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Visual distinctiveness *can* enhance recency effects

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Experimental efforts to meliorate the modality effect have included attempts to make the visual stimulus more distinctive. McDowd and Madigan (1991) failed to find an enhanced recency effect in serial recall when the last item was made more distinct in terms of its color. In an attempt to extend this finding, three experiments were conducted in which visual distinctiveness was manipulated in a different manner, by combining the dimensions of physical size and coloration (i.e., whether the stimuli were solid or outlined in relief). Contrary to previous findings, recency was enhanced when the size and coloration of the last item differed from the other items in the list, regardless of whether the "distinctive" item was larger or smaller than the remaining items. The findings are considered in light of other research that has failed to obtain a similar enhanced recency effect, and their implications for current theories of the modality effect are discussed.

Considerable research has sought to explain why recency effects are greater for auditory than for visual stimuli. Attempts to identify the characteristics of acoustic stimuli that account for this modality effect have included an emphasis on the greater duration of acoustic (Crowder & Morton, 1969) or, more broadly, speech-like stimuli in precategorical storage (Crowder, 1986); the easier linguistic encoding of such stimuli (Nairne, 1988; Shand & Klima, 1981); and the property that they have of changing states during temporal presentation (Campbell, Dodd, & Brasher, 1983; Glenberg, 1990; Glenberg & Swanson, 1986; Kallman & Cameron, 1989). These theoretical approaches are all similar in assuming that aspects of auditory stimuli somehow make them more "distinctive" and that this distinctiveness consequently enhances recency effects.

Following from this approach, experimental efforts to meliorate the modality effect have included attempts to make visual stimuli more distinctive. Distinctiveness has been manipulated in a number of different ways. The most common method of increasing visual distinctiveness is to present visual stimuli that change state, in a manner analogous to that of acoustic stimuli. For instance, a visual stimulus might be presented gradually over time (Crowder, 1986), or move through space (Glenberg, 1990; Kallman & Cameron, 1989), to mirror the temporal properties of a spoken stimulus. The effect of such manipulations is inconsistent: movement tends to enhance the visual recency effect, whereas temporal unfolding does not. Changing state is capable of enhancing recency, but it is most likely to do so if movement of an image is relevant to the subjects' task (Glenberg, 1990; Kallman & Cameron, 1989).

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An alternative method for increasing distinctiveness is to make the static visual properties of a set of stimuli more salient, by manipulating what Nairne (1988, 1990) refers to as "modality-dependent" features. McDowd and Madigan (1991) were unable to enhance recency effects in this manner, despite several attempts, which included making visual stimuli more distinctive in terms of their color, salience within the presentation environment (i.e., by minimizing visual interference), or spatial distribution.[1]

McDowd and Madigan's (1991) series of experiments can be broken down into two separate paradigms. In some experiments (Experiments 1 and 2), they made only the last item in a set distinctive, and compared serial recall for that condition to a control condition in which all items in a set had the same visual properties. This method is similar to that used in research on the von Restorff phenomenon, or isolation effect (von Restorff, 1933). Considerable research has shown that individual list items that are isolated from the rest of the list and hence made more vivid—by being printed in a different color, for example—are learned better (Wallace, 1965). McDowd and Madigan's "last-item" approach differs from standard demonstrations of the von Restorff effect in several ways. First, they measured short-term forgetting, as opposed to having subjects learn a list of items to criterion through repeated presentations. Second, they required subjects to perform serial recall, as opposed to the free recall or paired-associate tasks that are frequently used in research on the von Restorff effect (Wallace, 1965). And third and most importantly, they manipulated the distinctiveness of the final item, instead of embedding the incongruous item in the middle of the list. Their last-item experiments, then, can be viewed as an attempt to discover whether the von Restorff effect improves memory for the final item in a list above and beyond the recency effect.

In the remainder of McDowd and Madigan's (1991) research (Experiments 3–7), all items within the experimental stimulus sets were made distinct, and performance in this condition was compared with that in a control condition. For example, they investigated the effect of color in both paradigms. In the last-item approach, the last digit in the experimental sets had one color, and the rest of the digits in these sets had a second color; in the "whole-set" method, every digit in the experimental sets had a different color. In both experiments, the control condition consisted of sets that were uniform in color. Neither method resulted in an enhanced recency effect for the distinct condition. Since none of their other distinctiveness manipulations enhanced recency either, McDowd and Madigan concluded that making the static properties of visual stimuli more salient does not increase recency effects.

There are two problems with this conclusion, one conceptual and the other methodological. Conceptually, since *recency* refers to enhanced memory for the final item(s) in a stimulus set, any manipulation designed to influence recency ought logically to focus on those items, rather than on the entire set. If every item is different from every other item, the final item is not uniquely distinctive, in the sense of standing apart from an otherwise homogeneous group of items. Although McDowd and Madigan (1991) have convincingly demonstrated that manipulating the distinctiveness of the whole set (e.g., by changing colors or spatial distribution) does not improve recall for the whole set, in only two of their experiments did they manipulate solely the final digit, and both of these experiments were limited to the dimension of color. In order to draw strong conclusions about what does and does not affect recency, additional research is needed that explores the effect of other distinctiveness manipulations upon the last item in a set. In the present experiments, we sought to extend McDowd and Madigan's findings on stimulus color by investigating the effect on recency of the final item's size and coloration. *Coloration* refers not to an item's color (e.g., red or blue), but to whether or not it has a solid, filled-in appearance.

The methodological problem concerns McDowd and Madigan's (1991) operationalization of "enhanced recency," which they define as an interaction between serial position and treatment condition. Since *recency* refers to memory for only the final item(s), this definition is unnecessarily conservative. When the distinct and control conditions are identical except for the final item, an extremely large difference in performance on that item will be required for an interaction between treatment condition and serial position across a nine-item list to approach conventional statistical significance.

A less restrictive, yet more widely used, operationalization of recency is the "kickup" method, which compares performance at the last and next-to-last serial positions (e.g., Battacchi, Pelamatti, Umiltà, 1990; Campbell et al., 1983; Kallman & Cameron, 1989; LeCompte, 1992; Nairne & Pusen, 1984; Watkins & Sechler, 1989). Another common test of experimental effects on recency is a simple planned comparison of performance at the final position across conditions (e.g., Frankish & Turner, 1985; Frick, 1988, 1990; LeCompte & Watkins, 1995; Morton, 1976; Morton, Crowder, & Prussin, 1971; Neath, Surprenant, & Crowder, 1993). When recall for the entire list or across serial positions is of interest, as in McDowd and Madigan's (1991) whole-set paradigm (Experiments 3–7), an analysis of variance (ANOVA) with interaction term is the appropriate analysis; but to assess specifically whether recency has been enhanced by an experimental treatment, analyses focusing on the last item or items in a stimulus set are more straightforward.

McDowd and Madigan (1991) do not report either simple planned comparisons on the final item or analyses of the relative increase between the penultimate and final items. However, inspection of the graphs for their two "last-item" experiments (McDowd & Madigan, 1991, p. 372) shows that, in both cases, performance on the last item was better in the distinct than in the control condition. Since the present experiments specifically address the recency effect, we use both the kickup method and simple planned comparisons. To maintain consistency between this replication and McDowd and Madigan's research, overall analyses of variance are performed as well.

EXPERIMENT 1

Method

Except where noted, the experimental procedures and materials were the same as those used by McDowd and Madigan.

Subjects. The subjects were 26 Louisiana State University undergraduates who participated for extra course credit.

Materials and Design. The distinctiveness manipulation consisted of varying the size of the last item in the stimulus set relative to the other items in the set. Sets of nine digits (1–9 without repetition) were presented one digit at a time against a white background in the center of a computer screen. Half the stimulus sets were *control* lists, while half were *distinct* lists. In the control condition, all digits were outlined in black and were 13 mm in height (56-point Geneva font). In the distinct condition, the first eight digits were the same as in the control condition, but the ninth and final digit was solid black and 20 mm tall (i.e., approximately 50% larger than the control digits, or 86-point Geneva font). An example of the digit types is shown in Figure 1. The digits were presented in random sequence at a rate of one digit per second on Macintosh Classic II computers.

Procedure. Each subject was seated at a computer monitor with a keyboard. The subjects were instructed that they would be recalling lists of digits in the order in which the digits were presented. They were told that some digits might look different from others, but that their job was simply to remember as much of each list as was possible. The experiment began with three practice (control) trials to familiarize subjects with the procedure. The subjects were then exposed to 40 experimental trials, 20 of each type, in random order. The presentation order differs from McDowd and Madigan's (1991) procedure, in which blocked trials were used. Random order was chosen to counteract the positive practice effects found by McDowd and Madigan.

Immediately after the presentation of each list, the subjects were asked to recall the nine digits in order by typing the digits on the keyboard. The subjects were told to type a "/" in the serial position for any digits they could not remember. There was no time limit. As soon as the subjects typed their response for the final item, the screen cleared, and 2 sec later, a beep sounded to indicate that the next list was about to begin.

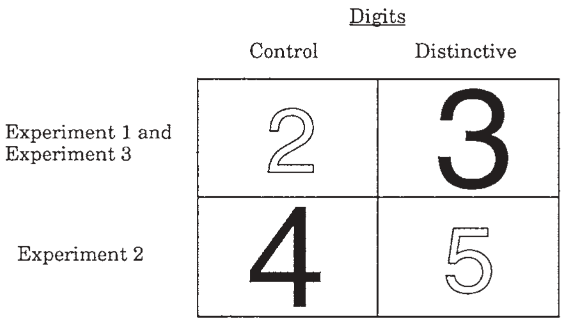

Figure 1. Examples of the control and distinctive digits used in Experiments 1–3.

Results

The results of Experiment 1 appear in Figure 2. A two-way ANOVA revealed no significant main effect of list type [$F(1,200) = 3.79$, $p < .07$]; that is, there was no reliable difference in overall memory performance between the lists of all similar digits and the lists with a final visually distinct digit.[2]

In addition to a main effect of serial position [$F(8,200) = 36.85$, $p < .0001$], the list type × serial position interaction was significant [$F(8,200) = 2.59$, $p = .01$]. Thus, even by the conservative standard imposed by the ANOVA, the distinctiveness of the final item in the set enhanced recency. This result was corroborated by two more specific measures of recency. The planned comparison of performance on the last serial position between the distinct and the control conditions was significant [$t(25) = 4.01$, $p < .001$, one-tailed]. An interaction contrast comparing performance on the ninth with that on the eighth position in the two conditions was also significant [$t(25) = 1.96$, $p < .05$, one-tailed], showing a greater increase in the probability of recall for the distinct than for the control condition. Thus, unlike varying the color of the last item in a set, varying distinctiveness

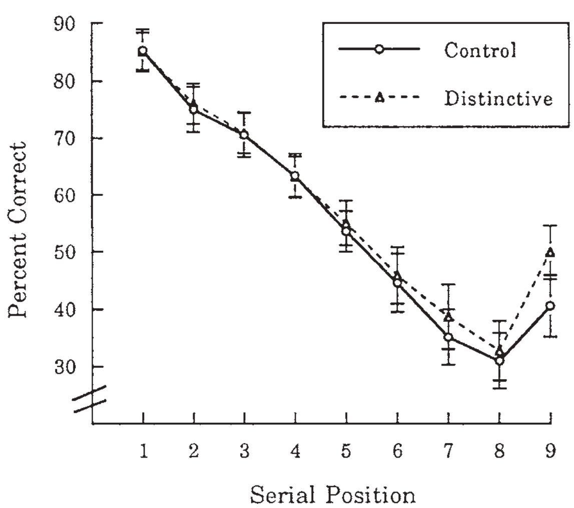

Figure 2. Percent correct (with standard errors) as a function of serial position and distinctiveness condition, Experiment 1.

in terms of the last item's size and coloration does produce a greater recency effect for visual stimuli.

EXPERIMENT 2

A possible interpretation of the enhanced recency effect in the distinct condition of Experiment 1 is that it does not have to do with the direct effect of distinctiveness on memory at all. Since the experimental manipulation varied items' size, the larger, more distinct stimulus might have been easier to recall simply because it was easier to perceive. However, research on the von Restorff effect suggests otherwise. Gumenik and Levitt (1968) demonstrated superior learning for an isolated CVC trigram that was embedded in a list of trigrams—in the sixth of nine positions—whether it was larger or smaller than the control items. The crucial factor was not the isolated item's size, but the contrast between it and the remaining items. In Experiment 2, we explored the implication of this finding for the recency effect by reversing the size of the distinct and the control digits, in order to ensure that the results of Experiment 1 were not due merely to the fact that the distinct digit was easier to perceive than the other digits.

Method

Subjects. The subjects were 34 Louisiana State University undergraduates who received extra course credit.

Materials and Design. The design was identical to that of Experiment 1, with the exception that the visual properties of the control and the distinct digits were reversed. The control digits were solid black and 20 mm in height, whereas the distinctive digit was outlined in black and 13 mm tall (see Figure 1). As in Experiment 1, all digits had the same properties except for the single distinctive digit, which in this case was smaller than the other digits.

Procedure. The procedure was identical to that of Experiment 1.

Results

The results of Experiment 2 appear in Figure 3. As in Experiment 1, there was a main effect of serial position [$F(8,264) = 62.84$, $p < .0001$], but no significant effect of list type [$F(1,264) = 3.20$, $p < .09$] (see note 2). Although the list type × serial position interaction was not significant [$F(8,264) = 1.62$, $p < .12$], the trend was in the predicted direction. Furthermore, the planned comparison of performance on the last digit in the two conditions once again showed a clear effect [$t(33) = 2.65$, $p < .01$, one-tailed], and a contrast performed on the final two items again showed greater enhancement in the distinct condition [$t(33) = 2.30$, $p < .05$, one-tailed]. When the final digit in the series is different in size from the other items in the list, it is remembered better whether it is larger or smaller. The enhanced recency effect appears to be due to the property of greater distinctiveness, and not to ease of perception.

EXPERIMENT 3

As mentioned previously, the order of the experimental conditions that was used in Experiments 1 and 2 dif-

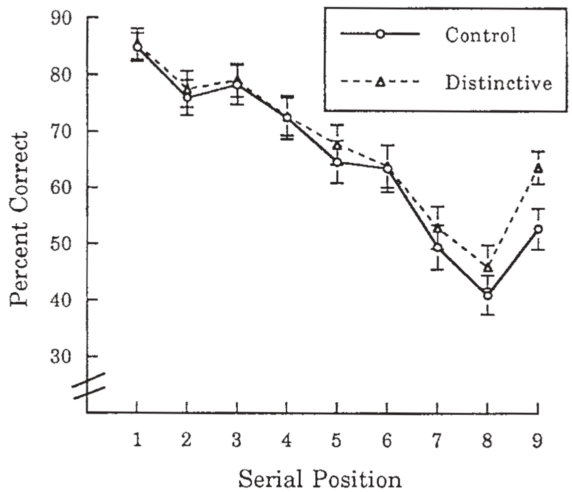

Figure 3. Percent correct (with standard errors) as a function of serial position and distinctiveness condition, Experiment 2.

fered from that used by McDowd and Madigan (1991). They presented *distinct* and *control* lists in a blocked format, whereas in the present experiments, we employed a mixed format. Whether a within-subjects experimental manipulation is presented in blocked or random order has been shown to affect performance on a variety of memory tasks (see, e.g., Barsalou & Ross, 1986; May, Cuddy, & Norton, 1979). Perhaps the discrepancy between our results and those of McDowd and Madigan (1991) was due to this variation in stimulus presentation. In Experiment 3, we tested this possibility by replicating Experiment 1, with a blocked presentation.

Method

The design and procedure were identical to those of Experiment 1, with the sole exception that the 20 control and 20 distinct lists were blocked. Half the subjects received the control lists first, and the other half received the distinct lists first. The subjects were 46 Louisiana State University undergraduates who received extra course credit.

Results

The results, which are depicted in Figure 4, are consistent with those of Experiments 1 and 2. There was a main effect of serial position [$F(8,360) = 68.38$, $p < .0001$], but no main effect of list type [$F(1,360) = 0.39$]. An enhanced recency effect for the distinct lists was obtained in all three analyses. Both the planned comparison on the final item [$t(45) = 3.41$, $p < .005$, one-tailed] and the kickup measure [$t(45) = 2.70$, $p < .005$, one-tailed] showed a reliable advantage for the distinct condition. The overall list type × serial position interaction was also significant [$F(8,360) = 4.09$, $p < .0001$]. Thus the enhanced recall of the final item on the list was due to its distinctive size and coloration and did not depend on presentation order. Rather than occurring only with random presentation, the size of the effects suggests that, if anything, the effect of visual distinctiveness on recency may be greater for blocked presentation.

DISCUSSION

Different means may be employed to increase the size of the recency effect with visual stimuli. One method is to make the entire set of visual stimuli more like auditory stimuli, provided that the added dimension is relevant to the subjects' task. Merely increasing the resemblance of a set of visual stimuli to auditory stimuli—such as by introducing temporal unfolding (Crowder, 1986) or by reducing extraneous interference (McDowd & Madigan, 1991)—is insufficient to enhance recency. However, this "whole-set" approach is capable of enhancing recency when the variation is important to subjects' performance. For example, changing states by having stimuli move affects recency if the task requires subjects to attend to stimulus movement to do well (Glenberg, 1990; Kallman & Cameron, 1989).

A second approach focuses on modality-dependent features of the visual stimulus itself (Nairne, 1988, 1990)—that is, by making certain visual features somehow more salient. Greater saliency of visually presented features should lead to improved recall, since it would strengthen the encoding of nonverbal information (Nairne, 1988). The effectiveness of visual distinctiveness at enhancing recency appears to depend on two factors: first, on whether saliency is manipulated for the entire set or just the last item; and second, on which dimension is used to make the static properties of the stimulus more salient.

McDowd and Madigan (1991) have demonstrated that increasing the visual distinctiveness of an entire set of items by varying each item's color or spatial location does not enhance recency. One explanation of these results is that, as with their last-item color manipulation, McDowd and Madigan's whole-set manipulations were simply not strong enough to produce an effect. Additional experiments employing the whole-set method are needed in order to show whether or not that was the case.

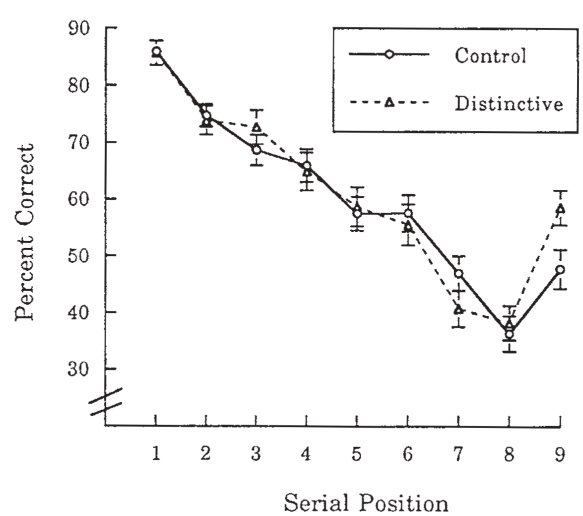

Figure 4. Percent correct (with standard errors) as a function of serial position and distinctiveness condition, Experiment 3.

However, since *recency* refers to enhanced memory for the final item, additional whole-set manipulations seem unlikely to improve performance, unless they are relevant to the subjects' task, as with changing-state manipulations. For example, if identification of stimulus color were somehow needed in order to determine what to recall, then a whole-set color manipulation should be capable of enhancing the recency effect (cf. Kallman & Cameron, 1989).

Greater distinctiveness of the last item, on the other hand, can enhance recency whether or not it is relevant to the subjects' task. Its capacity to do so depends on the dimension that is used. Changing the color of the last item, relative to that of other members of the set, does not affect the probability that it will be recalled (McDowd & Madigan, 1991); however, changing the size and coloration of the last item—in either direction—significantly increases the size of the recency effect. This result is consistent with research on the von Restorff effect, in which isolating a single item in the middle of the list by making it surprising or incongruous improves recall for that item (Wallace, 1965). Although most research on the von Restorff effect has manipulated stimulus color (Wallace, 1965), distinctive size has also been shown to produce an effect (e.g., Gumenik & Levitt, 1968; van Buskirk, 1932).

Visual distinctiveness can enhance the recency effect whether stimuli are presented in a blocked or in a mixed format. The discrepancy between the present experiments and McDowd and Madigan's (1991) results can be attributed to the greater saliency of the size and coloration manipulation, in comparison with their color manipulation. The larger of the two sizes used in the present experiments was approximately 50% bigger than the smaller size. With a distinctiveness manipulation this large, the recency effect is enhanced whether it is operationalized as an interaction between serial order and a treatment variable or as a simple effect.

Further research is needed in order to determine the size differential that is necessary for the contrast to be sufficiently distinctive to produce an effect, as well as to separate the relative contribution to the effect of the dimensions of size and coloration. Using a somewhat different methodology (free as opposed to serial recall, with a distractor task after each stimulus), Neath (1993, Experiment 3) obtained a distinctiveness effect by increasing stimulus size alone, which suggests that size has an effect independent of coloration. Experiments manipulating size and coloration orthogonally are clearly called for, in order to determine the relative contribution of both dimensions, as well as any possible interaction between them.

When the distinctive stimulus is embedded in the middle of the list, rather than at the end, the learning advantage increases as a linear function of the discrepancy between the distinctive and nondistinctive items (Gumenik & Levitt, 1968; Wallace, 1965). Making an individual embedded item distinct along a greater number of dimensions increases the size of the von Restorff effect as well (Ericksen, 1963). It seems plausible to expect that these findings would generalize to a distinctive final item. As the saliency of the final item—no matter how it is manipulated—increases or decreases, the recency effect should be moderated accordingly.

In summary, the effectiveness of visual distinctiveness at enhancing recency depends on the stimulus dimension that is manipulated. As is true for items in other list positions (von Restorff, 1933; Wallace, 1965), varying the size and coloration of the final item in a list of digits increases the probability that it will be recalled, even when these features are irrelevant to the subjects' task. Greater distinctiveness is thus capable of producing a von Restorff effect that improves recall of the final item above and beyond the typical recency effect. This enhanced recency effect is due solely to the difference in appearance between the final digit and the rest of the set, and not to other factors such as presentation order or the ease with which stimuli with different appearances can be perceived.

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NOTES

1. Battacchi, Pelamatti, and Umiltà (1990) reported a single experiment in which recency was enhanced by varying the spatial distribution of the stimuli, but LeCompte (1992) failed to replicate their finding in any of seven experiments.

2. The marginally significant advantage for distinct lists that was found in this experiment also appeared in Experiment 2, but there was no hint of an effect in Experiment 3. Although an enhanced final digit does imply the existence of a small overall list effect, research on the von Restorff effect has shown that an isolated item sometimes facilitates recall of other items and sometimes inhibits it, while most often having no effect at all on overall list retention (Wallace, 1965). Because our primary interest is with recency effects, we shall not discuss this finding any further.

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