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What explains the von Restorff effect? Contrasting distinctive processing and retrieval cue efficacy

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ABSTRACT

This study contrasted two explanations of the von Restorff effect – distinctive processing and retrieval cue efficacy, which differ in their assumptions about encoding processes. A homonym, *kiwi*, was used as the critical word and manipulated to either be synonymous with background items, or made an isolate by orienting participants towards its alternate meaning. The orientation was done at either the encoding or retrieval stages. Experiments 1a and 1b showed that even without distinctive processing at encoding, the von Restorff effect could still occur at retrieval in the presence of an effective retrieval cue. Experiments 2 and 3 eliminated the von Restorff effect through equating cue overload between the control and isolation lists. The results support the retrieval cue efficacy account and suggest that it is not necessary to have distinctive processing to obtain the isolation effect.

Introduction

The von Restorff effect, or the isolation effect, refers to better memory for items that "stand out". First demonstrated by Hedwig von Restorff in 1933, the effect illustrates that when one item is isolated, or made distinctive from other items in a list, memory for the isolated item is improved (von Restorff, 1933; see Wallace, 1965, for a review). Specifically, the key comparison for the von Restorff effect is between an item embedded within an isolation list such that it appears heterogeneous, against the same item presented in a control list for which it appears homogeneous. As illustrated in Table 1, the word *blue* stands out amongst a series of animals in the isolation list, but appears consistent with the series of colours in the control list. The word *blue* would thus be better recalled in the isolation list than in the control list.

Historically, the effect has proven robust, having been replicated and reliably obtained using a myriad of methodologies (for reviews, see Hunt, 1995; Wallace, 1965). Isolation techniques include manipulating a physical feature of the isolate (e.g., font size or colour), or by drawing the isolate from a different taxonomic category than other items in the list, such as in Table 1. Unique isolation techniques also include meaningfulness, background colour, and electric shock (Cimbalo, 1978).

While this phenomenon seems intuitively simple, there is no clear agreement on exactly what causes the effect. An early view proposed differential attention as the mechanism mediating the effect (Jenkins & Postman, 1948). Green (1956) then suggested that this differential attention is actually a result of surprise at the salience of the stimuli, due to its deviation from the surrounding context. These traditional explanations of the von Restorff effect posit that the salient item attracts additional processing at study. For example, encountering the word *blue* after consistently studying a series of animals elicits surprise due to its difference from the context, thus evoking additional processing for the word *blue*. This additional processing may be in the form of additional rehearsal (Rundus, 1971), elaboration (Waddill & McDaniel, 1998), or simply more overall processing (e.g., Watkins, LeCompte, & Kim, 2000; Wollen & Cox, 1981), thus facilitating memory for the isolate.

This once dominant explanation is now out of favour due to its key assumption of salience. Ironically, von Restorff's (1933) original experiment argues against the necessity of salience in explaining the isolation effect. As noted by Hunt (1995), most isolation paradigms have placed the isolate late in the list (e.g., Bireta, Surprenant, & Neath, 2008). However, von Restorff (1933) herself placed the isolate early in the list (i.e., serial positions 2 or 3), and subsequent research found the effect even when the isolate appeared as the first item in the list (e.g., Kelley & Nairne, 2001). At this point, no list context had been established, so there is no background of similarity against which the isolate can be deemed especially salient.

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Table 1
An example of isolation and control lists.

Isolation list	Control list
Lion	Red
Bear	Brown
Tiger	Silver
Goat	Yellow
Cow	Green
Blue*	Blue*
Horse	Purple
Sheep	Gold
Moose	Pink
Wolf	Orange
Deer	White

Note. Asterisk (*) indicates the isolate used for comparison.

Dunlosky, Hunt, and Clark (2000) further investigated the need for salience by using judgments of learning (JOLs) as an independent index of salience. JOLs are a metacognitive index of a participant's belief that a given item will be remembered on a later recall test, and evidence suggest that salience can elevate JOLs (e.g., Koriat, 1997). Dunlosky et al. (2000) reported that JOLs for an early isolate did not differ from the JOLs for matched items in a control list, whereas JOLs for a late isolate were inflated relative to controls. Nonetheless, the magnitude of the von Restorff effect did not differ between early and late isolates. Perceived salience thus does not seem necessary for the effect, undermining a key assumption of the early explanations.

Thus, with scant experimental evidence for encoding-centred explanations of the von Restorff effect, current theories now argue that the locus of the effect should be a joint effect of encoding and retrieval processes or just at retrieval. We discuss two frameworks that have been established: distinctive processing (Hunt, 2006, 2013; Hunt & Lamb, 2001), and retrieval cue efficacy, as instantiated by Nairne's (1990, 2006) feature model of immediate memory.

Distinctive processing theory

To explain the framework of distinctive processing, it is important to understand the theory of structural alignment (Markman & Gentner, 2005). Structural alignment holds that when a list is first studied, shared properties amongst items are spontaneously perceived. For example, in a list with the items *red, blue, yellow,* and *green*, the concept of colours is automatically identified. This is because information is assimilated into our existing knowledge structures in order to encode information quickly and reliably. Hence, by extension, in any isolation paradigm with a categorised list, similarities across items will be spontaneously encoded. This is termed relational or categorical processing.

A consequence of categorical processing is that the likelihood of item-specific processing amongst background items is reduced. Item-specific processing refers to the processing of individual features of an item not shared by other items in a list. The isolate, on the other hand, is the only item in its category, and thus receives both categorical and item-specific processing.

This combination of categorical processing and item-specific processing can be framed as the processing of difference in the context of similarity, thus giving the definition of distinctive processing (Hunt, 2006). Whereas the background items receive categorical processing, the isolate receives both categorical and item-specific processing, and thus the isolate is more distinctive at retrieval when the similarity context is reinstated, leading to better recall.

Hunt and Lamb (2001) empirically supported this explanation by examining how various orienting tasks affect the isolation effect. Participants were given lists containing either 10 related items (e.g., a list of vegetables) or 9 related items and 1 item from a different category (e.g., a tool). Participants then studied these lists by performing orienting tasks that required either a difference judgment or similarity judgment. The similarity and difference judgments were made between each current item and the preceding item. Two major findings emerged; first, when participants were asked to focus on item differences, the isolation effect was eliminated; second, when the orienting task was similarity based, a robust isolation effect occurred.

These findings are consistent with the crux of the argument that similarity amongst background items must be processed in order to provide a dimension against which the isolate can spontaneously stand out. Hence, the von Restorff effect only occurs if the isolate is processed as different from the context at encoding.

Retrieval cue efficacy

At the same time that Hunt and Lamb (2001)'s study was reported, Kelley and Nairne (2001) articulated a different approach to understanding the von Restorff effect. Their suggestion is not new, and borrows from Nairne's (1990) feature model of immediate memory. According to this explanation, memory performance is ultimately a matter of response selection aided by retrieval cues. From the vast amount of information that is potentially available, retrieval cues help discriminate between accurate and inaccurate responses. An item is chosen for recall by comparing, or matching, the operative retrieval cue to possible candidates in memory. Memory performance is thus a function of how well a retrieval cue can specify a particular item to be recalled, while excluding all other candidates. In short, memory performance depends on how efficacious the retrieval cue is.

To formalise this process, Nairne (1990, 2006) presented a simple ratio in his feature model of immediate memory. According to this ratio, the probability that an item, E_1, will be selected as a recall candidate follows the following formula:

$$P_r(X_1|E_1) = \frac{s(X_1, E_1)}{\sum s(X_1, E_1)}$$

The numerator $s(X_1, E_1)$ quantifies the cue-target match, and refers to the how well the retrieval cue matches the item. Cue-target match varies as a function of the number of matching or mismatching features between the two terms (Thomson & Tulving, 1970). The denominator $\sum s(X_1, E_1)$ quantifies cue overload, or the extent to which a retrieval cue is predictive of other items (Earhard, 1967; Watkins & Watkins, 1975). The probability that an item, E_1, will be selected as a recall candidate depends on how well the retrieval cue, X_1, matches E_1 to the exclusion of other possible recall candidates (e.g., $E_1, E_2, E_3, \ldots, E_N$).

Under this formulation, whether or not a retrieval cue can lead to successful recall of an item will thus be proportional to the cue-target match and inversely proportional to the amount of cue overload. This then nicely explains the von Restorff effect – holding cue-target match constant, the efficacy of a retrieval cue is reduced when it points to a large number of targets and increased when it specifies only a single target (Anderson, 1974; Watkins & Watkins, 1975). Therefore, in any isolation list, the operative retrieval cue for the isolate is likely to be more efficacious – since the isolate is the only item from its category in the isolation list, the retrieval cue is likely to specify only a single target and exclude all other possible recall candidates. In a control list however, the retrieval cue for the isolate is likely to encompass all other all other background items in the same category, and is less efficacious. For example, the cue "colour" in the isolation list in Table 1 refers to only one candidate (*blue*), resulting in high retrieval cue efficacy.