Journal of Memory and Language 73 (2014) 43–58

Contents lists available at ScienceDirect

Journal of Memory and Language

journal homepage: www.elsevier.com/locate/jml

All varieties of encoding variability are not created equal: Separating variable processing from variable tasks

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ARTICLE INFO

Article history:
Received 26 September 2013
revision received 18 February 2014
Available online 20 March 2014

Keywords:
Encoding variability
Item-specific and relational processing
Free recall
Recognition
False recognition

ABSTRACT

Whether encoding variability facilitates memory is shown to depend on whether item-specific and relational processing are both performed across study blocks, and whether study items are weakly vs. strongly related. Variable-processing groups studied a word list once using an item-specific task and once using a relational task. Variable-task groups' two different study tasks recruited the same type of processing each block. Repeated-task groups performed the same study task each block. Recall and recognition were greatest in the variable-processing group, but only with weakly related lists. A variable-processing benefit was also found when task-based processing and list-type processing were complementary (e.g., item-specific processing of a related list) rather than redundant (e.g., relational processing of a related list). That performing both item-specific and relational processing across trials, or within a trial, yields encoding-variability benefits may help reconcile decades of contradictory findings in this area.

Introduction

A classic debate in memory research is whether information that is encoded more than once is better remembered if the same or a different encoding strategy is used each time. According to the *encoding-variability (EV) hypothesis*, applying a variety of encoding strategies should be more beneficial than repeating a single encoding strategy, either because it increases the number of cues or routes that can be used to retrieve items at test (e.g., Estes, 1950), and/or because it increases the number of memory traces or the richness of a given trace (e.g., Glenberg, 1979). Although several studies have reported *EV benefits* relative to repeating an encoding task (e.g., D'Agostino & DeRemer, 1973; Greene & Stillwell, 1995; Hintzman & Stern, 1978; Hunt & Einstein, 1981; Maskarinec & Thompson, 1976; Postman & Knecht, 1983), others have shown no effect of EV (e.g., Bird, Nicholson, & Ringer, 1978; Dempster, 1987; Elmes & Bjork, 1975; Galbriath, 1975; Johnston, Coots, & Flickinger, 1972; Williams & Underwood, 1970), or even *EV costs* (e.g., Bobrow, 1970; Bower, Lesgold, & Tieman, 1969; Roediger, Sanches, & Agarwal, 2011; Young & Bellezza, 1982). The cause of these discrepant findings has never been satisfactorily determined. The present study aimed to reinvigorate research on EV by attempting to better specify some parameters that determine whether EV benefits are obtained.

Research on EV was launched by Estes' (1950) stimulus sampling theory, which characterized learning as a statistical association process between a stimulus and available contextual elements. During encoding, a study item and available encoding elements become associated, as in stimulus–response contingency learning. At test, available contextual elements can then be used to retrieve items that were sufficiently associated at encoding. Memory for an item is therefore a function of the contextual elements afforded at encoding and retrieval, and their associations with these elements. Conditions that produce variations

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http://dx.doi.org/10.1016/j.jml.2014.02.004
0749-596X/

in stimulus elements through EV increase the number of available associations at test, thus increasing the probability of successful retrieval relative to repeated encoding conditions (see also Martin, 1968).

Other memory theories also predict EV effects. For example, Melton (1970) suggested that the encoding context establishes retrieval routes that are then utilized during test. EV conditions presumably increase the number of available retrieval routes. In a similar vein, recursive reminding theory (Hintzman, 1974, 2004) also predicts a memory advantage for variable conditions. Here, study items are mentally "tagged" during encoding. When items are repeated, participants are reminded of the initial tags but also form additional tags if the item repetition differs qualitatively from the original presentation. When repetitions do not differ, reminded tags become recursively embedded in memory, thus restricting their utility at retrieval relative to conditions with differing repetitions that produce a variety of tags. In summary, many theories predict EV benefits irrespective of whether study items are encoded with elements, retrieval routes, or tags.

The primary use of the EV hypothesis to date has been to account for the spacing effect – a memory advantage for items studied multiple times in a distributed rather than massed fashion (e.g., Balota, Duchek, & Logan, 2007; Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006; Glenberg, 1977, 1979). Spaced presentations lead participants to encode items in a variety of contexts, thereby increasing the number of possible contextual elements that can later serve as retrieval cues. In contrast, massed presentations direct participants to encode items in the same or similar contexts, resulting in a redundancy of encoded elements and the generation of fewer potential retrieval cues. In concert with the encoding specificity principle (Tulving & Thomson, 1973), which emphasizes that memory benefits from similarities between cues present at study and test–increasing the number of study contexts should also increase the probability of a context match at test. In essence, conditions that maximize the availability of retrieval cues should also increase the probability of successful remembering.

The inconsistency of EV effects is likely partly attributable to prior studies having manipulated EV in very different ways. For example, Gartman and Johnson (1972; Winograd & Geis, 1974) had participants study homographs twice that were either presented both times in the context of the same meaning (e.g., fangs-*bat*-vampire and dark-*bat*-cave) or in the context of different meanings (e.g., plate-*bat*-baseball and fangs-*bat*-vampire). Recall was greater when homographs were studied in the different meaning (i.e., variable) condition, demonstrating an EV benefit. In contrast, Postman and Knecht (1983) presented to-be-remembered items in sentences. In the repeated condition, each word was presented three times in the same sentence whereas in the variable condition, the word was presented in three different sentences. Here EV did not benefit recall.

More pertinent to our study, the effects of EV have often been examined by varying the encoding tasks used to study a set of items, rather than varying the contexts in which items are studied. Bird et al. (1978) had participants study a list of words over two study blocks. Participants either used the same or a different study task on each block. Recall was equivalent in the variable-task and repeated conditions, demonstrating that varying the task type between study blocks does not always yield an EV benefit. Using a similar design, Young and Bellezza (1982) found that recall was greater in the repeated condition–an EV cost. The authors attributed this cost to an interference process: The additional retrieval routes created through variable tasks interfered with each other at test. Young and Bellezza did not provide any direct evidence of interference, but conceded that "the memory mechanisms relating encoding variability and recall performance have yet to be clearly specified" (p. 556). Their statement holds, 30 years after.

Our study targets the possibility that EV benefits will typically occur only when *qualitatively different types of processing* are required on each study block. One well-documented processing distinction is between item-specific and relational processing (Einstein & Hunt, 1980; Hunt & Einstein, 1981; Hunt & McDaniel, 1993; see Glenberg, 1979, for other distinctions). *Item-specific processing* occurs when tasks emphasize the unique characteristics of items over relative comparisons (e.g., rating items for pleasantness or mentally visualizing individual items). *Relational processing* occurs when tasks emphasize shared characteristics and relative comparisons among items (e.g., sorting items into categories or constructing narratives with items). At test, participants who had engaged in relational processing at encoding are more likely to organize their retrieval on the basis of item relations than those who had engaged in item-specific processing.

Hunt and Einstein (1981) essentially found that combining item-specific and relational processing improved recall (see too Einstein & Hunt, 1980), though they did not interpret their findings as evidencing EV benefits, and their work has not been cited in this connection. Participants studied categorically related list items. In the relational task, study items were sorted into one of six category-labeled sets. In the item-specific task, study items were rated for pleasantness. In the *single-task groups*, items were studied once in either the item-specific or relational task. In the *repeated-task groups*, items were studied twice using the same item-specific or relational processing task each time. Their key group was the *variable-processing group*, who first studied the items using the item-specific task, and then studied the items again using the relational task (or vice versa). Free recall was highest in the variable-processing group, consistent with the EV hypothesis, and was lower and equal in the single-task and repeated-task groups. The authors argued that the relatively poor recall in the repeated-task groups was due to a *redundancy* in processing. That is, processing tasks completed twice encode less additional information than if different processing tasks were performed in each block.

In contrast, Hunt and Einstein (1981) did not find that the combination of item-specific and relational processing maximized recognition. Instead, the item-specific repeated condition was equal to the variable-processing condition which, in turn, outperformed the relational repeated