged by the experimenters to be of the same concreteness level (i.e., concrete or abstract). For both the concrete and abstract new sets, 14 pairs were selected at each of high (primary or secondary response), medium (middle range of associative frequency), and low (response given by 1 or 2 subjects) levels of associative strength.

The 216 individual words were rated by 20 males and 20 females using standard instructions (Paivio et al., 1968) for rating the ease with which words arouse mental pictures, sounds, or other sensory experiences. The imagery ratings were reliable (alpha coefficient = .97), with means of 4.56 and 3.86 for the DB and new abstract words, and 6.27 and 6.17 for the DB and new concrete words. Imagery ratings for new abstract words were lower than the moderate ratings for DB abstract words. Sample pairs, in descending order of associative strength, are *answer-question*, *thought-idea*, and *advantage-success*, for the abstract items, and

iron-clothes, *orchestra-violin*, and *barrel-pickle* for the concrete items.

Eight random orders of half related and half unrelated pairs were constructed by first randomly dividing items into two sets, each containing 27 concrete and 27 abstract pairs. The 27 pairs included 6 DB pairs and 21 new pairs, 7 at each of the three levels of associative strength. For the first four lists, words in one set remained in related pairs, whereas stimuli in the other, unrelated set were randomly paired with four different responses from pairs at the same level of concreteness. For the other four lists, the related and unrelated sets were reversed. Each word therefore appeared in related pairs for four lists and in 4 different unrelated pairs for another four lists. Each subject rated 27 related concrete pairs, 27 related abstract pairs, 27 unrelated concrete pairs, and 27 unrelated abstract pairs. The 27 pairs in each set contained 6 DB pairs and 21 new pairs, equally divided among high, medium, and low associative strength. Associative strength was not available for the DB items, so the design was not fully crossed. Moreover, unrelated pairs were classified as DB or new, and as having low, medium, or high associative strength on the basis of their stimuli.

For the rating task, pairs were presented in 6-page booklets with 18 pairs per page randomly ordered so that every condition occurred equally often on each page. Recall booklets were different randomizations of stimulus items, with every condition again represented equally often on each page.

Procedure. Our instructions were based on those of Day and Bellezza (1983). One group rated the vividness of composite images, defined as mental pictures in which referents of the words interacted in some way. Very clear images received high vividness ratings (6 or 7), and unclear or nonexistent images received low ratings (1 or 2). Another group rated the ease or difficulty with which pairs aroused composite images. Interactive images that occurred quickly and easily received high ratings (6 or 7), whereas difficult or nonexistent images received low ratings (1 or 2). A third group rated the relatedness of the meanings of the two words. Highly related meanings received high ratings (6 or 7), and completely unrelated meanings received low ratings (1 or 2). The subjects were to use the entire range of numbers, if necessary, but to use particular numbers as often as they deemed appropriate.

Booklets were distributed randomly, with 5 subjects per condition receiving each of the eight randomizations. Four sample pairs were given (related and unrelated concrete, related and unrelated abstract), and the rating scale appeared at the top of each page. Following the ratings, the subjects were unexpectedly given cued recall booklets and wrote as many response terms as they could remember from the rating task. The subjects worked at their own pace, and had unlimited time for the rating task and about 5 min for recall.

Results and Discussion

Mean ratings and proportion recalled were determined as a function of item type (DB or new), concreteness, pair relatedness, and associative strength for new items (low, medium, or high). We report ratings and recall separately, describing important factorial effects of the variables before the Day and Bellezza contrast. The DB and new items produced similar results and are reported together. Where two means, *F* values, or *t* values are presented, the first refers to the DB analysis and the second to the new analysis. For the DB items, the degrees of freedom for the denominators of all effects were 39 and 78 for the relatedness and imagery measures, respectively. Analyses of the new items also had these degrees of freedom except for effects involving associative strength, for which

degrees of freedom were twice as large. Although associative strength was crossed with relatedness in the following analyses, it was not expected to affect the unrelated pairs.

Relatedness ratings. Mean relatedness ratings are shown in Figure 1 and Table 1. Relatedness ratings for both the DB and new items were significantly higher for related than unrelated pairs ($F_s = 1,024.46, 878.48, p_s = .000$), and relatedness ratings increased with increases in associative strength only for the related pairs ($F = 20.06, p = .000$, for the relatedness \times strength interaction). These effects confirmed the validity of the relatedness and associative strength variables.

Although relatedness ratings were higher for abstract pairs than for concrete pairs, this effect was qualified by the interaction between concreteness and relatedness shown in Figure 1 ($F_s = 25.40, 77.30, p_s = .000$). Relatedness ratings were substantially lower for concrete than abstract unrelated pairs ($t_s = 7.51, 4.55, p_s < .001$), whereas the original related concrete and abstract pairs were generally similar in measured relatedness ($t_s = 2.09, -1.39, p_s = .05$ or larger). The exceptionally low relatedness ratings found for unrelated concrete pairs have implications for imagery ratings if the latter are influenced, as expected, by associative factors.

Composite imagery ratings. The imagery ratings presented in Figure 1 and Table 1 are collapsed across vividness and ease of imagery instructions, which did not qualify any of the following effects. The hypothesized role of associative factors in composite imagery was supported by robust effects of relatedness and associative strength, and by other similarities between relatedness and composite imagery ratings. Imagery ratings were higher for

Table 1
Experiment 1: Mean Ratings for New Items as a Function of Relatedness, Concreteness, Instructions, and Associative Strength

Strength	Related		Unrelated	
	Concrete	Abstract*	Concrete*	Abstract
Imagery Instructions				
High	6.42	4.75	3.74	3.14
Medium	6.42	4.52	3.93	3.19
Low	5.96	4.66	3.95	3.08
Relatedness Instructions				
High	6.00	5.91	2.31	3.13
Medium	5.96	5.27	2.45	3.30
Low	5.26	5.24	2.30	3.18

*The critical Day and Bellezza (1983) conditions.

related than unrelated pairs ($F_s = 393.65, 439.16, p_s = .000$) and increased with associative strength for new related pairs but not for unrelated pairs ($F = 7.71, p = .001$) for the interaction. Relatedness and imagery ratings showed other similarities that implicated associative factors in composite imagery ratings, including similar three-way interactions due to differences between concrete and abstract medium-strength related pairs. Overall, the 12 relatedness means and the corresponding imagery means correlated .75.

Word concreteness also influenced composite imagery ratings, with higher ratings for concrete than abstract pairs ($F_s = 18.35, 65.27, p_s = .000$). Given the influence of relatedness on imagery ratings, however, the strength of this concreteness effect could be weakened by the observed confounding of concreteness and measured relatedness for unrelated pairs. This hypothesis was supported by a significant interaction between concreteness and relatedness ($F_s = 10.66, 112.78, p_s = .002, .000$; see Figure 1). For both DB and new items, the differences in composite imagery ratings between concrete and abstract related pairs ($t_s = 5.50, 6.46$) were larger than the differences between concrete and abstract unrelated pairs ($t_s = 2.56, 2.89$; see Figure 1). These effects reflect the most important correspondence between relatedness and imagery ratings, namely the larger effect of relatedness for concrete than abstract pairs.

A comparison between imagery ratings for pairs and individual words provides additional evidence for the hypothesis that low relatedness depressed imagery ratings for unrelated concrete pairs. Composite imagery ratings for unrelated concrete pairs ($M_s = 3.83, 3.87$) were much lower than their individual imagery ratings ($M_s = 6.27, 6.17$). Composite imagery ratings ($M_s = 3.42, 3.14$) for abstract unrelated items, however, were closer to their individual imagery ratings ($M_s = 4.56, 3.86$). Given the strong effects of relatedness on composite imagery ratings, the exceptionally low relatedness of unrelated concrete pairs seems a likely cause of their relatively low imagery ratings, which contribute to the Day and Bellezza rating effect.

The Day and Bellezza rating effect. Mean imagery ratings for unrelated concrete and related abstract pairs appear in Figure 1 and the middle two columns of

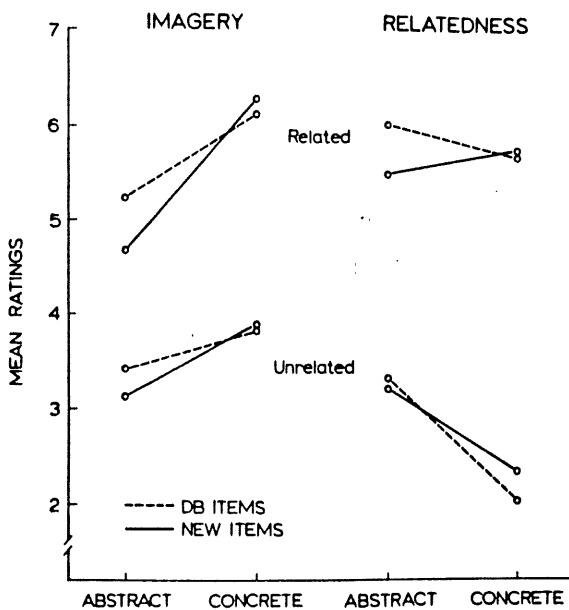


Figure 1. Imagery and relatedness ratings for Experiment 1 as a function of pair relatedness, concreteness, and item type. Abstract related and concrete unrelated are the critical Day and Bellezza (DB; 1983) conditions.

Table 1. Using pooled error terms from the preceding factorial analyses, we determined that unrelated concrete pairs always received significantly lower imagery ratings than did related abstract pairs ($ps < .001$). This was true irrespective of type of imagery instruction, associative strength, and type of item, although the mean composite imagery rating for related abstract pairs was somewhat lower for the new items than for the DB items. Since the present study used self-paced booklets and group testing, and counterbalanced words across related and unrelated conditions, we conclude that the Day and Bellezza result is a very general finding.

In light of the effects of relatedness on imagery ratings and the very low relatedness of unrelated concrete pairs, however, the imagery rating results are not problematic for dual coding theory. Composite imagery ratings were simply more influenced by pair relatedness than by concreteness, here as in Day and Bellezza's (1983, p. 254) study. There was even some evidence that subjects who were sensitive to associative relatedness were insensitive to concreteness, and vice versa. Specifically, for subjects in the imagery groups, concreteness effect scores (concrete M minus abstract M) and relatedness effect scores (related M minus unrelated M) were negatively correlated [$r(78) = -.59$].

Rating instructions and recall. Recall results, presented in Tables 2 and 3, were generally consistent with dual coding assumptions about the effects of concreteness, relatedness, and instructions. Recall by the imagery groups was not affected significantly by type of imagery instruction (vividness or ease). Subjects recalled more concrete than abstract words ($F_s = 190.81, 616.72, ps = .000$) for both DB and new items, and more related than unrelated words ($F_s = 64.54, 384.62, ps = .000$). Associative strength of new items had a significant main effect that was qualified by interactions with several variables, most notably relatedness ($F = 29.10, p = .000$). As shown in Table 3, recall increased with strength for related pairs, but not for unrelated pairs.

As can be seen in Tables 2 and 3, there were simple effects of concreteness and relatedness at both levels of the other variable, which is generally consistent with the

Table 2
Experiment 1: Mean Recall as a Function of Relatedness, Concreteness, Instructions, and Item Type

	Related		Unrelated	
	Concrete	Abstract*	Concrete*	Abstract
Imagery Instructions				
DB Items	.61	.28	.39	.16
New Items	.71	.28	.45	.09
Relatedness Instructions				
DB Items	.66	.39	.30	.18
New Items	.75	.36	.36	.10

*The critical Day and Bellezza (1983) conditions.

Table 3
Experiment 1: Mean Recall for New Items as a Function of Relatedness, Concreteness, Instructions, and Associative Strength

Strength	Related		Unrelated	
	Concrete	Abstract*	Concrete*	Abstract
Imagery Instructions				
High	.82	.39	.49	.10
Medium	.75	.23	.40	.09
Low	.55	.21	.46	.07
Relatedness Instructions				
High	.82	.51	.37	.11
Medium	.81	.33	.36	.09
Low	.62	.25	.36	.12

*The critical Day and Bellezza (1983) conditions.

dual coding assumption that referential imagery and associative relatedness contribute independently to memory. Nonetheless, concreteness and relatedness interacted ($F_s = 7.49, 9.30, ps = .008, .003$), so that absolute differences were larger between concrete and abstract related pairs than between concrete and abstract unrelated pairs. This deviation from strict additivity can be explained by the effect of associative relatedness on recall and the low degree of relatedness of unrelated concrete pairs. That is, for both DB and new unrelated pairs, the confounding of concreteness and relatedness would lower recall for unrelated concrete items.

Recall by subjects given relatedness instructions showed some of the same effects (see Tables 2 and 3), but now the relatedness effect was stronger than the concreteness effect. Subjects recalled more related than unrelated words ($F_s = 91.92, 453.22, ps = .000$) and more concrete than abstract words ($F_s = 34.63, 344.80, ps = .000$). As shown in Table 2, the absolute difference between concrete and abstract pairs was again greater for the related than the unrelated pairs ($F_s = 7.92, 17.03, ps = .008, .000$, for the interaction) between concreteness and relatedness. The main effect of associative strength was qualified by an interaction with relatedness ($F = 18.46, p = .000$). Recall increased with strength for related pairs and, as expected given the random pairings, not for unrelated pairs (see Table 3 and also Murray, 1982).

Both concreteness and associative relatedness benefited recall. Moreover, instructions may have affected the relative magnitude of the two effects, with the concreteness effect appearing larger under imagery instructions, and the relatedness effect appearing larger under relatedness instructions. Instructions may have particularly influenced recall for unrelated concrete and related abstract pairs, the two cells involved in the Day and Bellezza effect.

The Day and Bellezza recall effect. Pooled error terms from the preceding analyses were used to compare unrelated concrete and related abstract pairs. The imagery conditions replicated Day and Bellezza's results; that is, subjects given imagery instructions generally recalled more unrelated concrete pairs than related abstract pairs

for both DB and new items ($t_s = 3.73, 5.54$; see Table 2). This effect occurred with both vividness and ease of imagery instructions. Day and Bellezza's finding of superior recall for unrelated concrete pairs is therefore quite general, at least under imagery instructions. Table 3 shows, nonetheless, that even given imagery instructions, the difference between unrelated concrete and related abstract pairs decreased from low to medium to high levels of associative strength ($t_s = 7.96, 5.49, \text{ and } 3.18$, respectively).

From a dual coding perspective, the Day and Bellezza recall effect results from instructionally induced imagery that benefits episodic memory for unrelated concrete pairs. Given this assumption, the crucial Day and Bellezza recall effect should be weaker without imagery instructions, that is, for the relatedness group. Mean recall for subjects in the relatedness group appears in Tables 2 and 3, and confirms the predicted qualification of the Day and Bellezza recall effect. Subjects who rated relatedness actually recalled significantly more related abstract than unrelated concrete pairs for the DB items ($t = -3.01$), and there was no difference for the new items ($t = .08$). Table 3 shows, moreover, that the Day and Bellezza effect for the new items varied with the associative strength of the related abstract pairs. The higher recall for unrelated concrete than related abstract pairs disappeared and reversed from low to medium to high levels of associative strength ($t_s = 3.85, 1.19, \text{ and } -4.78$, respectively).

That the Day and Bellezza recall effect depended on imagery instructions is consistent with a dual coding model, which can also explain the qualifying effects of associative strength. Moreover, statistical comparisons between imagery and relatedness groups confirmed that related abstract words were remembered significantly better with relatedness than with imagery instructions, whereas unrelated concrete pairs were remembered significantly better with imagery than with relatedness instructions. It therefore seems that instructions to construct integrated images benefit unrelated concrete pairs more than related abstract pairs, whereas relatedness instructions, which activate preexisting verbal associative knowledge, benefit related abstract pairs more than unrelated concrete pairs. Day and Bellezza's hypothesis provides no obvious basis for expecting these qualifications.

EXPERIMENT 2

The Conceptual Peg Hypothesis

Experiment 1 provided an explanation for the Day and Bellezza rating effect, but did not explain why recall and imagery ratings showed opposite patterns. According to the conceptual peg hypothesis (Paivio, 1965, 1971, pp. 247-248), composite images facilitate cued recall only if the recall cue reintegrates the image that was constructed during study. Reintegration depends partly on the imagery value and concreteness of individual words. These scales measure the ease and reliability of image

arousal, as demonstrated by positive correlations with imagery reaction time (Paivio, 1968) and image stability (Morris & Reid, 1973; Paivio, Clark, Digdon, & Bons, in press). The Day and Bellezza recall effect suggests that words in abstract pairs, even related ones, are less likely than words in unrelated concrete pairs to evoke imaginal mediators during retrieval.

Several findings support the conceptual peg hypothesis. The theory correctly predicted that stimulus concreteness would be more important than response concreteness in cued recall (Paivio, 1965). Moreover, Yuille (1973) found that better memory for imaginal mediators accounted for most of the recall difference between concrete and abstract pairs. The retrieval of imaginal mediators has not been directly investigated as a function of relatedness, however, so Experiment 2 tested the prediction that reported memory of imaginal mediators given only the stimuli would be better for unrelated concrete pairs than for related abstract pairs. We also tested whether use of imagery during recall would be reported more often for unrelated concrete than related abstract pairs.

Method

Subjects. Subjects were 20 male and 20 female introductory psychology students who participated as a course requirement. Three additional subjects either failed to complete all of the ratings or misunderstood the instructions.

Materials and Procedures. We used the same materials and random orders from Experiment 1, except that the subjects received only the 24 pairs from each list associated with the DB stimuli. The subjects first rated pairs of words on the vividness of the composite or interactive images aroused by the pairs, which were presented in two-page booklets with 12 pairs per page in random order. Every condition occurred equally often on each page. Five subjects completed booklets for each of the eight orders. The subjects worked at their own pace and had a maximum of 4 min to complete the ratings. An incidental cued recall task followed. Recall booklets were different randomizations of stimulus items, with conditions represented equally often on each of two pages. Three minutes were allowed for recall.

The subjects then completed two image memory questionnaires. They rated how well they remembered their earlier images from the vividness rating task, giving a rating of 1 if they remembered nothing of their earlier image, 2 if they remembered part, and 3 if they remembered all of it. The proportion of three responses was used as a measure of image memory. For the first questionnaire, subjects were shown only the stimulus words, made their ratings, and then described briefly their images for items rated 2 or 3. They then completed a similar rating and image description task given both members of each pair. The stimuli or pairs were presented in booklets in the same order as during study. A final questionnaire asked subjects to indicate for which pairs they had used imagery during recall. Pairs were presented in the same order as during recall. An additional question about verbal mediators is ignored here.

Results and Discussion

Means were determined for individual subjects for each combination of concreteness and relatedness. The factors included in the analyses were concreteness, relatedness,

and gender. Gender had no effects and will not be discussed further. All comparisons involved 1 and 38 degrees of freedom.

The results presented in Table 4 replicate several findings of Experiment 1. For example, exceptionally low relatedness for unrelated concrete pairs presumably explains why composite imagery ratings for those pairs were even lower than ratings for unrelated abstract pairs. Subjects also recalled more concrete than abstract pairs ($F = 123.75, p < .001, MSe = .044$), and this effect was larger than the difference between related and unrelated pairs ($F = 45.90, p < .001, MSe = .029$). The Day and Bellezza effects were also replicated. Vividness ratings were higher for related abstract than unrelated concrete pairs ($F = 302.03, p < .001, MSe = .44$), and the proportion of words recalled was higher for unrelated concrete than related abstract pairs ($F = 26.46, p < .001, MSe = .027$).

Our primary concern in this study was memory for imaginal mediators, as measured by the proportion of pairs for which subjects indicated complete image retrieval (see Table 4), in particular for the unrelated concrete and related abstract pairs. When shown only the stimuli, subjects remembered more entire images for unrelated concrete than related abstract pairs ($F = 7.46, p < .01, MSe = .025$). Confirmation of this prediction extends Yuille's (1973) findings to related pairs and indicates that images for related abstract pairs were difficult to retrieve given only the stimuli, despite the high rated vividness of their composite images. Images for unrelated concrete pairs were well remembered despite imagery ratings that were even lower than those for unrelated abstract pairs. These findings confirm that word concreteness is a better indicator of the capacity for successful image retrieval than are composite imagery ratings, although the causal connection between recall and image retrieval cannot be determined by such correlational data.

When subjects were shown the pairs, the proportion of entire images remembered was the same for unrelated con-

crete and related abstract pairs ($F = .01, n.s., MSe = .033$). The lack of a difference here contrasts with the stimulus-only conditions, and supports the conceptual peg emphasis on the redintegrative capacity of concrete stimuli. That image retrieval was no better for abstract than concrete pairs shows the ephemeral quality of even the most highly rated images for abstract pairs. Moreover, image retrieval for concrete words was almost as good given only the stimuli as given the pairs ($M_s = .52$ and $.59$), whereas abstract stimuli were less effective image retrieval cues than abstract pairs ($M_s = .42$ and $.58$).

Subjects also reported using imagery during recall for a greater proportion of unrelated concrete than related abstract pairs ($F = 3.52, p < .05, one\ tailed, MSe = .028$). The reversal is once again quite striking, given the much higher vividness ratings for related abstract pairs. In a further analysis, recall was conditionalized on reported use of imagery. Since many subjects lacked nonimaged or imaged items for some cells, the average proportion of pairs imaged during recall and successfully recalled was used to estimate average conditional recall proportions given image use or no image use (see Table 1). Conditional recall was higher for unrelated concrete than related abstract pairs when imagery was used, but not when imagery was not used. Use of imagery may be necessary for the superior recall of unrelated concrete pairs.

The results of Experiment 2 supported the conceptual peg explanations for the Day and Bellezza recall effect. When presented as retrieval cues, the stimulus members of related abstract pairs simply failed to redintegrate the entire image, and fostered less use of imagery during recall than did cues from unrelated concrete pairs. One reason that composite imagery ratings to the pairs may not predict image retrieval is that such ratings are strongly affected by pair relatedness, as was demonstrated in Experiment 1.

GENERAL DISCUSSION

Day and Bellezza's (1983) results have led us to a better understanding of the effects of concreteness and pair relatedness on imagery ratings and cued recall. Dual coding theory was shown to be consistent with the earlier findings, and to predict several additional effects that were subsequently confirmed. The dual coding explanation was based on the differential activation of verbal associations and referential images, and on the conceptual peg hypothesis relating stimulus concreteness to cued redintegration of images.

Our findings suggest that composite imagery entails complex referential and associative processes, with the latter having surprisingly strong effects on ratings. The effects of associative relatedness included higher imagery ratings for related than unrelated pairs, and positive effects of associative strength on imagery ratings for related items. The separate importance of referential processes

Table 4
Rating, Recall, and Questionnaire Results for Experiment 2
as a Function of Relatedness and Concreteness

	Related		Unrelated	
	Concrete	Abstract*	Concrete*	Abstract
Day and Bellezza Measures				
Vividness Ratings	6.11	5.66	3.09	3.43
Cued Recall	.83	.42	.60	.28
Image Memory				
Image to Stimulus	.82	.42	.52	.21
Image to Pair	.91	.58	.59	.31
Image Use During Recall				
Used Image	.90	.63	.70	.41
Used Image and Recall	.77	.31	.52	.18
Recall If Image Use	.86	.49	.74	.44
Recall If No Image Use	.60	.30	.27	.17

*The critical Day and Bellezza (1983) conditions.

was shown by concreteness effects that were only partly obscured by the low relatedness of unrelated concrete pairs. Moreover, concreteness and relatedness competed in determining composite imagery ratings, as shown by a negative correlation between relatedness and concreteness effect scores. Given these findings that composite imagery ratings are strongly determined by associative processes, it is not surprising that they do not predict later image retrieval and cued recall as well as concreteness or word imagery value, purer measures of image availability.

Cued recall apparently depended on independent imaginal and verbal memory processes that were related to item attributes and instructions in ways consistent with dual coding theory in general and with the conceptual peg hypothesis in particular. Specifically, concrete words reintegrated their images at the time of recall better than abstract words, and were better remembered, especially under imagery instructions for unrelated concrete pairs. Preexperimental associations between words also facilitated cued recall, especially when related abstract pairs were processed for associative relatedness. Day and Bellezza pitted the recall effect of imagery against that of relatedness (i.e., unrelated concrete vs. related abstract pairs), and imagery won, consistent with other research on the relative mnemonic effectiveness of imagery and verbal processing (see Paivio, 1986, chap. 8). The imagery explanation for this effect was strengthened by evidence that image retrieval was better for unrelated concrete pairs, and the recall superiority disappeared when subjects rated relatedness or reported not using imagery.

Dual coding theory accounts for Day and Bellezza's findings and our new results, but we have said little about the alternative schema theory proposed by Day and Bellezza. Our understanding of that theory suggests that it incorporates many of the same features as dual coding theory. In particular, both theories emphasize perceptual information associated with physical objects as a major component in the mental structures for concrete words. Day and Bellezza, however, apparently endorsed the idea that relational knowledge is represented as generic, abstract schemata, whereas dual coding theory more closely ties relational information to the perceptual-motor experiences from which it derives. Some of Day and Bellezza's data are more consistent with the dual coding model. For example, their subjects reported that 93% of their images resembled specific prior experiences. Other cued recall phenomena that challenge the hypothesis of generic schema include interactive images' being more effective than sentence or other verbal mediators, and subjects' labelling their mediators as imaginal rather than as verbal or some other kind of mental event (see discussion by Paivio, 1986, chap. 8). Such findings are consistent with dual coding theory, which assumes that perceptual information is stored as imaginal representations and associations, and that it is the activation and use of this

nonverbal information that enhances memory (see earlier discussion).

In conclusion, Day and Bellezza's results demonstrate a need for more systematic investigations of the ways in which such factors as concreteness, relatedness, and instructions interact to determine composite imagery ratings and cued recall. The present paper sheds some light on the relevant processes, but many questions remain unanswered. We do not yet know precisely how concreteness and relatedness affect the generation of interactive images, and we do not understand fully the imaginal processes by which separate images might be transformed and manipulated into a composite unit. Research on these and other questions stimulated by Day and Bellezza's results will further our understanding of how cued recall and related phenomena are determined by imagery and verbal processes.

REFERENCES

- BEGG, I., & CLARK, J. M. (1975). Contextual imagery in meaning and memory. *Memory & Cognition*, 3, 117-122.
- CLARK, J. M., & PAIVIO, A. (1987). A dual coding perspective on encoding processes. In M. A. McDaniel & M. Pressley (Eds.), *Imagery and related mnemonic processes: Theories, individual differences, and applications* (pp. 5-33). New York: Springer-Verlag.
- DAY, J. C., & BELLEZZA, F. S. (1983). The relation between visual imagery mediators and recall. *Memory & Cognition*, 11, 251-257.
- KATZ, A. N., PAIVIO, A., MARSCHARK, M., & CLARK, J. M. (in press). Norms for 204 literary and 260 nonliterary metaphors on 10 psychological dimensions. *Metaphor and Symbolic Activity*.
- KUSYSZYN, I., & PAIVIO, A. (1966). Transition probability, word order, and noun abstractness in the learning of adjective-noun paired associates. *Journal of Experimental Psychology*, 71, 800-805.
- MORRIS, P. E., & REID, R. L. (1973). Recognition and recall: Latency and recurrence of images. *British Journal of Psychology*, 64, 161-167.
- MURRAY, D. J. (1982). Rated associability and episodic memory. *Canadian Journal of Psychology*, 36, 420-434.
- O'NEILL, B. J., & PAIVIO, A. (1978). Semantic constraints in encoding judgments and free recall of concrete and abstract sentences. *Canadian Journal of Psychology*, 32, 3-18.
- PAIVIO, A. (1965). Abstractness, imagery, and meaningfulness in paired-associative learning. *Journal of Verbal Learning & Verbal Behavior*, 4, 32-38.
- PAIVIO, A. (1966). Latency of verbal associations and imagery to noun stimuli as a function of abstractness and generality. *Canadian Journal of Psychology*, 20, 378-387.
- PAIVIO, A. (1968). A factor-analytic study of word attributes and verbal learning. *Journal of Verbal Learning & Verbal Behavior*, 7, 41-49.
- PAIVIO, A. (1969). Mental imagery in associative learning and memory. *Psychological Review*, 76, 241-263.
- PAIVIO, A. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart and Winston. Reprinted 1979, Hillsdale, NJ: Erlbaum.
- PAIVIO, A. (1972). Symbolic and sensory modalities of memory. In M. E. Meyer (Ed.), *The Third Western Symposium on Learning: Cognitive learning* (pp. 109-136). Bellingham: Western Washington State College.
- PAIVIO, A. (1986). *Mental representations: A dual coding approach*. New York: Oxford University Press.
- PAIVIO, A. (1974). *Imagery and familiarity ratings for 2448 words: Unpublished norms*. Unpublished manuscript, University of Western Ontario, Department of Psychology, London, Ontario, Canada.

- PAIVIO, A., & BEGG, I. (1971). Imagery and associative overlap in short-term memory. *Journal of Experimental Psychology*, *89*, 40-45.
- PAIVIO, A., CLARK, J. M., DIGDON, N., & BONS, T. (in press). Referential processing: Reciprocity and correlates of naming and imaging. *Memory & Cognition*.
- PAIVIO, A., & FOTH, D. (1970). Imaginal and verbal mediators and noun concreteness in paired-associative learning: The elusive interaction. *Journal of Verbal Learning & Verbal Behavior*, *9*, 384-390.
- PAIVIO, A., YUILLE, J. C., & MADIGAN, S. A. (1968). Concreteness, imagery, and meaningfulness values for 925 nouns. *Journal of Experimental Psychology*, *78*(1, Pt. 2).
- RICHARDSON, J. T. E. (1980). *Mental imagery and human memory*. London: Macmillan.
- YUILLE, J. C. (1973). A detailed examination of mediation in PA learning. *Memory & Cognition*, *1*, 333-342.
- YUILLE, J. C., & PAIVIO, A. (1967). Latency of imaginal and verbal mediators as a function of stimulus and response concreteness-imagery. *Journal of Experimental Psychology*, *75*, 540-544.

NOTE

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