Does the isolation effect require attention?

Tamra J. Bireta¹ · Colleen M. Mazzei¹

Published online: 21 July 2015
© Psychonomic Society, Inc. 2015

Abstract An item that differs from the surrounding items is remembered better than an item that is consistent with its surroundings; this is known as the *von Restorff effect* or *isolation effect* (von Restorff, *Psychologische Forschung*, 18, 299–342, 1933). Theoretical explanations have proposed that the isolate is processed differently from control items, though some research has suggested that this processing might require more attention for semantic than for physical isolates. To test this possibility, in the present study we examined the isolation effects for physical isolates and semantic isolates under full and divided attention. Participants viewed lists of categorized words, with some lists containing either a physical or a semantic isolate, followed by immediate written free recall. Across three experiments, divided attention eliminated the semantic isolation effect but did not impact the physical isolation effect. Furthermore, semantic isolates were output earlier in recall than controls, whereas physical isolates were output more similarly to controls. These findings suggest that semantic isolation effects require attention during encoding, whereas physical isolation effects are relatively automatic.

Keywords Attention · Divided attention · Isolation effect · Semantic isolate · Physical isolate · Distinctiveness

Memory is influenced by a variety of contextual factors, such as biological state (e.g., Peterson, 1977), the environment (e.g., Godden & Baddeley, 1975), or the manner in which items are processed (e.g., Morris, Bransford, & Franks,

1977). Research has shown that when an item violates the established context, such as viewing a hand mixer in an office setting, memory for the distinctive item improves (e.g., Mäntylä & Bäckman, 1992). This benefit is seen when a list item is different from the other items in the list, known as the *isolation effect*, or the *von Restorff effect* (after von Restorff, 1933). Early explanations of the isolation effect proposed that greater attention is devoted to the isolates than to the background items (e.g., Jenkins & Postman, 1948), though several lines of data have refuted such an explanation (for a review, see Hunt & Lamb, 2001). More recent views have abandoned differential attention in favor of other processing requirements. Although isolates may not require greater attention, it is unclear whether attention is necessary at all. This may depend on the nature of the way in which the isolated item differs from the background. Processing the unique features of isolated items may be more attention-demanding for isolates that are conceptually distinctive (e.g., different category) than for isolates that are perceptually distinctive (e.g., different font color). To that end, the purpose of the present study was to examine whether isolation effects require attention during encoding, and whether this depends on the nature of the isolated items.

The isolation effect has been reliably obtained using a variety of methodologies (for reviews, see Hunt, 1995; Schmidt, 1991; Wallace, 1965). Isolation effects can be achieved by manipulating a physical feature of the item, such as the font size or color, or by selecting an item from a different taxonomic category in a list of words from a single category. Manipulations of color, size, and spacing have been found to be the most effective techniques for producing large isolation effects (e.g., Cimbalò, Capria, Neider, & Wilkins, 1977). There is also some evidence that the effect size increases as the difference between the background and the isolated item increases (e.g., Gumenik & Levitt, 1968).

✉ Tamra J. Bireta
tbireta@tcnj.edu

¹ Department of Psychology, The College of New Jersey, 2000 Pennington Road, Ewing, NJ 08628, USA

One important point made by von Restorff (1933) is that difference alone is not sufficient to yield an isolation effect. For example, if the isolated item was a digit in a list containing various types of items (e.g., a symbol, word, letter, shape, etc.), the isolate would be just as different from the other items as it would be if the list contained only one type of item (e.g., words). Yet, von Restorff demonstrated that the advantage for the isolate only occurs when the isolate is presented amongst a background of similar items. Thus, the isolate must not only be different, but also distinctive. The memory improvement associated with this distinctiveness has resulted in the isolation effect being referred to as “the generic label for the effects of distinctiveness on memory” (Hunt, 1995, p. 105; but see Schmidt, 1991, for a review and a broader discussion of how the effects of distinctiveness on memory depend on how distinctiveness is defined and operationalized). Although the isolation effect has been referred to as “the mother of all distinctiveness effects” (Hunt & Lamb, 2001, p. 1359), the exact cause of the memory improvement has been debated since von Restorff’s experiments.

Attention and the isolation effect

Early explanations of the isolation effect proposed that extra attention is paid to the isolate during encoding (e.g., Jenkins & Postman, 1948). The items that precede the isolate establish a context (e.g., font size or semantic category), and the isolated item becomes salient because it deviates from the established context. This salience may surprise participants, resulting in additional attention and processing (e.g., Green, 1956). The mechanism by which the additional attention aids memory is not clear. Rundus (1971) proposed that the isolate is remembered better because it is rehearsed more than the other items.

Several lines of data have argued against the differential-attention view (for a more thorough discussion, see Dunlosky, Hunt, & Clark, 2000). For example, increased processing of the isolate should reduce processing of the immediately surrounding items, resulting in impaired memory for those items. Such an impairment has been found in some studies (e.g., Hunt & Mitchell, 1982), but not in others (e.g., Bruce & Gaines, 1976; Fabiani & Donchin, 1995). Additionally, isolation effects are obtained when the isolate is placed first in the list (e.g., Bellezza & Cheney, 1973; Kelley & Nairne, 2001; Pillsbury & Rausch, 1943). In such instances, the isolate should not receive differential attention, since no context has been established and the isolate’s difference is not salient to participants. Dunlosky, Hunt, and Clark also found isolation effects for items that appear early in the list, even when those items were not judged to be more salient and were not rehearsed more by participants.

Current explanations of the isolation effect

More recent accounts of the isolation effect have abandoned the idea of differential attention. Instead, current theories argue that isolated items have an advantage at retrieval. Hunt and Lamb (2001; Hunt, 1995, 2006) explained that categorized lists result in participants spontaneously encoding the similarities across the list items (categorical processing), but reduce the likelihood of participants focusing on features of the individual items (item-specific or difference processing). They proposed that the isolated item, on the other hand, receives both categorical and item-specific processing. Categorical processing involves spontaneously identifying the category of the isolate, and item-specific processing is increased because the isolate is the only item in its category. Given that the background items receive categorical processing, whereas the isolated item receives both categorical and item-specific processing, the isolated item is more distinctive at retrieval.

Hunt and Lamb (2001) empirically supported this explanation by showing that isolation effects were obtained when participants engaged in similarity processing (naming similarities across items during encoding), whereas isolation effects were not obtained when participants engaged in difference processing (naming differences). Their explanation is also consistent with von Restorff’s (1933) original explanation, in which she proposed that the similar background items were agglutinated, resulting in the isolate standing out “as figure against the ground of homogeneous items” (Hunt, 1995, p. 107). Although von Restorff did not experimentally control the type of processing that participants engaged in, she demonstrated that isolation effects only occurred when the background items were similar to each other. Hunt and Lamb’s explanation furthers von Restorff’s original proposal, in that the background items not only have to contain a similarity, but this similarity must be processed in order to obtain improved memory for the isolate.

Nairne (2006; Kelley & Nairne, 2001) proposed a similar retrieval-based explanation of the isolation effect using his feature model of immediate memory (e.g., Nairne, 1990). According to this model, the processing of list items results in residual traces in primary memory. These traces are used as cues to retrieve items from secondary memory. Memory performance is a function of how well the cues match the target versus the competitor set. The residual trace for the isolate will be more likely to contain features unique to that item, making the trace more effective than traces for other items. This distinctiveness results in improved memory performance for the isolate. Nairne (2006) presented mathematical modeling data in support of this theory and attributed the isolation effect to cue overload.

Nairne’s feature model explanation of the isolation effect differs from that of Hunt and Lamb (2001) in that it does not

make assumptions about the type of processing that occurs during encoding. Whether or not an isolation effect will be obtained is determined strictly by the relationship between the cues, targets, and competitors at retrieval. This relationship, though, is impacted by manipulations that alter the extent to which participants focus on similarities and differences across list items. For example, Nairne (2006) accounted for the results of Hunt and Lamb by proposing that similarity processing increases the feature overlap amongst the background items (thus making the isolate more discriminable as the background items experience greater cue overload). On the other hand, difference processing decreases feature overlap, which reduces cue overload for both isolates and background items—this removes some or all of the advantage afforded to isolates.

Revisiting the need for attention

The amount of attention available during encoding directly impacts performance on memory tests. When attention during encoding decreases, explicit memory is reduced (e.g., Baddeley, Lewis, Eldridge, & Thomson, 1984; Craik, Govoni, Naveh-Benjamin, & Anderson, 1996). Although this relationship generally holds, the memory decline depends on the nature of the items and the features that need to be encoded. A wealth of literature has argued that perceptual information can be processed automatically with little impact by dividing attention during encoding, whereas processing conceptual information requires greater attentional resources and is more impaired by dividing attention (for a review, see Mulligan, 1998). Although retrieval-based explanations of the isolation effect do not invoke differential attention, they do require the encoding of relevant features that result in a retrieval advantage. It is unclear whether encoding these features is attention-demanding or more automatic in nature, and this may depend on how the isolate differs from the background items. Perceptual differences (e.g., a change in the font size or color) may be detected and encoded relatively automatically, whereas conceptual differences (e.g., a change in category) may require greater attentional resources during encoding.

This possibility is consistent with Smith's (2011) contextual support for similarity and difference (CSSD) framework, which she proposed as an extension of Hunt's (2006) distinctiveness processing and Craik's (1986) environmental-support views. Smith argued that the context influences the likelihood that similarity and difference processing will occur spontaneously. Specifically, she proposed that older adults are more likely to spontaneously engage in this type of processing when an isolate is perceptually different from the background items than when an isolate differs conceptually from the background. She provided empirical support for this framework

by finding that age-related differences in the isolation effect depended on the nature of the isolate. When the isolate was placed early in the list, older adults benefited from items that were perceptually distinct (numbers in a list of words, Exp. 2), but not from items that were conceptually distinct (the word "table" in a list of types of fish, Exp. 1). These differences were presumed to reflect differences in the resources at encoding that were necessary to process the two types of isolates. If age-related differences in the benefits for distinctive information are due to age-related deficits in attentional resources (e.g., Geraci et al., 2009; Gounden & Nicolas, 2012; Mäntylä & Bäckman, 1992; Smith, 2006), then manipulations of distinctiveness that lack age-related differences would, presumably, require less attention.

Although perceptual isolates may increase the likelihood of spontaneous similarity and difference processing, Geraci and Rajaram (2002) argued that "all distinctiveness effects, even those that are perceptually manipulated, involve conceptual processing" (p. 287). They defined conceptual processing as both the processing of the meaning of a stimulus and the conscious, controlled processing of "comparative evaluation of a stimulus against its context" (p. 288). They demonstrated that orthographic distinctiveness effects are reduced (Exps. 2a and 2b) or eliminated (Exp. 2c) under divided attention, presumably due to a reduced ability to engage in conceptual processing. Contrary to these findings, Gounden and Nicolas (2012) found that dividing attention did not reduce orthographic distinctiveness effects. They also included older adults and found that aging did not impact the orthographic distinctiveness effect. The large number of methodological differences (e.g., type of test, number of studied items, length of delay before test, etc.) between the two studies makes it difficult to determine why they obtained disparate patterns of results. However, the results obtained by Gounden and Nicolas are consistent with previous work attributing the orthographic distinctiveness effect to perceptual processing that occurs automatically (e.g., Hunt & Elliot, 1980; Hunt & Toth, 1990).

If perceptual isolation effects are mediated by automatic processing and conceptual isolation effects require greater attentional resources, then manipulations that alter the manner in which participants encode the items should have a greater impact on conceptual isolation effects than on perceptual isolation effects. Fabiani and Donchin (1995) provided support for this idea in a study that involved presenting participants with lists containing nonwords, words from a single category, a physical isolate, and a semantic isolate. The physical isolate was a word from the same category that was presented in a larger font, and the semantic isolate was a word from a different category. Participants engaged in one of two orienting tasks: making a judgment about the font size (physical task) or making a judgment about whether each item was a word or a nonword (semantic task). The results showed that semantic isolation effects were obtained with the semantic

orienting task, but not with the physical orienting task. This pattern is consistent with Hunt and Lamb (2001), in that only the semantic task would promote processing the similarities of the background items (the category of the real words) while also processing the difference of the isolate (a word from a different category). The physical isolation effect, on the other hand, was unaffected by the orienting task, suggesting that the perceptual distinctiveness of the physical isolates was encoded even when attention was focused on semantic features.

Fabiani and Donchin (1995) used event-related potential (ERP) analyses to examine how physical and semantic isolates are processed during encoding. They examined the P300 and N400 ERP components, because these components are associated with the detection of deviation from the context. The P300 is sensitive to deviance along a variety of physical and semantic dimensions, provided that the dimension is relevant to the task (for reviews, see Donchin, 1981; Fabiani, Gratton, Karis, & Donchin, 1987). Fabiani and Donchin obtained a larger P300 for physical isolates than for controls, regardless of the orienting task. This implies that the deviation of the physical isolate was processed in all orienting conditions. The P300 component was also correlated with the physical isolation effect at recall, suggesting that the detection of deviance is strongly tied to a retrieval advantage. In a related study, Fabiani, Karis, and Donchin (1990) found that this correlation was apparent for participants using rote rehearsal, but not for participants using more elaborative mnemonic strategies. Thus, ERPs are sensitive to the differences in the ways that isolates are processed.

Fabiani and Donchin (1995) found that the relationship between the P300 and the isolation effect was different for semantic isolates. Participants exhibited a larger P300 component for semantic isolates than for controls in the semantic orienting task, but not in the physical orienting task. This suggests that the deviation of the semantic isolate was not processed in the physical orienting task, which is consistent with the literature on the P300. However, the N400 component is particularly sensitive to semantic deviance (for reviews, see Kutas & Van Petten, 1988; Pritchard, Shappell, & Brandt, 1991) and was larger for semantic isolates regardless of the orienting task, suggesting that participants detected the deviation of the semantic isolate in both orienting groups, though this detection did not always result in an advantage at recall. This implies that the processing involved in the simple detection of an isolate as deviating from the background items is not necessarily the same processing that results in the memory advantage for those items. The detection of an isolate as being deviant may be sufficient for the physical isolation effect to occur, whereas the semantic isolation effect may require greater attentional resources.

The present study

In summary, early accounts of the isolation effect proposed that isolation effects are due to greater attention being devoted to isolates during encoding (for reviews, see Green, 1956; Jenkins & Postman, 1948). Several lines of data have argued against the need for greater attention (for reviews, see Hunt & Lamb, 2001; Hunt & Seta, 1984), and recent theories have abandoned differential attention in favor of enhanced distinctiveness at retrieval (e.g., Hunt & Lamb, 2001; Kelley & Nairne, 2001; Nairne, 2006). It is unknown, however, whether the processing at encoding that results in greater distinctiveness at retrieval is more automatic in nature or requires attentional resources. There is evidence suggesting that this may depend on whether the isolate is perceptually or conceptually different from the background items (e.g., Fabiani & Donchin, 1995; Smith, 2011). To that end, in the present study we examined the isolation effect under full and divided attention using semantic isolates (Exp. 1), physical isolates (Exp. 2), and both types of isolates (Exp. 3). We predicted that physical isolation effects would be equivalent under full and divided attention, whereas semantic isolation effects would be eliminated by divided attention.

Experiment 1

Method

Participants A total of 36 undergraduates (mean age 20 years, age range 18–22) from The College of New Jersey participated in the present experiment to partially satisfy a course requirement. All participants were native speakers of American English.

Materials Forty categories were selected from the category norms in Van Overschelde, Rawson, and Dunlosky (2004). For each category selected, 12 items were chosen to create categorized word lists. For example, the “precious stones” category included items such as *diamond*, *ruby*, *emerald*, *pearl*, *garnet*, and *jade*. Two versions of the experiment were created, with 20 of the 40 lists being assigned to each version. In each version, the ten control lists contained 12 items from the same category. The ten isolate lists contained 11 items from the same category and one item from a different category at the seventh serial position. The lists in the two versions were counterbalanced such that the target items appeared equally often as controls and isolates across participants. The remaining items in the lists appeared in a random order for each participant.

Design A 2 (Type of Attention: full, divided) $\times$ 2 (Type of List: isolate, control) within-subjects design was used. There

were 20 trials, with five trials in each of the four conditions (full-attention control, full-attention isolate, divided-attention control, and divided-attention isolate). Within each trial, words were presented individually at a rate of 1 s/word. For trials in the full-attention condition, the items would begin immediately upon initiating the trial. For divided attention trials, the computer selected a random three-digit number (e.g., 428), and a message was displayed prior to the presentation of the list that indicated that participants should begin counting backward aloud by ones from that number (e.g., “Count backward from 428”) for the duration of the presentation of the list. The list type (full/divided, isolate/control) was randomly selected on each trial. Participants recalled the items using free written recall.

Procedure Participants clicked a button labeled “Next Trial” to begin each trial. They were instructed to silently read the words as they appeared on the screen. Participants were told that on some trials they would see a message that instructed them to count backward from a random number. For example, if the number was 428, the participant was told to say aloud, “428, 427, 426, . . .” until the prompt, “Please recall the items,” appeared. They were instructed to stop counting backward at this point and to begin recalling the items in any order by writing the items on a response sheet. Recall was self-paced, and participants could take breaks between trials as needed. Each participant was tested individually, and the research assistant remained in the room to ensure compliance with the directions.

Results

Overall recall The proportion of items recalled from each list was analyzed with a 2 (List Type: isolate, control) $\times$ 2 (Attention: full, divided) $\times$ 12 (Serial Position: 1–12) analysis of variance (ANOVA). For this and all subsequent analyses, alpha was set to .05. As can be seen in Fig. 1, overall recall of the isolate lists ($M = .49$) did not differ from that of control lists ($M = .49$), with no main effect of list type ($F < 1$). More list items were recalled with full attention ($M = .59$) than with divided attention ($M = .39$), yielding a significant main effect of attention [$F(1, 35) = 192.352$, $MSE = 0.097$, $p < .001$, $\eta_p^2 = .846$]. The reduction in performance under divided attention was greater for early than for late serial positions, resulting in a significant interaction between attention and serial position [$F(11, 385) = 3.359$, $MSE = 0.045$, $p < .001$, $\eta_p^2 = .088$]. Typical primacy and recency effects were obtained, resulting in a significant main effect of serial position [$F(11, 385) = 40.321$, $MSE = 0.057$, $p < .001$, $\eta_p^2 = .535$]. Control lists and isolate lists were similarly impacted by the attention manipulation, resulting in the lack of a significant interaction between list type and attention ($F < 1$). In the overall data, an isolation effect (better recall of isolates vs. controls in the

7th serial position) would be evidenced by an interaction between list type and serial position—this interaction was not significant in the present experiment ($F < 1$). The lack of an interaction likely occurred because the isolation effect was present under full attention (7th position isolates $M = .60$ vs. 7th position controls $M = .40$), but absent under divided attention (7th position isolates $M = .34$ vs. 7th position controls $M = .35$), resulting in a marginally significant three-way interaction between list type, attention, and serial position [$F(11, 385) = 1.761$, $MSE = 0.037$, $p = .059$, $\eta_p^2 = .048$].

Recall of target items The results were consistent with the predictions that (1) a semantic isolation effect would be demonstrated under full attention and (2) dividing attention would eliminate the semantic isolation effect. The proportions correct for target items in Position 7 were analyzed with a 2 (Item Type: isolate, control) $\times$ 2 (Attention: full, divided) ANOVA. A greater proportion of isolates were recalled than controls ($M = .47$ vs. $M = .38$), yielding a main effect of item type [$F(1, 35) = 6.44$, $MSE = 1.32$, $p < .05$, $\eta_p^2 = .155$]. More items were recalled under full attention ($M = .50$) than under divided attention ($M = .35$), yielding a main effect of attention [$F(1, 35) = 11.91$, $MSE = 21.01$, $p < .01$, $\eta_p^2 = .254$]. As can be seen in Fig. 2, the recall advantage for isolates over controls, or the isolation effect, was obtained with full attention ($M = .60$ vs. $M = .40$), but not with divided attention ($M = .34$ vs. $M = .35$), yielding a significant interaction between attention and item type [$F(1, 35) = 9.44$, $MSE = 1.01$, $p < .01$, $\eta_p^2 = .212$].

Output order In addition to examining the recall data, we examined whether isolates were more likely than controls to be output early during retrieval. The output positions were calculated for control and isolate target items to reflect the proportion of targets output at each serial position (1–12) for each participant. In order to calculate the output positions for control and isolate targets, participants needed to have recalled at least one of each type of item. Under full attention, five participants failed to recall at least one of a given type of target, and thus were excluded from the analyses. Then t tests were performed on the remaining 31 participants to determine whether the proportion of items output at each of the first two positions differed for control versus isolate targets. As had been found in Fabiani and Donchin (1995), evidence indicated that semantic isolates were more likely than controls to be output early in the list (see Fig. 3). Specifically, a significantly greater proportion of semantic isolates than of controls were recalled in the first output position [semantic $M = .16$ vs. control $M = .06$, $t(30) = 2.079$, $p < .05$, $d = 0.47$]. We observed a similar trend at the second position, though the difference was not statistically significant [semantic $M = .13$ vs. control $M = .08$, $t(30) = 1.006$, $p = .16$].

Next we examined output order for the divided-attention condition. The analyses were restricted to the

Fig. 1 Mean proportion recall as a function of list type and attentional condition. Full attention is shown on the left, and divided attention on the right. The isolated items occurred in the 7th serial position. Participants viewed control lists (containing words from a single category). In

addition, they viewed either semantic isolate lists (Exp. 1), physical isolate lists (Exp. 2), or both (Exp. 3). Error bars represent standard errors of the means

21 participants who recalled at least one isolate and one target control item. Unlike in the full-attention condition, semantic isolates were not recalled earlier than controls. The proportion of semantic isolates output in the first position was identical to that of controls ($M_s = .12$ for both), and no significant difference was apparent in the second position (semantic $M = .17$ vs. control $M = .14$), $t(20) = 0.366$, $p = .72$.

Discussion

As expected, an isolation effect was obtained for semantic isolates under full attention, but the effect was eliminated

under divided attention. These findings are in accordance with our predictions that attention is required during encoding for semantic isolation effects to be obtained. Under full attention, semantic isolates were more likely to be output at early positions during recall than were controls. This difference in output order was not apparent under divided attention. These results are consistent with the output order analyses reported in Fabiani and Donchin (1995), in which semantic isolates were output very early in recall, though Fabiani and Donchin did not compare the output orders of isolates versus control items or include a divided-attention condition. Together, these results demonstrate that when a semantic isolate is fully processed,

Fig. 2 Mean proportion recall of isolate and control target items in the 7th serial position as a function of attentional condition. Error bars represent standard errors of the means

differences are seen both in the likelihood of recall and in the manner in which the item is output. On the other hand, when a semantic isolate cannot be processed fully (i.e., under divided attention), there is no advantage in recall of the isolate, and the isolate is not output differently at recall. This pattern of results supports explanations of the isolation effect that include the requirement for conceptual processing (e.g., Geraci & Rajaram, 2002; Hunt & Lamb, 2001). If physical isolation effects are mediated by perceptual processing, which is relatively automatic in nature, then dividing attention should have little or no impact on the physical isolation effect. To that end, the purpose of Experiment 2 was to examine the effect of divided attention on the physical isolation effect.

Experiment 2

Method

Participants A total of 36 undergraduates (mean age 20 years, age range 18–26) from The College of New Jersey participated in the present experiment to partially satisfy a course requirement. All of the participants were native speakers of American English, and none had participated in Experiment 1.

Materials The items consisted of the 40 categorized lists from Experiment 1, with the exception that all of the items in each list were from the same category. Twenty of the 40 lists were

Fig. 3 Mean proportions of items output at each output position. Results are shown for target items originally presented in the 7th serial position. Full attention is shown on the left, and divided attention on the right. The

target items consisted of control words and either semantic isolates (Exp. 1), physical isolates (Exp. 2), or both (Exp. 3). Error bars represent standard errors of the means

randomly selected for each participant, and the words in each list were presented in a random order. Half of the lists were control lists, with items presented in a black font against a white background. The other half of the lists were isolate lists, in which the 7th item in each list was presented in red font. Unlike in Experiment 1, there was no need for counterbalancing, because the lists were randomly selected and the items in each list were in a random order; thus, the control and isolate target items in the 7th position were completely randomized for each participant.

Design and procedure The design and procedure were identical to those of Experiment 1.

Results

Overall recall As in Experiment 1, the proportion of items recalled from each list was analyzed with a 2 (List Type:

isolate, control) $\times$ 2 (Attention: full, divided) $\times$ 12 (serial position: 1–12) ANOVA. The overall recall of isolate lists ($M = .48$) did not differ significantly from that of control lists ($M = .48$), with no main effect of list type [$F(1, 35) = 1.021$, $MSE = 0.043$, $p = .319$, $\eta_p^2 = .028$]. More list items were recalled with full attention ($M = .59$) than with divided attention ($M = .36$), yielding a significant main effect of attention [$F(1, 35) = 282.074$, $MSE = 0.127$, $p < .001$, $\eta_p^2 = .890$]. The reduction in performance under divided attention was greater for early than for late serial positions, resulting in a significant interaction between attention and serial position [$F(11, 385) = 2.241$, $MSE = 0.077$, $p < .05$, $\eta_p^2 = .060$]. Typical primacy and recency effects were obtained, resulting in a significant main effect of serial position [$F(11, 385) = 29.657$, $MSE = 0.090$, $p < .001$, $\eta_p^2 = .459$]. A significant isolation effect, in which isolated items are recalled better than control items in Position 7 (isolates $M = .60$ vs. controls $M = .39$), can be seen in the significant interaction between list type and serial position

[$F(11, 385) = 4.354$, $MSE = 0.062$, $p < .001$, $\eta_p^2 = .111$]. The control lists and isolate lists were similarly impacted by the attention manipulation, resulting in the lack of a significant interaction between list type and attention [$F(1, 35) = 1.510$, $MSE = 0.058$, $p = .227$, $\eta_p^2 = .041$]. As can be seen in Fig. 1, the isolation effect was similar under full attention (7th position isolates $M = .69$ vs. 7th position controls $M = .47$) and divided attention (7th position isolates $M = .51$ vs. 7th position controls $M = .31$); thus, the three-way interaction between list type, attention, and serial position was not significant ($F < 1$).

Recall of target items The results were consistent with the predictions that (1) a physical isolation effect would be demonstrated under full attention and (2) dividing attention would fail to eliminate the physical isolation effect. As in Experiment 1, the proportions correct for target items in Position 7 were analyzed with a 2 (Item: isolate, control) $\times$ 2 (Attention: full, divided) ANOVA. A greater proportion of items were recalled under full attention ($M = .58$) than under divided attention ($M = .41$), yielding a main effect of attention [$F(1, 35) = 19.75$, $MSE = 26.69$, $p < .001$, $\eta_p^2 = .361$]. The isolation effect was obtained, in which isolates were recalled better than controls ($M = .60$ vs. $M = .39$), yielding a main effect of item type [$F(1, 35) = 36.10$, $MSE = 1.11$, $p < .001$, $\eta_p^2 = .508$]. As can be seen in Fig. 2, the recall advantage for isolates over controls did not differ significantly for full attention ($M = .69$ vs. $M = .47$) versus divided attention ($M = .51$ vs. $M = .31$), with no significant interaction between attention and item type [$F(1, 35) = 0.02$, $MSE = 1.49$, $p = .89$].

Output order The output positions were calculated for control and isolate target items in the same manner as in Experiment 1. In the full-attention condition, we restricted our analyses to include participants who recalled at least one isolate and one control target item (32 out of 36 participants). As predicted, the output orders were more similar for physical isolates and controls (see Fig. 3) than in Experiment 1, in which semantic isolates were recalled earlier than controls. Our t tests revealed no significant difference between physical isolates and controls in the proportions of items output at the first and second output positions [first position: physical $M = .11$ vs. control $M = .06$, $t(31) = 1.126$, $p = .27$; second position: physical $M = .13$ vs. control $M = .08$, $t(31) = 1.044$, $p = .31$].

Under divided attention, we analyzed the 28 participants who recalled at least one of each type of item. As in the full-attention condition, physical isolates were not output significantly more often than controls in the first position [physical $M = .15$ vs. control $M = .09$, $t(27) = 1.470$, $p = .15$]. However, physical isolates were significantly less likely than controls to be output in the second position [physical $M = .18$ vs. control $M = .34$, $t(27) = 2.151$, $p < .05$].

Discussion

As expected, an isolation effect was obtained for physical isolates, and the effect sizes were equivalent under full and divided attention. The lack of an effect of divided attention on the physical isolation effect differs from the results in Experiment 1, in which divided attention eliminated the semantic isolation effect. These differential effects of divided attention suggest that the processing required to obtain a physical isolation effect is less effortful and more automatic than that required to obtain a semantic isolation effect. Experiments 1 and 2 also differed in the impacts of the isolate manipulation on output order. Specifically, in the full-attention condition, semantic isolates were recalled at earlier output positions than controls in Experiment 1, whereas physical isolates and controls did not significantly differ in their output positions in Experiment 2.

The different patterns of results in Experiments 1 and 2 are consistent with the idea that semantic isolation effects require more attentional resources than physical isolation effects. When participants are able to fully process semantic isolates, they are both recalled better and output earlier than control items. Conversely, when attention is divided, both the differences in recall and output order disappear. Physical isolation effects, on the other hand, appear to be more automatic in nature and are unaffected by dividing attention.

Although the data suggest that the physical isolation effect was not impacted by dividing attention, a closer inspection of recall of the control targets lends an alternative interpretation. Specifically, divided attention had a small impact on recall of the control items in Experiment 1 (performance declined from .40 to .35 mean proportion recall) and a larger impact on recall of the control items in Experiment 2 (performance declined from .47 to .31 mean proportion recall). Thus, the differences in the isolation effect across the two experiments may lie in the effects of divided attention on the control items rather than on the isolated items. Having each participant view control lists as well as both types of isolate lists would eliminate the differences in recall of the control targets. If divided attention continued to impact the two types of isolation effects differently, this would provide further evidence for the conclusion that the necessary processing for semantic and physical isolation effects differs. To that end, a third experiment was conducted in which the type of isolate was manipulated as a within-subjects variable.

Experiment 3

The purpose of Experiment 3 was to determine whether the results of Experiments 1 and 2 could be replicated with a within-subjects design. Thus, participants viewed both types of isolates (semantic and physical) across trials.

Method

Participants A total of 48 undergraduates (mean age 20 years, age range 18–26) from The College of New Jersey participated in the present experiment to partially satisfy a course requirement. All of the participants were native speakers of American English, and none had participated in Experiment 1 or 2.

Materials The same 40 categories from Experiments 1 and 2 were used, along with eight additional categories from the same source (Van Overschelde et al., 2004), yielding a total of 48 categories. Again, 12 items were chosen from each category to create categorized word lists. Six versions of the stimuli were created, such that the target items appeared equally often as controls, semantic isolates, and physical isolates under full attention and controls, semantic isolates, and physical isolates under divided attention. The semantic isolate lists and physical isolate lists were constructed in the same manner as in Experiments 1 and 2, respectively. The set of lists viewed by a given participant in the present experiment differed from those of Experiments 1 and 2 in that participants viewed both types of isolate lists (semantic and physical) rather than only one type of isolate list.

Design and procedure The design differed slightly from that of Experiments 1 and 2 due to the presence of two types of isolate lists, rather than only one. Thus, a 2 (Type of Attention: full, divided) $\times$ 3 (Type of List: semantic isolate, physical isolate, control) within-subjects design was used. A total of 24 trials were presented, with four trials in each of the six conditions (full-attention control, full-attention semantic isolate, full-attention physical isolate; divided-attention control, divided-attention semantic isolate, and divided-attention physical isolate). There were no other differences in the design or procedure.

Results

Overall recall As in Experiments 1 and 2, the proportion of items recalled from each list was analyzed with a 3 (List Type: physical isolate, semantic isolate, control) $\times$ 2 (Attention: full, divided) $\times$ 12 (Serial Position: 1–12) ANOVA. Overall recall of the three isolate lists was similar ($M = .51$ control lists, $M = .50$ physical isolate lists, $M = .51$ semantic isolate lists), with no main effect of list type [$F(2, 94) = 1.128$, $MSE = 0.046$, $p = .328$, $\eta_p^2 = .023$]. Recall was worse under divided attention ($M = .39$) than under full attention ($M = .63$), yielding a significant main effect of attention [$F(1, 47) = 321.965$, $MSE = 0.154$, $p < .001$, $\eta_p^2 = .873$]. Dividing attention impaired earlier serial positions to a greater degree than later serial positions, yielding a significant interaction between attention and serial position [$F(11, 517) = 5.008$, $MSE = 0.059$, $p < .001$, $\eta_p^2 = .096$].

Dividing attention similarly impaired all list types, with no significant interaction between attention and list type [$F(2, 94) = 2.173$, $MSE = 0.043$, $p = .120$, $\eta_p^2 = .044$]. Typical primacy and recency effects, as well as higher recall in Position 7 (the location of the isolate), resulted in a significant main effect of serial position [$F(11, 517) = 49.062$, $MSE = 0.075$, $p < .001$, $\eta_p^2 = .511$]. As can be seen in Fig. 1, the isolation effect can also be observed in the significant interaction between list type and serial position, in which Position 7 had higher recall in isolate lists than in control lists [$F(22, 1034) = 4.768$, $MSE = 0.052$, $p < .001$, $\eta_p^2 = .092$]. The three-way interaction between list type, serial position, and attention was not significant [$F(22, 1034) = 1.317$, $MSE = 0.057$, $p = .149$, $\eta_p^2 = .027$].

Recall of target items The results replicated those of Experiments 1 and 2, and were consistent with the predictions that (1) both physical and semantic isolation effects would be demonstrated under full attention, (2) dividing attention would eliminate the semantic isolation effect, and (3) dividing attention would fail to eliminate the physical isolation effect.

In order to more closely analyze the presence or absence of the isolation effects in the different conditions, the proportions correct for target items in Position 7 were analyzed with a 3 (Item Type: physical isolate, semantic isolate, control) $\times$ 2 (Attention: full, divided) ANOVA. Items were recalled better under full ($M = .66$) than under divided ($M = .42$) attention, resulting in a significant main effect of attention [$F(1, 47) = 74.93$, $MSE = 0.056$, $p < .001$, $\eta_p^2 = .615$]. As can be seen in Fig. 2, a physical isolation effect was obtained, in which physical isolates ($M = .70$) were recalled better than control items ($M = .44$), yielding a significant main effect of item type [$F(2, 94) = 39.99$, $MSE = 0.046$, $p < .001$, $\eta_p^2 = .460$]. Although the semantic isolation effect was minimal when performance was collapsed across full and divided attention ($M = .47$ semantic vs. $M = .44$ control), semantic isolates were recalled better than controls under full attention ($M = .65$ semantic vs. $M = .56$ control); semantic isolation effects, however, were not obtained under divided attention ($M = .28$ semantic vs. $M = .32$ control). Unlike the semantic isolation effect, the physical isolation effect was apparent under both full attention ($M = .76$ physical vs. $M = .56$ control) and divided attention ($M = .64$ physical vs. $M = .32$ control). This difference in the impacts of divided attention on semantic and physical isolation effects resulted in a significant interaction between item type and attention [$F(2, 94) = 5.063$, $MSE = 0.071$, $p < .01$, $\eta_p^2 = .097$]. A series of paired-samples t tests confirmed that the physical isolation effect was significant under both full attention [$t(47) = 3.653$, $p < .01$, $d = 0.71$] and divided attention [$t(47) = 7.730$, $p < .001$, $d = 1.45$]. Conversely, the semantic isolation effect was marginally significant under full attention [$t(47) = 1.555$, $p = .06$, $d = 0.32$], but absent under divided attention [$t(47) = 0.828$, $p = .21$]. The failure to obtain an

isolation effect under divided attention does not appear to have been due to a lack of power, because semantic isolates were recalled slightly worse than controls under divided attention.

Output order The output positions were calculated and analyzed in the same fashion as in Experiments 1 and 2, with 41 out of 48 participants meeting the requirement that at least one of each target type was recalled under full attention. Although the general pattern was similar to those of Experiments 1 and 2 (see Fig. 3), participants rarely output control targets in the first position, resulting in both semantic and physical isolates being significantly more likely to be output first than were control items [semantic $M = .22$ vs. control $M = .01$, $t(40) = 3.845$, $p < .001$, $d = 0.86$; physical $M = .11$ vs. control $M = .01$, $t(40) = 2.863$, $p < .01$, $d = 0.64$]. Consistent with Experiments 1 and 2, the early output of isolates was more pronounced for semantic than for physical isolates, with semantic isolates being significantly more likely than physical isolates to be output first [$t(40) = 2.136$, $p < .05$, $d = 0.37$]. The findings for the second output position were also consistent with those from the previous experiments, in that semantic isolates were significantly more likely to be output than control items [semantic $M = .12$ vs. control $M = .04$, $t(40) = 1.776$, $p < .05$, $d = 0.42$], whereas physical isolates were not [physical $M = .10$ vs. control $M = .04$, $t(40) = 1.502$, $p = .63$].

The divided-attention analyses were restricted to the 31 participants who recalled at least one of each target item. As in the previous experiments, t tests on the first two output positions showed that significant differences in output orders were eliminated for semantic isolates relative to controls, and continued to be absent for physical isolates relative to controls (all $ps > .05$). The output order differences between semantic and physical isolates that were found under full attention were also eliminated under divided attention (all $ps > .05$).

Discussion

The purpose of Experiment 3 was to confirm that the pattern of results found in Experiments 1 and 2 would be replicated when the type of isolate (physical vs. semantic) was manipulated within subjects rather than across experiments. The results of Experiment 3 replicated those of Experiments 1 and 2. First, participants demonstrated both semantic and physical isolation effects under full attention. Second, dividing attention eliminated the semantic isolation effect, but did not impact the physical isolation effect. Finally, analyses of output order suggested that, under full attention, participants tended to output semantic isolates earlier than control or physical isolates during recall. This difference disappeared, along with the semantic isolation effect, under divided attention. Thus, the results of Experiment 3 are consistent with the prediction that semantic isolates require more attentional resources than

physical isolates, in that dividing attention eliminates the semantic isolation effect, but not the physical isolation effect.

General discussion

As predicted, isolation effects were obtained under full attention in all three experiments. This is consistent with a large body of research in which items that differed from the surrounding context were recalled better than items that were consistent with the surrounding context (for reviews, see Hunt, 1995; Kelley & Nairne, 2001). Isolation effects were obtained under full attention for both semantic isolates (Exps. 1 and 3) and physical isolates (Exps. 2 and 3), replicating earlier findings in which both types of manipulations resulted in significant isolation effects. The present experiments included a divided-attention condition to determine whether reducing the available processing resources at encoding would decrease the isolation effects. It was predicted that a greater amount of attentional resources would be necessary for semantic isolation effects than for physical isolation effects. The results supported these predictions, in that dividing attention eliminated the semantic isolation effect, but not did impact the physical isolation effect.

The elimination of the semantic isolation effect under divided attention (Exps. 1 and 3) is consistent with Hunt and Lamb (2001), in that there appears to be a requirement for conceptual processing of the semantic isolate. The present study did not address whether this conceptual processing comes in the form of encoding similarities and differences, as was proposed by Hunt and Lamb. However, the findings support the requirement for some type of effortful processing that demands attention in order to obtain an isolation effect. This result is also consistent with Geraci and Rajaram's (2002) argument that all distinctiveness effects require effortful, conceptual processing.

The finding of an apparent processing requirement for a semantic isolation effect in the present study is also consistent with the literature on isolation effects with incidental learning (for reviews, see Hunt & Lamb, 2001; Wallace, 1965). Specifically, many studies have failed to demonstrate an isolation effect under conditions of incidental learning (e.g., Koyanagi, 1957; cf. Postman & Phillips, 1954; Saltzman & Carterette, 1959; Saul & Osgood, 1950; Wallace, 1965). For example, Postman and Phillips instructed participants in the incidental-learning condition to read aloud the list items (syllables or numbers) to other participants, who were instructed to learn the list (intentional). Although the incidental and intentional learners performed similarly in the recall test, only the intentional group demonstrated significant isolation effects. Postman and Phillips argued that the effect is only obtained when the orienting task is relevant for the dimension on which the isolated item differs from the surrounding items.

Such findings support the idea that isolation effects will only be obtained with certain types of processing.

The results of Experiments 2 and 3, on the other hand, in which the physical isolation effect was not impacted by divided attention, argue against this idea. Divided attention significantly lowered overall performance, demonstrating that the processing resources available at encoding were reduced. The benefit of the isolate at recall, however, was not reduced. This demonstrates that the physical isolation effect can be readily obtained with minimal attentional resources during encoding. Given that participants are less able to engage in effortful processing under conditions of divided attention, yet the physical isolation effect is not reduced, the results suggest that attention is not required (or is minimally required) in order to encode the relevant features that result in a physical isolation effect. Such findings mirror those of Gounden and Nicolas (2012), in which orthographic distinctiveness effects were maintained under divided attention and under faster presentation rates; they argued that these effects rely on perceptual rather than conceptual processing.

Differences in output orders were also obtained across the three experiments. Under full attention, semantic isolates were output early in recall more often than were either controls (Exps. 1 and 3) or physical isolates (Exp. 3). These findings suggest that the semantic isolate was processed in a conceptual manner that resulted in both output order differences and a recall advantage relative to control items. Fabiani and Donchin (1995) argued that semantic isolates are placed in a different category in memory. The relationship between the semantic isolation effect and the presence of output order differences supports this argument, in that the conceptual processing of a semantic isolate would result in both an advantage for the item at recall and separate output of the item during recall. Unlike semantic isolates, physical isolates differ from the surrounding items in a perceptual manner, but they are still part of the dominant category. The lack of a difference in output order for physical isolates versus controls in Experiment 2 and the reduced output order differences in Experiment 3 of the present study support this distinction.

One limitation of the present study is that secondary-task performance was not measured. Thus, we cannot ensure that attention was divided equally across all list items in all types of lists. Although the secondary task of counting backward by ones was relatively easy and participants appeared to be speaking continuously, it is possible that they devoted fewer of their attentional resources to the secondary task for certain items, such as physical isolates. Future studies should examine secondary task performance to determine whether it is equivalent for both isolates and controls.

Some research has suggested that the distinctive nature of an isolate may not be realized and processed immediately. Instead, the salience of an early isolated item may unfold during the course of a list as the context becomes

established. Dunlosky et al. (2000) found that isolates presented in the second position in a list were not perceived as salient, and that increased salience judgments for isolated items only occurred for isolates presented later in the list. This supports the idea that participants would not be immediately aware of an item's distinctiveness when it is presented early in the list. Geraci and Manzano (2010), however, asked participants to make salience judgments after a delay (i.e., the salience judgment for an item was not made until two additional list items had been presented). They demonstrated higher salience ratings for both early and late isolates when the judgment was made after a delay. This suggests that the distinctive processing that occurs for isolated items may not occur at the moment the isolate is presented, but instead may occur later in the course of the presentation of the list, after the context has become established.

When participants are presented with categorized lists across trials, it is reasonable to assume that they would learn to anticipate that each list would have a category (perhaps with an additional item from a different category). Hunt and Lamb (2001) stated that participants "spontaneously encode" the categories of list items, including the category of the isolate (p. 1361). Given that a category is encoded for a single isolate, it is plausible that the category of the list would be partially activated as soon as the first item was presented. Thus, placing the isolate in the first position would be a stronger test of whether isolation effects can be obtained prior to establishing a context. If the processing required to achieve an isolation effect is more attention-demanding for semantic than for physical isolates, then semantic isolation effects might be less likely than physical isolation effects to occur in the first position. Although isolation effects have been obtained in the first position, such research has been limited to two studies in which the isolate was physically distinctive. Bone and Goulet (1968) manipulated font color, and Kelley and Naime (2001) manipulated font size (Exps. 1 and 2; but see their Exp. 4, in which isolation and generation manipulations were combined). Thus, it is unknown whether isolation effects would be obtained if a semantic isolate were presented first in the list.

Unlike many other explanations of the isolation effect, Fabiani and Donchin (1995) acknowledged that distinctiveness effects might occur as a result of several different types of processing, which depends on the nature of the distinctiveness. They argued that theoretical explanations overgeneralize about the processing required to obtain a benefit for distinctive information, and that researchers should not generalize about processing requirements from one type of experimental paradigm (e.g., the benefit in recall of final words in a sentence) to another paradigm (e.g., the isolation effect). The results of the present study suggest that this claim can be taken further, to argue that it is unwarranted to generalize about the processing requirements from one type of isolation effect (e.g., semantic) to another (e.g., physical). Certain

isolation effects appear to depend on processing that is relatively automatic in nature, whereas other isolation effects require greater attentional resources during encoding. Although previous research has refuted the theory that differential attention is given to isolates relative to controls (see Dunlosky et al., 2000), our study suggests that attentional demands exist for isolation effects during encoding, and these demands depend on the nature of the distinctiveness. Further research will be needed to determine whether these results can be replicated with other manipulations of semantic and physical isolation effects or with other methodologies. It is also unknown whether the processing at retrieval that results in isolation effects is attention-demanding or occurs automatically. Future studies could divide attention during the retrieval phase to determine the necessity of attention.

Author note This research was supported in part by the MUSE (Mentored Undergraduate Summer Experience) program, funded by The College of New Jersey. We thank the research assistants in the Memory and Aging Lab at The College of New Jersey for their assistance with data collection and analyses. We also thank R. Reed Hunt and Emanuel Donchin for their reviews and helpful comments on earlier drafts of the manuscript.

References

- Baddeley, A., Lewis, V., Eldridge, M., & Thomson, N. (1984). Attention and retrieval from long-term memory. *Journal of Experimental Psychology: General*, 113, 518–540. doi:10.1037/0096-3445.113.4.518
- Bellezza, F. S., & Cheney, T. L. (1973). Isolation effect in immediate and delayed recall. *Journal of Experimental Psychology*, 99, 55–60. doi:10.1037/h0034756
- Bone, R. N., & Goulet, L. R. (1968). Serial position and the von Restorff isolation effect. *Journal of Experimental Psychology*, 76, 494–496. doi:10.1037/h0025505
- Bruce, D., & Gaines, M. T. (1976). Tests of an organizational hypothesis of isolation effects in free recall. *Journal of Verbal Learning and Verbal Behavior*, 15, 59–72. doi:10.1016/S0022-5371(76)90007-4
- Craik, F. I. M. (1986). A functional account of age differences in memory. In F. Klix & H. Hagendorf (Eds.), *Human memory and cognitive capabilities: Mechanisms and performances* (pp. 409–422). Amsterdam, The Netherlands: Elsevier.
- Craik, F. I. M., Govoni, R., Naveh-Benjamin, M., & Anderson, N. D. (1996). The effects of divided attention on encoding and retrieval processes in human memory. *Journal of Experimental Psychology: General*, 125, 159–180. doi:10.1037/0096-3445.125.2.159
- Cimballo, R. S., Capria, R. A., Neider, L. L., & Wilkins, M. C. (1977). Isolation effect: Overall list-facilitation in short-term memory. *Acta Psychologica*, 41, 419–432. doi:10.1016/0001-6918(77)90001-4
- Donchin, E. (1981). Surprise ... Surprise? *Psychophysiology*, 18, 493–513. doi:10.1111/j.1469-8986.1981.tb01815.x
- Dunlosky, J., Hunt, R. R., & Clark, E. (2000). Is perceptual salience needed in explanations of the isolation effect? *Journal of Experimental Psychology*, 26, 649–657. doi:10.1037/0278-7393.26.3.649
- Fabiani, M., & Donchin, E. (1995). Encoding processes and memory organization: A model of the von Restorff effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 224–240. doi:10.1037/0278-7393.21.1.224
- Fabiani, M., Gratton, G., Karis, D., & Donchin, E. (1987). Definition, identification, and reliability of measurement of the P300 component of the event-related brain potential. In P. K. Ackles, J. R. Jennings, & M. G. H. Coles (Eds.), *Advances in psychophysiology* (Vol. 2, pp. 1–78). Greenwich, CT: JAI Press.
- Fabiani, M., Karis, D., & Donchin, E. (1990). Effects of mnemonic strategy manipulation in a von Restorff paradigm. *Electroencephalography and Clinical Neurophysiology*, 75, 22–35.
- Geraci, L., & Manzano, I. (2010). Distinctive items are salient during encoding: Delayed judgments of learning predict the isolation effect. *Quarterly Journal of Experimental Psychology*, 63, 50–64. doi:10.1080/17470210902790161
- Geraci, L., McDaniel, M. A., Manzano, I., & Roediger, H. L., III. (2009). The influence of age on memory for distinctive events. *Memory & Cognition*, 37, 175–180. doi:10.3758/MC.37.2.175
- Geraci, L., & Rajaram, S. (2002). The orthographic distinctiveness effect on direct and indirect tests of memory: Delineating the awareness and processing requirements. *Journal of Memory and Language*, 47, 273–291. doi:10.1016/S0749-596X(02)00008-6
- Godden, D. R., & Baddeley, A. D. (1975). Context-dependent memory in two natural environments: On land and underwater. *British Journal of Psychology*, 66, 325–331. doi:10.1111/j.2044-8295.1975.tb01468.x
- Gounden, Y., & Nicolas, S. (2012). Ageing and secondary-distinctiveness-based effects: The orthographic distinctiveness effect is more robust than the bizarreness effect. *Quarterly Journal of Experimental Psychology*, 65, 1820–1832. doi:10.1080/17470218.2012.673630
- Green, R. T. (1956). Surprise as a factor in the von Restorff effect. *Journal of Experimental Psychology*, 52, 340–344. doi:10.1037/h0047496
- Gumenik, W. E., & Levitt, J. (1968). The von Restorff effect as a function of the difference of the isolated item. *American Journal of Psychology*, 81, 247–252. doi:10.1037/h0029722
- Hunt, R. R. (1995). The subtlety of distinctiveness: What von Restorff really did. *Psychonomic Bulletin & Review*, 2, 105–112. doi:10.3758/BF03214414
- Hunt, R. R. (2006). The concept of distinctiveness in memory research. In J. B. Worthen (Ed.), *Distinctiveness and memory* (pp. 3–25). New York, NY: Oxford University Press.
- Hunt, R. R., & Elliot, J. M. (1980). The role of nonsemantic information in memory: Orthographic distinctiveness effects on retention. *Journal of Experimental Psychology: General*, 109, 49–74. doi:10.1037/0096-3445.109.1.49
- Hunt, R. R., & Lamb, C. A. (2001). What causes the isolation effect? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 27, 1359–1366. doi:10.1037/0278-7393.27.6.1359
- Hunt, R. R., & Mitchell, D. B. (1982). Independent effects of semantic and nonsemantic distinctiveness. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 8, 81–87. doi:10.1037/0278-7393.8.1.81
- Hunt, R. R., & Seta, C. E. (1984). Category size effects in recall: The roles of relational and individual item information. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 10, 454–464. doi:10.1037/0278-7393.10.3.454
- Hunt, R. R., & Toth, J. P. (1990). Perceptual identification, fragment completion, and free recall: Concepts and data. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16, 282–290. doi:10.1037/0278-7393.16.2.282
- Jenkins, W. O., & Postman, L. (1948). Isolation and the spread of effect in serial learning. *American Journal of Psychology*, 61, 214–221.
- Kelley, M. R., & Nairne, J. S. (2001). Von Restorff revisited: Isolation, generation, and memory for order. *Journal of Experimental*

- Psychology: Learning, Memory, and Cognition*, 27, 54–66. doi:10.1037/0278-7393.27.1.54
- Koyanagi, K. (1957). Studies in incidental learning: I. Intention of learning and the isolation effect. *Japanese Journal of Psychology*, 27, 270–278.
- Kutas, M., & Van Petten, C. (1988). Event-related brain potential studies of language. In P. K. Ackles, J. R. Jennings, & M. G. H. Coles (Eds.), *Advances in psychophysiology* (Vol. 3, pp. 139–187). Greenwich, CT: JAI Press.
- Mäntylä, T., & Bäckman, L. (1992). Aging and memory for expected and unexpected objects in real-world settings. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18, 1298–1309. doi:10.1037/a0022715
- Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior*, 16, 519–533. doi:10.1016/S0022-5371(77)80016-9
- Mulligan, N. W. (1998). The role of attention during encoding in implicit and explicit memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24, 27–47. doi:10.1037/0278-7393.24.1.27
- Naime, J. S. (1990). Similarity and long-term memory for order. *Journal of Memory and Language*, 29, 733–746. doi:10.1016/0749-596X(90)90046-3
- Naime, J. S. (2006). Modeling distinctiveness and memory: Implications for general memory theory. In R. R. Hunt & J. B. Worthen (Eds.), *Distinctiveness and memory* (pp. 27–46). New York, NY: Oxford University Press.
- Peterson, R. C. (1977). Retrieval failures in alcohol state-dependent learning. *Psychopharmacology*, 55, 141–146. doi:10.1007/BF01457849
- Pillsbury, W. B., & Rausch, H. L. (1943). An extension of the Kohler–Restorff inhibition phenomenon. *American Journal of Psychology*, 56, 293–298.
- Postman, L., & Phillips, L. W. (1954). Studies in incidental learning: I. The effect of crowding and isolation. *Journal of Experimental Psychology*, 48, 48–56. doi:10.1037/h0060802
- Pritchard, W. S., Shappell, S. A., & Brandt, M. E. (1991). Psychophysiology of N200/N400: A review and classification scheme. In P. K. Ackles, J. R. Jennings, & M. G. H. Coles (Eds.), *Advances in psychophysiology* (Vol. 4, pp. 43–106). Greenwich, CT: JAI Press.
- Rundus, D. (1971). Analysis of rehearsal processes in free recall. *Journal of Experimental Psychology*, 89, 63–77. doi:10.1037/h0031185
- Saltzman, I. J., & Carterette, T. (1959). Incidental and intentional learning of isolated and crowded items. *American Journal of Psychology*, 72, 230–235. doi:10.2307/1419367
- Saul, E. V., & Osgood, C. E. (1950). Perceptual organization and materials as a factor influencing ease of learning and degree of retention. *Journal of Experimental Psychology*, 40, 372–379. doi:10.1037/h0060018
- Schmidt, S. R. (1991). Can we have a distinctive theory of memory? *Memory & Cognition*, 19, 523–542. doi:10.3758/BF03197149
- Smith, R. E. (2006). Adult age differences in episodic memory: Item-specific, organizational, and distinctive information. In R. R. Hunt & J. B. Worthen (Eds.), *Distinctiveness and memory* (pp. 259–287). New York, NY: Oxford University Press.
- Smith, R. E. (2011). Providing support for distinctive processing: The isolation effect in young and older adults. *Psychology and Aging*, 26, 744–751. doi:10.1037/a0022715
- Van Overschelde, J. P., Rawson, K. A., & Dunlosky, J. (2004). Category norms: An updated and expanded version of the Battig and Montague (1969) norms. *Journal of Memory and Language*, 50, 289–335. doi:10.1016/j.jml.2003.10.003
- von Restorff, H. (1933). Über die Wirkung von Bereichsbildungen im Spurenfeld [On the effect of sphere formations in the trace field]. *Psychologische Forschung*, 18, 299–342. doi:10.1007/BF02409636
- Wallace, W. P. (1965). Review of the historical, empirical, and theoretical status of the von Restorff isolation effect. *Psychological Bulletin*, 63, 410–424. doi:10.1037/h0022001