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# Short article

# Age-related differences in the von Restorff isolation effect

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When one item is made distinct from the other items in a list, memory for the distinctive item is improved, a finding known as the isolation or von Restorff effect (after von Restorff, 1933). Although demonstrated numerous times with younger adults and children, this effect has not been found with older adults (Cimbalo & Brink, 1982). In contrast to the earlier study, we obtained a significant von Restorff effect for both younger and older adults using a physical manipulation of font colour. The effect size for older adults was smaller than that obtained for younger adults, confirming a prediction of Naveh-Benjamin's (2000) associative deficit hypothesis, which attributes age-related differences in memory performance to older adults' reduced ability to form associations. The findings are consistent with related research in which older adults demonstrate similar—but smaller—benefits for distinctive information to those for younger adults.

*Keywords*: Ageing; Distinctiveness; Free recall; Isolation effect; von Restorff.

Normal ageing is typically associated with declines in memory performance across a wide variety of tasks and for many different types of information (Zacks, Hasher, & Li, 2000). Explanations for these changes in memory performance usually cite a deficit in some process involved in memory formation/retrieval (e.g., forming associations; Naveh-Benjamin, 2000) or a deficit in a general cognitive factor (e.g., processing speed; Salthouse, 1996). None of these theories, however, propose that memory mechanisms operate in a fundamentally different manner in older adults. Consistent with this assumption, younger and older adults usually show similar benefits from experimental manipulations that improve memory, including generation (Taconnat & Isingrini, 2004), and levels of processing (Troyer, Häfliger, Cadieux, & Craik, 2006). One factor that may be an exception

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to this rule is distinctiveness: The available data suggest that the benefit of distinctiveness may be reduced—or even absent—for older adults. There are two purposes of the research reported here: (a) to examine age-related differences in the effects of distinctiveness and (b) to evaluate the hypothesis that an associative deficit in older adults (Naveh-Benjamin, 2000) underlies age-related deficits in memory.

When a particular item is made distinct from other items in a list, memory for the distinctive item is improved. This is known as the von Restorff effect or the isolation effect (von Restorff, 1933). Recall of the distinctive item is typically compared to that of a control item that is consistent with the background items. Isolation effects can be achieved with both physical manipulations (e.g., size, colour, or font type) and semantic changes (e.g., meaningfulness or category). Numerous studies have demonstrated the robustness of this effect using various stimuli and methodologies (for a review, see Hunt, 1995), and the isolation effect is reliably obtained in college-age adults as well as in children (Howe, Courage, Vernescu, & Hunt, 2000). The size of the isolation effect depends on several factors, including the manner in which the isolate differs from the other items in a list. Large effects are obtained using size, colour, and spacing manipulations, and isolation effects increase in magnitude as the difference between the isolate and the other list items increases (Gumenik & Levitt, 1968; see also Hunt, 1995).

Despite the large literature on isolation effects in children and young adults, only one published study has examined the isolation effect in older adults. Cimbalo and Brink (1982) displayed lists of nine consonants to younger and older adults for immediate written serial recall, with the isolate lists containing a consonant in a larger font in the fifth position. Younger, but not older, adults recalled the isolates better than the control items. The authors argued that older adults noticed the size difference, but suggested that the lack of an isolation effect reflected a deficit in using structural information to organize the list. The isolate, then, "may have been considered as analogous to noise, something to be ignored" by the older adults (p. 76).

Most current theories of ageing and memory, including theories based on inhibition, reduced resources, and slower speed of processing, predict that older adults will show lower overall performance than younger adults on most episodic memory tasks (Zacks et al., 2000). They lack, however, a specific reason why older adults might show a reduced or nonexistent benefit for the isolate. In contrast, the associative deficit hypothesis (Naveh-Benjamin, 2000) offers a specific explanation for age-related differences in the isolation effect. Naveh-Benjamin argued that it is important to distinguish between memory for a single unit and memory for associations among units. Associations between two units can include two items, an item and its context, two contextual features, or "the representation of two mental codes" (p. 1170). He proposed that the reason older adults show poorer memory in most episodic memory tasks is that older adults have difficulty "merging different aspects of an episode into a cohesive unit" (p. 1185).

Naveh-Benjamin and colleagues (Naveh-Benjamin, 2000; Naveh-Benjamin, Hussain, Guez, & Bar-On, 2003; Naveh-Benjamin, Guez, Kilb, & Reedy, 2004) have demonstrated that an important predictor of when older adults will show worse performance than younger adults is whether the task requires memory for units versus memory for the association between units. For example, compared to younger adults, older adults recognized fewer word–nonword and word–word pairs despite similar levels of performance for recognition of the individual items (Naveh-Benjamin, 2000). This type of associative deficit was replicated using pictorial stimuli (Naveh-Benjamin et al., 2003) and face/name pairs (Naveh-Benjamin et al., 2004). This view has also been successful in accounting for older adults' reduced memory for contextual details (for a meta-analysis, see Spencer & Raz, 1995) using the idea that older adults can remember individual units (i.e., the items or the contextual features), but suffer when they must also remember associations amongst them (i.e., which contextual feature went with which items). Naveh-Benjamin (2000, Exp. 3) ruled out the possibility that older adults simply lack information about contextual details in general by presenting words in different fonts, followed by tests for the words, fonts, and words–font relations. Older adults showed equivalent memory for the words and for the fonts, but a large deficit in recalling the word–font relations.

According to the associative deficit hypothesis, age-related differences in the isolation effect are due to the difficulty that older adults have in associating contextual features with items such as the colour in which a word was presented. The association of the contextual element (colour) to an item is necessary for an isolation effect to occur because it is this contextual element that causes the isolate to have increased distinctiveness at retrieval (due either to items being placed in different categories, e.g., Hunt & Lamb, 2001, or cues uniquely specifying the isolate, e.g., Nairne, 2006). If older adults do not associate contextual elements to items as well as younger adults, then a smaller or nonexistent isolation effect should be found for older adults.

The current experiment was designed to compare isolation effects in younger and older adults and to test a prediction of the associative deficit hypothesis that older adults will show reduced isolation effects. Participants viewed lists of 12 unrelated nouns, with the isolate lists consisting of one item in a red font and all other items in a black font. Immediately following presentation, participants recalled the items using free written recall. In addition, two different presentation rates were used to determine whether older adults would show greater isolation effects when given an increased opportunity to encode the information.

## Method

The design of the current experiment differed from the Cimbalo and Brink (1982) study in the following ways: First, the list items were presented one at a time rather than simultaneously to ensure that all items were given equal opportunity to be encoded. Second, presentation time was held constant across lists for a given participant rather than varied unpredictably. Third, the isolate manipulation involved a perceptually obvious manipulation of colour rather than a slight size difference (1 mm) between controls and isolates. Finally, the test was free rather than serial recall, a task that typically yields larger isolation effects (e.g., Kelley & Nairne, 2001).

### *Participants*

A total of 80 younger adults ($M$ = 19.3 years, range 18–26) and 80 older community-dwelling adults ($M$ = 70.1 years, range 60–89) participated in this experiment. The younger adults were Purdue University undergraduates who participated in exchange for course credit. The older adults were paid $10 per hour and were recruited from the community. The education levels of older adults ranged from high school to graduate/professional degrees, with 79% of the participants completing at least some college coursework (highest level of education was a high-school degree for 21% of the older adults; some college for 15%; a college degree for 21%; some graduate or professional education for 3%; and a graduate or professional degree for 40%). All participants reported themselves to be in good health, and none reported using any medications that might interfere with cognitive functioning.

All participants were administered a 20-item vocabulary test adapted from Salthouse (1993) and a computerized memory span task based upon the reading span test in Kane et al. (2004) in order to obtain an estimate of each participant's overall level of cognitive functioning. Typical results obtained: There was a slight difference in favour of the younger adults for memory span (younger $M = 7.6$, $SD = 1.1$; older $M = 6.7$, $SD = 1.0$), $t(158) = 5.35$, $p < .01$, but older adults did significantly better on the vocabulary test (younger $M = 7.9$, $SD = 3.4$; older $M = 13.6$, $SD = 5.2$), $t(158) = 8.24$, $p < .01$.

### *Materials*

The stimuli were 241 nouns selected from Clark and Paivio (2004). The nouns selected were of medium to high imageability ($M = 6.03$, range 4.00−6.90 out of 6.90), familiarity ($M = 5.97$, range 4.21−6.92 out of 7.00), and frequency ($M = 1.75$, range of 1.00 to 2.00 using log Thorndike−Lorge frequency; $M = 1.70$, range of 1.00 to 2.77 using log Kucera−Francis frequency).

*Design*

Age (younger, older) and presentation rate (1.5 s, 3 s) were between-subjects variables, and the isolation manipulation of list type (isolate, control) and serial position (1−12) were within-subjects variables. Participants viewed the to-be-remembered items one at a time in the middle of a computer screen and were asked to read each word silently. Each list contained 12 different items, with each item presented for either 1.5 or 3 s and no delay between items. The items on each list were randomly selected without replacement from the 241 stimuli; thus no word was repeated within or across lists for any individual. All of the items in the control lists were presented in black against a white background. In the isolate lists, the 7th item was presented in red, and the other 11 items were black. The isolate always appeared in the 7th serial position to maximize the possibility of obtaining an isolation effect for older adults. First, fewer trials are required to obtain reliable data than if all positions are tested, and, second, effect sizes are likely to be larger in middle serial positions than in earlier and later positions (because of the absence of primacy and recency effects). There were 20 trials in total: 10 control lists and 10 isolate lists. List type on any given trial was random.

*Procedure*

Participants were told that they would see 12 words one at a time followed by the cue "please recall the words". They were asked to recall as many words as possible by writing the words down on a response sheet that contained trial numbers and 12 numbered lines per trial. They were informed that they could recall the items in any order and could take as much time as necessary. To proceed to the next list, the participant clicked on a button labelled "next trial". Participants were tested one at a time, and the experimenter remained in the room to ensure compliance with the instructions.

## Results

As Figure 1 illustrates, older adults clearly showed a von Restorff isolation effect regardless of the presentation rate. When questioned after the experiment, all of the younger adults and all but 2 of the 80 older participants reported awareness of the isolate.

*Free recall*

The data were first analysed with a 2 (age: younger, older) × 2 (presentation rate: fast, slow) × 2 (list type: control, isolate) × 12 (serial position: 1−12)

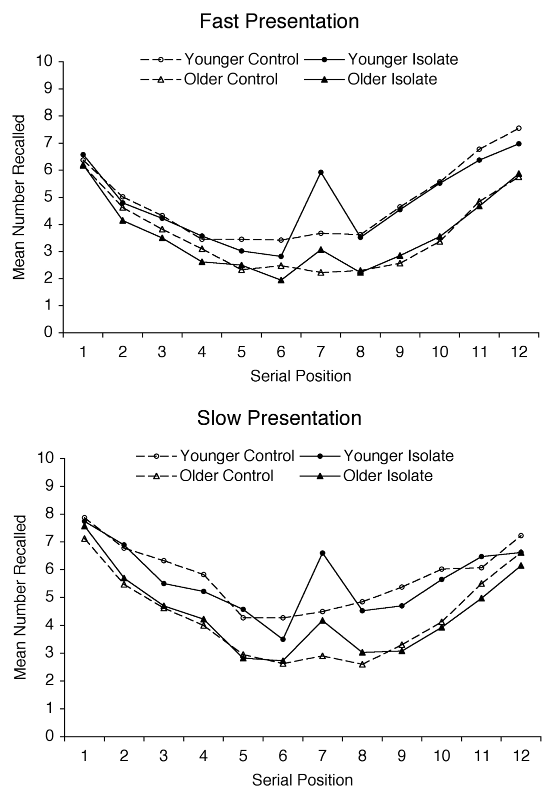


**Figure 1.** *Recall of control and isolate lists as a function of group and serial position. The top panel shows fast presentation, and the bottom panel shows slow presentation.*

analysis of variance (ANOVA). For this and all subsequent analyses, alpha was set to .05. Younger adults recalled more list items than older adults (5.28 out of 12 vs. 3.99), yielding a main effect of age, $F(1, 156) = 60.12$, $MSE = 26.24$. More words were recalled with the slower presentation rate than with the faster rate (5.05 vs. 4.22), resulting in a main effect for presentation rate, $F(1, 156) = 25.13$, $MSE = 26.24$. Overall, lists containing the isolate were not recalled differently from control lists (4.63 vs. 4.64), $F(1, 78) < 1$. Typical primacy and recency effects were obtained, resulting in a main effect of serial position, $F(11, 1716) = 121.96$, $MSE = 4.45$.

The difference in recall between younger and older adults increased from earlier to later serial positions (collapsed across presentation rates), with a significant interaction between age and position, $F(11, 1716) = 4.66$, $MSE = 4.45$. This occurred primarily because of the increased recency effects that younger adults displayed with fast than with slow presentation. List type interacted with position, reflecting the isolation effect in which the item in the 7th serial position was better recalled in the isolate lists than the control lists (4.94 vs. 3.33), $F(11, 1716) = 10.35$, $MSE = 2.24$. Slow presentation resulted in a memory advantage over fast presentation for earlier, but not for later, serial positions, yielding a significant interaction between position and presentation rate, $F(11, 1716) = 4.91$, $MSE = 4.45$. There were no other significant interactions.

### *Isolation effect*

To examine the effects of age on the isolation effect, additional analyses were performed on recall of just the items occurring in the 7th serial position. A 2 (age: younger, older) × 2 (presentation rate: fast, slow) × 2 (list type: control, isolate) ANOVA yielded main effects for all variables. More items were recalled by younger than older adults (5.18 vs. 3.09), $F(1, 156) = 82.76$, $MSE = 4.19$, and with slow than fast presentation (4.54 vs. 3.73), $F(1, 156) = 12.81$, $MSE = 4.19$, and the isolates were recalled more often than control items (4.94 vs. 3.23), $F(1, 156) = 78.03$, $MSE = 2.69$. Younger adults demonstrated a larger difference between isolates and controls (6.26 vs. 4.09) than did older adults (3.63 vs. 2.56), resulting in a significant interaction between age and list type, $F(1, 156) = 9.21$, $MSE = 2.69$. A $t$ test confirmed an isolation effect for older adults, with the means for isolates (3.63) and controls (2.56) differing significantly, $t(80) = 4.29$. No other interactions were significant. The lack of a significant three-way interaction between age, presentation rate, and list type, $F(1, 156) = 0.62$, $MSE = 2.69$, suggests that the difference in the size of the isolation effect for younger compared to older adults does not depend on presentation rate.

### *Participant variables*

The sample of older adults included many who had graduate or professional degrees. One possible concern is that the von Restorff effect that was observed was driven by a subgroup of highly educated and potentially higher performing older participants. The older participants were divided into two groups based on level of education. The closest we could come to a median split that resulted in groups with equivalent ages was to define the "high education" group as those with at least some graduate school ($N = 34$, $M = 70.41$, range 60 to 82) and the "low education" group as everyone else ($N = 46$, $M = 69.85$, range 60 to 89). Both groups showed a significant von Restorff effect, $t(32) = 4.02$ and $t(44) = 2.41$ for the "high" and "low", respectively, although the high education group had a larger isolation effect than the low education group (2.56 vs. 3.91 compared to 2.56 vs. 3.41). However, the age-related difference remains even when the high education group was compared to the younger adults (4.09 vs. 6.26). Thus, high levels of education in older adults reduces, but does not eliminate, the age-related differences seen in the magnitude of the isolation effect.

Because our sample included a wide range of ages for older adults, it was possible to examine differences in the isolation effect between the young–old (ages 60–74, $N = 59$) and the old–old (ages 75–89, $N = 21$). Each age group showed a significant isolation effect: 3.78 isolates versus 2.69 controls for the young−old, $t(19) = 2.53$, compared to 2.19 isolates versus 3.19 controls for the old−old, $t(57) = 3.97$. The magnitude of the isolation effect did not differ, $t(78) = 0.15$. Thus, the benefit of the isolate appears relatively stable across older age.

### *Output order*

One possible explanation for the higher recall of the isolate may be that it is output earlier than the control item, which reduces output interference. To check for this, mean output position for recalling the item from the 7th position (when it was recalled) in both the control and isolate lists was calculated (see Figure 2). A 2 (age: younger, older) × 2 (presentation rate: fast, slow) × 2 (item type: control, isolate) ANOVA was conducted on average output position for isolates and controls. Of most importance, isolate items were not output at earlier positions than control items, $F(1, 56) < 1$. However, older adults output the 7th items (collapsed across control and isolate lists) significantly earlier than did younger adults (position 3.7 vs. 4.4), resulting in a main effect of age, $F(1, 156) = 14.22$, $MSE = 2.48$. This is due to the fewer total number of items recalled by older adults than by younger adults. The isolated items were also output earlier with fast presentation compared to slow presentation (3.7 vs. 4.3), $F(1, 156) = 12.27$, $MSE = 2.48$. Again, this effect occurred as a result of the fewer items recalled with fast than with slow presentation. There were no significant interactions. This analysis was repeated on normalized data, which takes into account the differential levels of recall; again, no evidence of early output of the isolated item was observed.

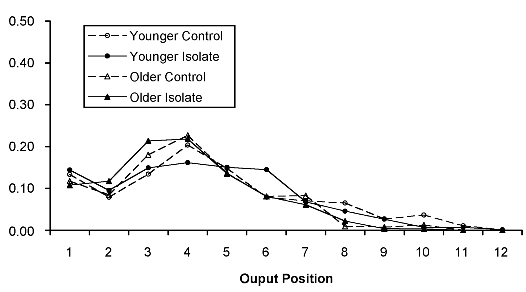


**Figure 2.** *Proportion of responses for isolates and controls (7th position) by output position.*

## GENERAL DISCUSSION

Younger adults demonstrated better memory for isolated items than did controls in lists of homogeneous background items, replicating the well-known isolation effect (von Restorff, 1933). In contrast to the results obtained by Cimbalo and Brink (1982), the results of the current study clearly demonstrate a significant isolation effect for older adults. Because of the numerous methodological differences between the Cimbalo and Brink study and the current experiment, it is not clear why the effect was not obtained in their study. However, their combination of serial recall, simultaneous presentation, and a relatively small difference between isolate and control items may all have contributed to the difference. The current study used a more typical methodology and found that older adults are affected by distinctiveness in a qualitatively similar way to younger adults.

Although the older adults showed a significant isolation effect, it was smaller than that of the younger adults. These results support the predictions of Naveh-Benjamin's (2000) associative deficit hypothesis. According to this view, older adults show poorer memory in most episodic memory tasks due to difficulty "merging different aspects of an episode into a cohesive unit" (p. 1185). In the current experiment, memory for each list requires associations amongst the items and/or associations between each item and the surrounding context, both of which will be deficient for older adults. This view, therefore, correctly predicts overall lower performance for older adults. Further, because older adults are not able to associate contextual elements with specific items as well as younger adults, they are not able to use these contextual features as retrieval cues as effectively. The weaker association between the unique colour information and the item will reduce the isolation effect because it is this contextual element that causes the isolate to have increased distinctiveness at retrieval.

The finding of a reduced isolation effect for older adults could also be explained by accounts that postulate processing differences between younger and older adults, as processing differences have been shown to affect the magnitude of the isolation effect (e.g., Fabiani, Karis, & Donchin, 1990). For example, one view states that distinctive processing, defined as "processing the difference in the context of similarity", is more difficult for older adults (see Smith, 2006, p. 279). This difficulty arises from the need to process information about the item as well as information about the relationships between the items, which draws upon cognitive resources that are limited for older adults. According to this view, older adults are less likely to engage in distinctive processing when the task requires a large amount of cognitive resources. Therefore, in a task such as the one in the current study that requires a large amount of cognitive resources, older adults would be less able to engage in the distinctive processing that results in the isolation effect.

Most current accounts of the isolation effect attribute it to the increased distinctiveness at retrieval for the isolate relative to the background items (e.g., Hunt & Lamb, 2001; Kelley & Nairne, 2001; Nairne, 2006). Research in other areas has found that older adults do benefit from enhanced distinctiveness at retrieval, albeit to a lesser extent than younger adults (e.g., Mäntylä & Bäckman, 1992; Smith, 2006), and it would therefore be surprising if older adults did not show an isolation effect. Contrary to the only other published study, the results reported here show that older adults do show a typical isolation effect, and, in parallel with findings in other areas, the effect is reduced for older adults.

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