Mem Cogn (2011) 39:1162–1173
DOI 10.3758/s13421-011-0097-9

Dissociative effects of orthographic distinctiveness in pure and mixed lists: an item-order account

Mark A. McDaniel · Michael Cahill · Julie M. Bugg · Nathaniel G. Meadow

Published online: 17 May 2011

Abstract We apply the item-order theory of list composition effects in free recall to the orthographic distinctiveness effect. The item-order account assumes that orthographically distinct items advantage item-specific encoding in both mixed and pure lists, but at the expense of exploiting relational information present in the list. Experiment 1 replicated the typical free recall advantage of orthographically distinct items in mixed lists and the elimination of that advantage in pure lists. Supporting the item-order account, recognition performances indicated that orthographically distinct items received greater item-specific encoding than did orthographically common items in mixed and pure lists (Experiments 1 and 2). Furthermore, order memory (input–output correspondence and sequential contiguity effects) was evident in recall of pure unstructured common lists, but not in recall of unstructured distinct lists (Experiment 1). These combined patterns, although not anticipated by prevailing views, are consistent with an item-order account.

Keywords Orthographic distinctiveness · Item-order account · Memory · Mixed vs. pure lists

M. A. McDaniel (✉) · J. M. Bugg · N. G. Meadow
Department of Psychology, Washington University,
Campus Box 1125, St. Louis, MO 63130-4899, USA
e-mail: mmcdanie@artsci.wustl.edu

M. Cahill
Saint Louis University,
St. Louis, MO, USA

A pervasive finding in the memory literature is that uncommon or atypical information is remembered better than common or typical information (for reviews, see Hunt & Worthen, 2006; McDaniel & Bugg, 2008; Schmidt, 1991). This empirical pattern, termed the *distinctiveness* effect, has been paralleled by the emergence of distinctiveness as a central theoretical concept employed to describe a range of memory phenomena (see, e.g., Hunt & Worthen, 2006). Despite the intense empirical and theoretic focus on distinctiveness, delineating the mechanism(s) that underlie distinctiveness effects remains a challenge (see, e.g., Geraci & Rajaram, 2002, 2004). One of the theoretical challenges turns on the consistent finding that the free recall advantage for unusual items is limited to mixed lists of unusual and more typical items. In pure-list designs in which recall for lists of unusual items is compared with recall for lists of typical items, the recall advantage for unusual items, relative to typical items, is often eliminated or reversed (see McDaniel & Bugg, 2008, Table 1).

Recently, McDaniel and Bugg (2008) proposed a unifying framework based on conjoint considerations of encoding of order information and item-specific information to account for why mixed- and pure-list manipulations produce differential recall patterns (see Nairne, Riegler, & Serra, 1991, for original work with the generation effect). That framework successfully accommodated detailed memory patterns for five memory phenomena for which necessary data were available (generation effect, word frequency effect, bizarreness effect, enactment effect, and perceptual interference effect). Because one of these phenomena, the bizarreness effect, has often been considered a distinctiveness effect (Einstein & McDaniel, 1987), we raise the possibility that the item-order framework might more generally serve to increase understanding of distinctiveness effects.

In the present article, we examine a well-documented distinctiveness effect, that of orthographic distinctiveness, from the perspective of the item-order framework (McDaniel & Bugg, 2008; Nairne et al., 1991; see also DeLosh & McDaniel, 1996; Merritt, DeLosh, & McDaniel, 2006; Serra & Nairne, 1993). The orthographic distinctiveness effect displays the divergent pattern (in free recall) for mixed and pure lists described above and, consequently, might be understood under the lens of the item-order framework. When lists are mixtures of words that have unusual letter combinations (e.g., *lynx*) and words that have more typical letter combinations (e.g., *bison*), the words with unusual letter combinations are recalled better than the words with the typical letter combinations (Geraci & Rajaram, 2002; Hunt & Elliott, 1980; Hunt & Mitchell, 1978, 1982; Hunt & Toth, 1990). In contrast, when pure lists of orthographically distinct words are contrasted with pure lists of orthographically common words, recall is equivalent for the two types of words (Hunt & Elliott, 1980; see also Hunt & Mitchell, 1982). We briefly review the extant explanations of this pattern and then propose an explanation based on the item-order framework. Reasoning from the item-order framework, we generate predictions encompassing a complex pattern of recall, recognition, and order memory measures and report two experiments performed to evaluate these predictions.

Theoretical explanations of the orthographic distinctiveness effect

A straightforward explanation for why the orthographic distinctiveness effect is limited to mixed lists is that, in these lists, the orthographically common words provide a backdrop against which the orthographically distinct words appear different or more "surprising" and, accordingly, attract additional encoding not enjoyed by the common words (either relatively automatically (Hunt & Elliott, 1980) or involving attentional resources (Geraci & Rajaram, 2002)). This view converges on the key point that the presence of common items in the mixed list establishes a necessary context that stimulates or leads to the encoding of the (distinctive) information that provides the mnemonic benefit to the orthographically distinct items (Hunt & Mitchell, 1982, pp. 84–85; cf. Schmidt, 1991). In pure lists of orthographically distinct items, there is no local context of common items that serves to highlight the differences or unusualness of the orthographically distinct items. Depending on the particular theoretical perspective, the consequence is that, in pure lists, either no additional encoding of orthographically distinct items is stimulated or the fairly automatic encoding of the orthographically distinct features does not provide a mnemonic advantage, because all of the items in the list share that information (Hunt & Mitchell, 1982).

Alternatively, Geraci and Rajaram (2002) proposed that orthographically distinct items receive additional conceptual processing that is not necessarily dependent on list context. On their view, the conceptual processing is the consequence of a comparative process that evaluates the orthographically distinct items as being inconsistent with some standard, a standard that presumably represents a normative appearance of words. Accordingly, distinct items could enjoy richer item-specific encoding in pure and mixed lists. As it stands now, however, this view does not specify why the free recall advantage for orthographically distinct items is limited to mixed lists.

The item-order account

The item-order framework was originally developed to account for variation in generation effects across mixed and pure lists (Nairne et al., 1991) and was recently expanded as a more general, unifying account of the widespread pattern that free recall effects diverge in mixed- versus pure-list manipulations of stimuli (or encoding conditions; see McDaniel & Bugg, 2008, for a complete description of the framework and supporting evidence). This framework rests on several fundamental assumptions about free recall. First, free recall performance depends jointly on encoding information about the individual items in the list (termed *item-specific* processing) and information about the relations among the list items (termed *relational* processing; Einstein & Hunt, 1980; Hunt & McDaniel, 1993; Mandler, 1969). Second, for lists of unrelated items (such as those used in the orthographic distinctiveness literature), the primary relational information available is the serial order in which the list items are presented (e.g., Toglia & Kimble, 1976; Tzeng, Lee, & Wetzel, 1979), and such information is relied upon to guide free recall (Burns, 1996; Postman, 1972).

The critical assumption potentially bearing on the differential free recall effects of orthographically distinct stimuli in mixed versus pure lists is the following: The encoding of item-specific information and order information is influenced by the nature of the stimuli. For unusual (e.g., orthographically distinct) items, attention is lured toward their interpretation, thereby resulting in rich encoding of item-specific information. This item-specific elaboration, however, can come at the expense of encoding serial order. In contrast, common (e.g., orthographically common) items ordinarily do not attract extensive item-specific encoding; however, serial information for lists of common items is noticed, encoded, and exploited to help guide free recall. Importantly, in mixed lists, the level of serial order encoding ordinarily associated with particular kinds of items will be modulated by the presence of the alternative item type, and consequently, distinct and common items will be on more equal footing with regard to order encoding (see McDaniel & Bugg, 2008, for further details).

These assumptions provide the basis for a novel explanation of the orthographic distinctiveness effect. Consider first the pure list situation. Here, the augmented item-specific encoding of orthographically distinct items will be offset by a reduction in order encoding or the use of that information in recall (see McDaniel, DeLosh, & Merritt, 2000), relative to common items. Because free recall depends on both item-specific and relational information, the reduced order encoding for orthographically distinct items in pure lists will nullify its advantage in free recall and may even reverse it, given that initial access to an item is assumed to depend on relational information (Hunt & McDaniel, 1993; Hunt & Mitchell, 1982). Consider next the mixed-list situation. The levels of serial order information encoded for orthographically distinct and common items are expected to approach one another, with the result being that the use of order information in free recall will be evidenced more so than in the orthographically distinct pure lists. With orthographically distinct and common items now both being guided by some order information, the item-specific advantage for the orthographically distinct items can be manifested in free recall.

Experiment 1

In the present experiment, we reinforce previous reports of a free recall advantage for orthographically distinct items (relative to common items) in mixed lists and an elimination of this orthographic distinctiveness advantage under pure-list conditions. More important, we test several novel predictions regarding the expected differences in encoding of item-specific information across pure lists of orthographically distinct and orthographically common items (by also testing recognition) and the use of order information in recall (by examining input–output correspondences and more fine-grained contingencies in recall among contiguous items).

The first novel prediction is that item-specific elaboration of orthographically distinct items does not depend on their presence (isolation) in mixed lists. Instead, the present position is that orthographically distinct items are favored by increased item-specific processing (relative to common items) in pure lists as well. According to this position, but not some existing explanations (Hunt & Elliott, 1980; Hunt & Mitchell, 1982), a memory advantage for pure lists of orthographically distinct items should be evidenced on a recognition test, a test that relies on item-specific information (Einstein & Hunt, 1980).

Another set of predictions concerns the encoding and use of serial order information. One novel expectation derived from the item-order account is that for pure lists of orthographically distinct items, memory for serial order and its use in recall should be significantly reduced, relative to pure lists of orthographically common items. Specifically, for pure lists of orthographically common items, there should be significant correspondence between the presentation (i.e., input) order of the items and the order in which they are recalled (i.e., output). By contrast, the input–output correspondence for distinct items should be minimal and significantly reduced, relative to that observed for the common items. For mixed lists, use of order information should be somewhat intermediate between pure lists (higher than pure distinct lists, but not quite as high as pure common lists). Note that existing views of orthographic distinctiveness provide no leverage for anticipating possible differential patterns across orthographically distinct and common items in terms of order memory and its use in free recall.

In addition to gauging input–output correspondence with the relative Asch and Ebenholtz (1962) measure used in previous work examining variation in recall effects across pure and mixed lists (e.g., DeLosh & McDaniel, 1996, with word frequency effects), we applied a more fine-grained measure of sequential contingencies in recall (see Howard & Kahana, 1999; Kahana, 1996). This measure indicates the probability of recall for items at various lags (relative to the original presentation order) from the previous item recalled in the list. Of particular interest here is the degree to which recall of item x is immediately followed by recall of the next item presented in the list (assuming that next item is recalled), because this value indicates the degree to which the order of contingent items is encoded and used to support free recall.

Finally, we assessed order memory with an order reconstruction test (see, e.g., Merritt et al., 2006; Serra & Nairne, 1993). One possible criticism of some previous studies relating to the item-order theory is that the order memory tests were repeated across lists (see, e.g., DeLosh & McDaniel, 1996; McDaniel, Einstein, DeLosh, May, & Brady, 1995, Experiment 5; Nairne et al., 1991; Serra & Nairne, 1993), thereby allowing for the possibility that participants anticipated and prepared for the order memory tests (after the first list). Accordingly, in the following experiment, participants were given an unexpected order reconstruction test on a fourth list of items that followed three lists tested for free recall; the drawback is that we were restricted to low numbers of observations for this assessment of order memory.

Method

Participants and design One hundred eight Washington University students were randomly assigned to three conditions: an *orthographically distinct* pure-list condition (n = 36), an *orthographically common* pure-list condition (n = 36), and a *mixed*-list condition for which half of the words were distinct and half common (n = 36). These conditions can be construed as a 2 × 2 factorial design, with orthographic distinctiveness as one independent variable and design type (between subjects–pure lists vs. within subjects–mixed lists) as the other independent variable. The experiment lasted approximately 20 min; participants were compensated with $5 or course credit.

Materials In a pilot study, participants rated the "visual weirdness" of 321 words on a scale from 1 to 5. On the basis of these ratings, 32 *orthographically distinct* words (M = 3.31) and 32 *orthographically common* words (M = 1.98) were selected (see the Appendix); the rated difference between the two sets of words was significant, $F(1, 62)$ = 244.40, MSE = .116, $p < .001$. Also, we attempted to match as closely as possible the frequency of the orthographically distinct and orthographically common words (M = 2,073, SD = 2,267 for common words and M = 1,167, SD = 1,723 for distinct words, on the basis of Hyperspace Analogue to Language (HAL) norms; Lund & Burgess, 1996).[1] Sixteen lists (four pure orthographically common lists, four pure orthographically distinct lists, and eight mixed lists) of eight words each then were constructed from these words (each word was used in one pure list and one mixed list). Participants viewed four lists (all four orthographically common lists, all four orthographically distinct lists, or four of the mixed lists). The mixed lists were grouped into sets of four, and these sets were counterbalanced across participants in the *mixed* condition. For all conditions, list order was counterbalanced such that all lists appeared in every serial position (1–4) an equal number of times. Serial order of words within each list was randomized across participants.

Procedure Participants were instructed to view word lists and remember them for a later recall test. Words were presented in black lowercase font in the center of a white background for 1,500 ms, with a 200-ms interstimulus interval. Each list of eight words was followed by a 30-s delay period, in which participants counted backward by threes using pen and paper, starting from a number presented on the monitor.

For lists 1–3, list presentation and the delay period were followed by a recall phase in which participants were given 1 min to write down words from the immediately preceding list. After the (30-s) delay period following list 4, a surprise order reconstruction task was administered (instead of the recall task). The eight words from list 4 were presented in a single column in the center of the monitor in a random order (one random order was constructed for each counter-balancing condition), and participants were instructed to write down the words in the order they were presented, placing the first word in the top blank and the last word in the bottom blank.

After the order reconstruction task, participants completed a recognition task consisting of the 32 words from the previously presented lists (*old items*) and 32 lures. Lures were matched with old items on orthographic distinctiveness for both the orthographically common items (old items, M = 1.98; lures, M = 2.07; $F(1, 62)$ = 1.21, MSE = .116, p = .23) and the orthographically distinct items (old items, M = 3.31; lures, M = 3.25; $F < 1$, p = .71). During the task, the 5 and 6 keys on the number pad were labeled with "Y" and "N," respectively, and participants were instructed to press the "Y" key if they saw a word previously presented in the experiment and the "N" key if they saw a new word. Words were presented one at a time in the center of the screen in random order and remained visible until the participant responded. A 200-ms interstimulus interval separated trials.

Results

Free recall The first row of Table 1 displays the average proportion of orthographically distinct and common words recalled for pure and mixed lists. Clearly, the orthographic distinctiveness effect emerged with mixed lists; by contrast, in pure lists, there was a slight advantage for orthographically common words. To directly test the interaction of word type (orthographically distinct or common) and list design (pure vs. mixed lists), we conducted a 2 × 2 analysis

[1] The difference is not significant, $F(1, 61) = 3.17$, $p < .10$ (frequency information for the word *epoxy* was not available). Moreover, this slight difference in HAL word frequency across distinct and common items parallels that found for the set of orthographically distinct and common words used in Geraci and Rajaram (2002), from which some of the present words were sampled. For this set of words, the HAL means were 2,124 and 1,242 for common and distinct items, respectively, $F(1, 53) = 2.90$, $p < .10$. These words were also used in previous work on the mnemonic effects of orthographic distinctiveness (e.g., Hunt & Toth, 1990; Rajaram, 1998). Thus, the present materials are representative of the word frequency properties of materials from previous studies of the orthographic distinctiveness effect.

Table 1 Free recall, input–output (I–O) correspondence, order reconstruction, and recognition as a function of orthographic distinctiveness and list type in Experiment 1

	Pure Lists				Mixed Lists			
	OC		OD		OC		OD	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Free recall	.59	(.13)	.56	(.17)	.51	(.18)	.66	(.14)
I–O correspondence	.64	(.18)	.55	(.17)	.61	*(.17)*	.61	*(.17)*
Reconstruction	.51	(.28)	.45	(.25)	.52	(.35)	.51	(.31)
Recognition								
Hits	.86	(.08)	.89	(.08)	.85	(.11)	.94	(.07)
False alarms	.05	(.05)	.02	(.03)	.05	(.07)	.02	(.04)
Corrected recognition	.81	(.10)	.86	(.09)	.80	(.14)	.92	(.07)
d′	2.90	(.63)	3.28	(.61)	2.94	(.79)	3.67	(.53)

Note. OC, orthographically common words; OD, orthographically distinct words. The I–O correspondence values for OC and OD items in mixed lists pertain to mixed lists as a whole

of variance (ANOVA) using Erlebacher's (1977) procedure. There was a significant main effect of word type, $F(1, 94) = 6.15$, $MSE = .02$, $p < .05$; however, this effect was significantly altered as a function of list design ($F(1, 94) = 13.71$, $MSE = .02$, $p < .001$, for the interaction). Planned comparisons confirmed a significant orthographic distinctiveness effect in mixed lists, $F(1, 62) = 9.05$, $MSE = .02$, $p < .01$, but not in pure lists, $F < 1$.

Input–output correspondence To examine the extent to which order memory might have been related to free recall (for the first three lists), we first computed Asch and Ebenholtz's (1962) index of the correspondence between the input order of the items and the order in which they were output in recall. This index computes the proportion of adjacently recalled pairs that maintain the correct relative order; a value of .50 indicates chance performance, and a value of 1.00 indicates perfect preservation of relative order. We analyzed these scores (see Table 1, second row) with a between-subjects ANOVA (pure distinct, pure common, mixed), followed by direct contrasts between the different conditions. (Note that Asch–Ebenholtz values pertain to the list as a whole, so that separate values for distinct and common items cannot be computed for mixed lists.) The ANOVA revealed that input–output scores tended to be lowest for the pure orthographically distinct lists and highest for the pure common lists, $F(2, 105) = 2.88$, $MSE = .03$, $p = .06$. Contrasts confirmed that the recall of pure common lists retained the original input order better than did recall of the pure orthographically distinct lists, $F(1, 105) = 5.56$, $MSE = .03$, $p < .05$. Furthermore, input–output correspondences for mixed lists and pure common lists, but not pure distinct lists, were significantly higher than chance ($ts(35) = 4.90$, 4.73, and 1.84, respectively).

To obtain a more refined picture of the degree to which the retrieval dynamics reflected the original input order, following Howard and Kahana (1999), we computed the probability of recalling item *y* after item *x* (conditional on recall of item *y*) as a function of the lag (y–x) for all recalled items.[2] These data are summarized in conditional response probability curves in Fig. 1. An inspection of Fig. 1 reveals that for pure common lists, the probability of successive recall from adjacently presented items is substantially higher than is the probability of successive recall for remote items or adjacent backward positions, whereas for pure distinct lists, the probabilities of recall for adjacent items is substantially diminished (relative to pure common lists) and at levels that do not differ greatly from that of more remote items. A between-subjects ANOVA (pure distinct, pure common, mixed) of the probabilities of successive recall for adjacent forward positions indicated that the probability of adjacent recall was highest for the pure common lists and lowest for pure distinct lists, $F(1, 105) = 4.23$, $MSE = .04$, $p < .05$. Planned comparisons confirmed that the likelihood of immediately recalling an adjacent item after the currently recalled item was higher in pure common lists than in pure distinct lists, $F(1, 105) = 7.41$, $MSE = .04$, $p < .01$, and also higher in mixed lists than in pure distinct lists, $F(1, 105) = 5.38$, $MSE = .04$, $p < .05$.

Order reconstruction We next examined the influence of word type and list design on performance in the order reconstruction task. We computed the mean proportion of items that were correctly placed in order (on the

[2] Conditional response probabilities (CRPs) were computed using the MATLAB Behavioral Toolbox, available on Mike Kahana's Computational Memory Lab Website (http://memory.psych.upenn.edu/Software). In computing a participant's CRP for lag *x*, the denominator is the sum, across the three lists, of the number of lag *x* transitions that could have occurred, given the items that were recalled. The numerator is the number of lag *x* transitions that actually did occur, summed across the three lists.

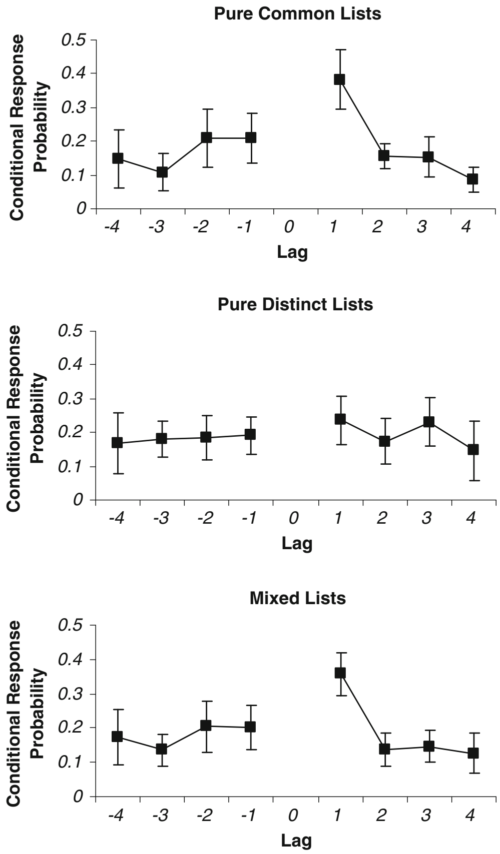

Fig. 1 Conditional response probability (CRP) curves for Experiment 1 recall. The CRP curve for the pure orthographically common list condition is displayed in the top panel, the CRP curve for the pure orthographically distinct list condition is shown in the center panel, and the CRP curve for the mixed-list condition is in the bottom panel. Lag is the difference in input position between consecutively recalled items. Error bars represent 95% within-subjects confidence intervals calculated according to the procedure of Loftus and Masson (1994)

final word list; see third row of Table 1 for means).[3] The nominal patterns were generally as predicted, with order reconstruction scores higher for common words than for orthographically distinct words, and perhaps more so in pure lists. But the 2 (word type) × 2 (design type) ANOVA using Erlebacher's (1977) technique revealed no significant effects, largest F = 1.04.

Recognition The proportion of hits and proportion of false alarms were tabulated, and the means are displayed in Table 1. (For mixed lists, the false alarms for common and for distinct lures were computed separately.) In addition, to provide several summary indices of recognition performance, both corrected recognition scores (hits-false alarms) and d' were computed, and we conducted 2 × 2 ANOVAs for the recognition and d' scores, using the Erlebacher (1977) technique. When the hits and false alarms were considered together in the corrected recognition score, the pattern showed a clear recognition advantage for orthographically distinct items, relative to common items, $F(1, 89) = 28.36$, $MSE = .01$, $p < .001$, with this effect tending to be less pronounced in pure lists ($F(1, 89) = 3.62$, $MSE = .01$, $p < .07$, for the interaction). An ANOVA that included only the pure-list groups confirmed that recognition was significantly better for pure lists of orthographically distinct words than for pure lists of common words, $F(1, 70) = 6.11$, $MSE = .009$, $p < .05$.

The results for d' mirrored those for the corrected recognition score. An advantage for orthographically distinct items, relative to common items, again emerged, $F(1, 96) = 30.08$, $MSE = .36$, $p < .001$, and this effect tended to be less robust for pure than for mixed lists ($F(1, 96) = 3.00$, $MSE = .36$, $p < .09$, for the interaction). An ANOVA including only the pure-list groups confirmed that d' was significantly greater for pure lists of distinct words than for pure lists of common words, $F(1, 70) = 6.65$, $MSE = .39$, $p < .05$.

Discussion

Using Erlebacher's (1977) ANOVA procedure, we directly demonstrated the interaction of orthographic distinctiveness with list composition. The pattern was consistent with previous findings reporting comparisons conducted separately for pure and mixed lists. Orthographically distinct words were recalled significantly better than orthographically common words in mixed lists. In pure lists, this orthographic distinctiveness effect was eliminated, with orthographically common words now showing a nominal recall advantage. The item-order account developed in the introduction accommodates this pattern on the basis of the account's assumptions regarding the degree to which orthographically distinct and common items are afforded item-specific and serial order processing. For mixed lists, the account assumes that recall is more pronounced for distinct items than for common items because the former item type receives more item-specific processing at encoding, and the presence of distinct items detracts from the processing of order information that usually favors common items and is relied upon to guide retrieval in short lists. For pure lists, the account assumes that the recall advantage is negated or reversed because, although the distinct items still attract greater item-specific processing, the encoding of order information is disrupted in pure lists of distinct but

[3] For mixed lists, the reconstruction scores are not necessarily independent, because if a participant incorrectly places one type of item (e.g., a distinct item) in an order position that should be occupied by another type of item (e.g., a common item), that item will necessarily also be incorrectly ordered (we thank Dan Burns for noting this issue).

not pure lists of common items and, thus, is not available to guide retrieval.

In line with the expectations above, item-specific processing, as indexed by recognition performance, was greater for the orthographically distinct, relative to the common, items regardless of list composition. This is the first report of a pure-list recognition advantage for orthographically distinct versus common items. Previous work had not examined recognition in pure orthographically distinct and common lists, possibly because extant theories would not have anticipated pure-list recognition differences. One concern with the present result is that recognition was tested after recall (three lists) and order reconstruction (one list) tests, which may have contaminated recognition performance. Note that because a nominal pure-list recall advantage was found for common items, common items would have received slightly more exposure than orthographically distinct items prior to the recognition test. Accordingly, the present recall patterns, if anything, biased against the emergence of the recognition advantage (in pure lists) for orthographically distinct items. Indeed, the advantage for orthographically distinct items was attenuated (albeit nonsignificantly) in pure lists, relative to mixed lists, a pattern that would not rule out the theoretical idea that mixed lists stimulate additional item-specific processing of the orthographically distinct words. To provide a more conclusive assessment of recognition, we conducted a second experiment (reported below) that avoided possible contamination of recognition performance by administering only the recognition test. We defer additional discussion of the recognition results until Experiment 2.

Additionally, the input–output correspondence scores indicated greater than chance reliance on order information for the pure lists of common items and the mixed lists, but not the pure lists of distinct items. More precisely, as revealed by the sequential contingency analyses, recall in pure lists of common items was characterized by retrieval of contiguously presented items (in a forward direction) much more so than recall of pure distinct lists. Similarly, serial order processing, as indexed by performance on the order reconstruction task, was nominally greater for the common items, and more so in pure lists. These findings converge in supporting the fruitfulness of the item-order account as an explanation of the divergent patterns of orthographic distinctiveness effects in recall across mixed and pure lists.

Experiment 2

A fundamental claim of the item-order account, but not some existing theoretical positions (e.g., Hunt & Elliott, 1980; Hunt & Mitchell, 1982), is that orthographically distinct items stimulate increased item-specific processing (relative to common items) in pure lists (in addition to mixed lists). Yet the evidence bearing on this key theoretical issue is sparse. As was noted at the outset of this article, the recall results in pure lists are ambiguous because recall involves contributions from both item-specific and relational information (Hunt & McDaniel, 1993). Recognition performance more directly legislates between these two positions because a recognition test is assumed to rely extensively on item-specific information (Einstein & Hunt, 1980).

However, to date, no studies except for the present Experiment 1 have examined recognition of pure lists of orthographically distinct and common items. Accordingly, we thought it prudent to attempt to replicate and extend the Experiment 1 recognition findings. We used the same design as in Experiment 1, but unlike in Experiment 1, participants received only a recognition test on the studied items (i.e., free recall and order reconstruction did not precede recognition). On the basis of the item-order view, we expected to replicate the recognition advantage for pure lists of orthographically distinct items, with the magnitude of the advantage approaching (not significantly different from) that observed in mixed lists.

Method

Participants One hundred eight Washington University students were randomly assigned to the pure-list and mixed-list conditions described in Experiment 1 (n = 36 in each condition). Participation lasted approximately 15 min; participants were compensated with $5 or course credit.

Procedure The procedure was identical to that in Experiment 1, except that participants did not complete the recall or order reconstruction tasks after each list presentation. Participants were instructed to try to remember words during list presentation, and they were told that, after each delay period, they should prepare to view the next list. After the delay period following list 4, the same recognition test as that used in Experiment 1 was administered.

Results and discussion

The mean proportions of hits, proportions of false alarms, recognition scores, and d' values as a function of list type are shown in Table 2. Separate 2 (word type) × 2 (list type) ANOVAs were computed for corrected recognition and for d', using Erlebacher's (1977) technique. Turning first to the recognition score, distinct items were recognized better than

Table 2 Proportions of hits and false alarms, corrected recognition scores, and d' scores as a function of orthographic distinctiveness and list type in Experiment 2

	Pure Lists				Mixed Lists			
	OC		OD		OC		OD	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Hits	.83	(.13)	.90	(.07)	.77	(.17)	.89	(.11)
False alarms	.14	(.12)	.09	(.08)	.15	(.13)	.11	(.13)
Corrected recognition	.69	(.18)	.81	(.10)	.62	(.19)	.79	(.20)
d'	2.33	(0.77)	2.90	(0.65)	2.10	(0.84)	2.87	(1.01)

Note. OC, orthographically common words; OD, orthographically distinct words

common items, $F(1, 89) = 34.16$, $MSE = .02$, $p < .001$, and this effect was comparable across pure and mixed lists ($F < 1$ for the interaction). Furthermore, the orthographic distinctiveness advantage in recognition was robust in pure lists, as indicated by a between-subjects ANOVA for the pure-list conditions, $F(1, 70) = 13.49$, $MSE = .02$, $p < .001$. With d' as the recognition index, the results were identical. Distinct items had a recognition advantage, relative to common items, $F(1, 90) = 30.31$, $MSE = .53$, $p < .001$, and this advantage was similar in mixed and common lists ($F < 1$ for the interaction). A between-subjects ANOVA confirmed that d' was significantly greater in pure lists of distinct words than in pure lists of common words, $F(1, 70) = 11.35$, $MSE = .51$, $p < .01$.

To gain further leverage on testing the idea that the magnitude of the orthographic distinctiveness effect was statistically equivalent for pure and mixed lists, we performed a Bayesian analysis for the likelihood that the item type interacted with list type. The null hypothesis (interaction absent) and alternative hypothesis (interaction present) were set up as competing models, and using the method developed by Wagenmakers (2007; see also Masson, 2011), Bayes information criterion (BIC) values were used to estimate a Bayes factor and generate the posterior probability for each hypothesis. With corrected recognition as the index, this analysis indicated that the probability of the null (interaction absent) model, given the data, $p_{BIC}(H_0|D)$, is .83 (i.e., the null hypothesis has an 83% chance of being true). Using d' in the analyses yielded similar results, $p_{BIC}(H_0|D)= .82$. The results for both analyses fall within the range of positive support for the null (interaction absent) hypothesis, on the basis of the guidelines proposed by Raftery (1995).

Thus, the results converge with those in Experiment 1 in showing that orthographically distinct items are recognized better than orthographically common items in pure lists, as well as mixed lists. This finding supports the item-order account's assumption that in pure lists, orthographically distinct items stimulate relatively more item-specific elaboration than do common items. Importantly, the present results also indicated that the recognition advantage for orthographically distinct items in pure lists was virtually equivalent to that found in mixed lists. The implication, departing from existing views (Hunt & Elliot, 1980; Schmidt, 1991), is that the additional item processing stimulated by orthographically distinct items does not require that the study context include common items against which distinct items can be compared. In agreement with existing views, we suppose that the additional individual item processing may include incorporation of visual perceptual features (see Hunt & Elliot, 1980) and/or conceptual features (Geraci & Rajaram, 2002). Our findings of additional individual item processing for distinct items in pure lists suggest, however, that such processing may be a consequence of distinct items' uniqueness, relative to everyday experience with normal orthography (Hunt & Mitchell, 1982) or a standard established by normative experience (Geraci & Rajaram, 2002), rather than a contrast to the study context.

General discussion

Recall (and recognition) differences between orthographically distinct and common items have been limited in the literature to mixed-list designs, which have constrained the theoretical frameworks developed to account for the advantage of distinct items, relative to common items, in free recall (and in recognition). We replicated these classic mixed-list advantages of orthographic distinctiveness (Experiment 1). More important, we reported two experiments that consistently showed that mnemonic differences between pure lists of distinct and common items exist and that these differences will manifest in opposing directions depending on the memory measures used. Of theoretical import, these somewhat complex patterns can be accommodated, and indeed were generally anticipated, by a new item-order explanation of orthographic distinctiveness effects proposed at the outset. In the following, we summarize the novel patterns reported and discuss their theoretical implications.

A first novel finding was that pure lists of orthographically distinct items were recognized significantly better than pure lists of common items (Experiments 1 and 2). This finding counters the view that an immediate list context (at encoding or at test; see Hunt & Elliott, 1980, p. 58) containing common words must be present to induce distinct processing of orthographically distinct items (Hunt & Elliott, 1980). Instead, orthographically distinct items even in pure lists appear to stimulate richer item-specific processing than do common items. Specifically, the unusual appearance of the orthographically distinct items, relative to the learner's general experience with English orthography, is sufficient to encourage richer item-specific encoding. These recognition findings thus support a central assumption of the item-order framework of orthographic distinctiveness effects proposed at the outset.

Our results do not allow specification of the precise nature of the richer item-specific processing; it may involve increased perceptual processing (Hunt & Elliott, 1980; Hunt & Mitchell, 1982), additional conceptual processing resulting from comparative processes that evaluate the distinct item against some standard (Geraci & Rajaram, 2002, 2006), or both. Regardless, on these views and in the present framework, the richer item-specific encoding enjoyed by orthographically distinct items supports their advantage in recall in mixed lists. A key puzzle, however, introduced by the present finding of richer item-specific processing for pure distinct lists (i.e., recognition) is the typically reported finding that distinct items are not recalled better than common items in pure lists (Geraci & Rajaram, 2002; Hunt & Elliott, 1980; Hunt & Mitchell, 1982). Indeed, in the present Experiment 1, for pure lists, common items were recalled nominally better than distinct items. This recall finding is also troublesome for Geraci and Rajaram's (2002, 2006) account, which assumes that orthographically distinct items can stimulate richer conceptual processing even when presented in pure lists.

A second novel constellation of findings from Experiment 1 provides leverage on understanding the pure-list recall pattern. Input–output correspondence was significantly higher for common lists than for distinct lists, and for distinct lists the correspondence approached chance levels. Moreover, the conditional probabilities of recalling immediately adjacent items (in the forward direction) were substantial for common lists and significantly greater than for distinct lists. These results indicate that the advantage in item-specific processing for orthographically distinct items is accompanied by an expense in pure lists to processing serial order during encoding, to use of order-related information at retrieval, or both. Because order information can help structure or guide search in recall (e.g., Burns, 1996; Postman, 1972; see also Sederberg, Howard, & Kahana, 2008, for recall guided by order based on temporal context), reduced reliance on order information for recall of pure lists of orthographically distinct items would penalize recall, thereby offsetting the advantage of the richer item-specific encoding for the distinct items (as revealed in recognition performances). We suggest that these two dynamics, in concert, result in levels of recall that are relatively similar to those for pure lists of common items (which enjoy the benefits of order information but reduced item-specific processing; see Nairne et al., 1991, for a similar analysis of an absence of generation effects in pure lists).

More generally, the present findings may help resolve the theoretical conundrum of explaining why secondary distinctiveness effects in recall are limited to mixed lists (secondary distinctiveness refers to items that are distinct with regard to one's general knowledge, such as orthographically distinct words or sentences describing bizarre relations among words; McDaniel & Geraci, 2006; Schmidt, 1991). One prominent idea has been that unusual items attract enhanced encoding only when those items are processed in the context of an active conceptual framework for which the unusual items are incongruent, a context present for mixed but not pure lists (see Schmidt's, 1991, incongruity view). In a sense, this view is that items that are unusual with regard to general knowledge gain functional distinctiveness only by being presented in the context of common items (e.g., McDaniel & Einstein, 1986). To the extent that the present recognition results with orthographically distinct items reflect secondary distinctiveness effects more generally, they disfavor the position that enhanced encoding for items that are unusual, relative to general knowledge, requires a context of common items (mixed lists). As was noted above, the enhanced encoding in pure lists for secondarily distinct items has not been evident in free recall, because it appears that these items also disrupt order information, information that contributes to recall. The present interpretation also provides a more clear-cut differentiation between secondary distinctiveness and primary distinctiveness (items that are unusual with respect to their immediate encoding context; e.g., the isolation effect): Primary distinctiveness requires a local context in which the distinct item stands out, but secondary distinctiveness does not (because the item is distinct relative to general knowledge).

More recent approaches have attempted to explain the emergence of distinctiveness effects in mixed but not pure lists by appealing to retrieval processes (Hunt & Lamb, 2001; McDaniel, Dornburg, & Guynn, 2005; Waddill & McDaniel, 1998). The idea is that in retrieval (recall) of mixed lists, the unusual items have features (e.g., orthographically distinct features) that serve to discriminate them from the other (common) items in the list, thereby allowing them to be recalled better. By contrast, in pure lists of unusual items, these features are shared by the entire list of items, and accordingly, they lose their discriminative function. Models that formalize this idea assume that the encoding processes are similar for the distinct items and the common items (e.g., the SIMPLE model; Brown, Neath, & Chater, 2007). In SIMPLE, the distinct items would gain an advantage in recall of mixed lists because the unusual features associated (encoded) with the distinct items diagnostically identify these items, relative to other target items (the common items); in pure lists, these unusual features would no longer be diagnostic, relative to the other items in the list.

The present findings do not rule out these retrieval dynamics, but it is unclear whether retrieval-based models (e.g., SIMPLE) could a priori accommodate the Experiment 1 patterns showing significantly more involvement of order-related information in recall of pure common lists, as compared with pure orthographically distinct lists. The models could assume that temporal context or order features are relied upon more prominently in the absence of other distinct features (e.g., Knoedler, Hellwig, & Neath, 1999; note again that in these models, in the pure distinct lists, the unusual item features lose their diagnosticity). If so, however, these order dynamics should be equally evidenced in common and distinct pure lists (to accommodate the absence of differences in recall levels), yet the order reconstruction and the sequential contingency analyses showed that this clearly was not the case. Thus, it appears that these retrieval-based models would need to incorporate some assumptions about differential encoding processes for distinct items or add retrieval heuristics that differ as a function of item type (distinct vs. common items).

As well, several interesting theoretical issues remain unspecified in the item-order framework that we have presented. First, the precise dynamics of the trade-offs between item-specific processing and order processing are uncertain. One idea is that limited resources for encoding present a resource allocation challenge (cf. Navon & Gopher, 1979), such that attention to one kind of information (e.g., item-specific) necessarily detracts from attending to the other kind of information (e.g., order; see Burns, 1996; DeLosh & McDaniel, 1996: Serra & Nairne, 1993). Accordingly, if attention is required for full interpretation of the stimulus (e.g., for orthographically unusual items, for items that need to be generated, for low-frequency items), then resources are unavailable to encode order information.

Another idea is that the characteristics of the materials stimulate participants (learners) to spontaneously focus on certain features of the event more so than on other features. The notion is that for distinct items, item-specific information can be readily encoded and, accordingly, participants exploit that opportunity to the relative exclusion of elaborating other available information. For common items, on the other hand, item-specific features are not as prominent, and therefore participants may rely on more characteristic encoding routines (e.g., associative processes that relate contingent items (Sederberg et al., 2008); organization of events in terms of temporal order, as is common for everyday events). On this idea, with appropriate guidance (e.g., through orienting activities), participants could display relatively rich encoding of both types of information.

Clearly, the present data do not legislate between these alternatives; however, we cautiously favor the second view, for two reasons. First, there is evidence indicating that with appropriate orienting activities, the encoding focus stimulated by the particular materials (e.g., item specific) is augmented with encoding of other types of information (relational) not ordinarily encoded, which, in turn, results in concomitant increases in free recall (see, e.g., Einstein & Hunt, 1980; McDaniel, Einstein, & Lollis, 1988, for results with item-specific and organizational encoding). Second, Mulligan (2000) has reported that for the perceptual interference effect (increased item encoding in conditions that interfere with word perception), the enhanced item-specific processing per se does not disrupt order information, because the item-specific processing is perceptual in nature, whereas the order information depends on post-perceptual processes. In a similar vein, to the extent that enhanced processing of orthographically distinct items is perceptual in nature (Hunt & Elliott, 1980), it may be that order encoding is not compromised by such item-specific processes.

The foregoing discussion also highlights that our theoretical framework has not yet specified the nature of the order information that is affected across pure distinct and common lists. One possibility is that encoding of absolute order information is disrupted by pure distinct lists (cf. McDaniel & Bugg, 2008, p. 251; see Greene, Thapar, & Westerman, 1998, for such effects with generation; see Mulligan, 2000, for such effects with perceptual interference). In light of the nonsignificant differences between distinct and common lists in the order reconstruction measure, a measure of memory for absolute order of list items, we cautiously conclude that orthographically distinct items did not substantially disrupt the encoding of absolute order information, relative to common items. Along these lines, it is worth noting that we conducted an experiment following the design of Experiment 1 but testing order reconstruction with three separate lists (rather than one). The results were consistent with those reported in Experiment 1, with pure lists of common items showing only slightly and nonsignificantly higher order reconstruction scores ($M = .56$, $N = 28$) than did pure lists of orthographically distinct items (M = .51, N = 28; F < 1).

By contrast, the input–output correspondence data and the sequential contingency analyses (Experiment 1), both of which are indices of the degree to which the relative input order of items is preserved in recall, converge on the conclusion that pure distinct lists negatively impacted relative order information. Such order information may depend on contextual information and associations between items and context (e.g., Howard & Kahana, 2002). One ambiguity, however, is that neither the input–output correspondence nor the recall contingency patterns reveal whether the distinct lists suffered decreased order encoding (perhaps because of attention directed at item-specific features; McDaniel & Bugg, 2008) or discouraged use of order information during recall (i.e., participants may have failed to exploit whatever order information they encoded to recall orthographically distinct lists; see, for instance, McDaniel et al., 1995, with bizarre sentences). Both possibilities appear to have merit.

This said, it is worth noting that the sequential contingency analyses of recall are taken to index contiguity-based associations (Kahana, 1996), associations that in some models are considered to play a fundamental role in recall dynamics (e.g., the temporal context models [TCMs]; Howard & Kahana, 2002; Sederberg et al., 2008). According to these models, the recall process depends prominently on the associations among contiguous items. Therefore, the finding in Experiment 1 that pure distinct lists significantly attenuated the conditional probability of recall of immediately successive items would imply that distinct lists disrupted the encoding of this type of order information. As an additional observation, this finding also suggests that the TCM models would need to be extended to account for these orthographic distinctiveness effects on contingency patterns (if not distinctiveness effects more generally), since their basic associative encoding mechanisms (item to context and context to item) are silent with regard to modulations caused by item distinctiveness.

In sum, the present study has established the item-specific benefits of orthographic distinctiveness even in pure lists along with the concomitant deficits stimulated by orthographic distinctiveness in the encoding of order information or of its use during recall (or both), thereby providing a more complete understanding of the mnemonic consequences of orthographic distinctiveness. The findings generally favor the item-order account of orthographic distinctiveness effects that we developed in the introduction and that is based on a general framework (McDaniel & Bugg, 2008) for explaining pure-list/mixed-list recall dissociations of the type found with orthographic distinctiveness.

Appendix

Words used in Experiments 1 and 2

Orthographically Common	Orthographically Distinct
abstain	afghan
almond	alfalfa
amplification	asphyxiation
arcade	asylum
bison	calypso
cedar	crypt
cookie	czar
cube	epoxy
eraser	fjords
flank	gnat
glacier	gnaw
glue	gypsum
grit	hyena
harp	hymn
kennel	khaki
kidney	knoll
leaky	llama
lens	lymph
loser	lynx
mentor	methyl
parachute	phlegm
pawnshop	physique
postmark	pneumonia
probate	ptomaine
refinement	rhetoric
reminder	rheumatism
ruler	rhyme
setter	sphinx
shank	suede
sleet	svelte
tram	tsar
trinket	typhoon

References

Asch, S. E., & Ebenholtz, S. M. (1962). The process of recall: Evidence for non-associative factors in acquisition and retention. *Journal of Psychology: Interdisciplinary and Applied, 54*, 3–31.

Brown, G. D., Neath, I., & Chater, N. (2007). A temporal ratio model of memory. *Psychological Review, 114*, 539–576.

Burns, D. J. (1996). The item-order distinction and the generation effect: The importance of order information in long-term memory. *The American Journal of Psychology, 109*, 567–580.

DeLosh, E. L., & McDaniel, M. A. (1996). The role of order information in free recall: Application to the word-frequency effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22*, 1136–1146.

Einstein, G. O., & Hunt, R. R. (1980). Levels of processing and organization: Additive effects of individual-item and relational processing. *Journal of Experimental Psychology: Human Learning and Memory, 6*, 588–598.

Einstein, G. O., & McDaniel, M. A. (1987). Distinctiveness and mnemonic benefits of bizarre imagery. In M. A. McDaniel & M. Pressley (Eds.), *Imagery and related mnemonic processes: Theories, individual differences, and applications* (pp. 78–102). New York: Springer.

Erlebacher, A. (1977). Design and analysis of experiments contrasting the within- and between-subjects manipulation of the independent variable. *Psychological Bulletin, 84*, 212–219.

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.

Geraci, L., & Rajaram, S. (2004). The distinctiveness effect in the absence of conscious recollection: Evidence from conceptual priming. *Journal of Memory and Language, 51*, 217–230.

Geraci, L., & Rajaram, S. (2006). The distinctiveness effect in explicit and implicit memory. In R. R. Hunt & J. Worthen (Eds.), *Distinctiveness and memory* (pp. 211–234). New York: Oxford University Press.

Greene, R. L., Thapar, A., & Westerman, D. L. (1998). Effects of generation on memory for order. *Journal of Memory and Language, 38*, 255–264.

Howard, M. W., & Kahana, M. J. (1999). Contextual variability and serial position effects in free recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25*, 923–941.

Howard, M. W., & Kahana, M. J. (2002). A distributed representation of temporal context. *Journal of Mathematical Psychology, 46*, 269–299.

Hunt, R. R., & Elliott, J. M. (1980). The role of nonsemantic information in memory: Orthographic distinctiveness effects on retention. *Journal of Experimental Psychology: General, 109*, 49–74.

Hunt, R. R., & Lamb, C. A. (2001). What causes the isolation effect? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 27*, 1359–1366.

Hunt, R. R., & McDaniel, M. A. (1993). The enigma of organization and distinctiveness. *Journal of Memory and Language, 32*, 421–445.

Hunt, R. R., & Mitchell, D. B. (1978). Specificity in nonsemantic orienting tasks and distinctive memory traces. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 4*, 121–135.

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.

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.

Hunt, R. R., & Worthen, J. (2006). *Distinctiveness and memory*. Oxford University Press: New York.

Kahana, M. J. (1996). Associative retrieval processes in free recall. *Memory & Cognition, 24*, 103–109.

Knoedler, A. J., Hellwig, K. A., & Neath, I. (1999). The shift from recency to primary with increasing delay. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25*, 474–487.

Loftus, G. R., & Masson, M. E. J. (1994). Using confidence intervals in within-subjects designs. *Psychonomic Bulletin & Review, 1*, 476–490.

Lund, K., & Burgess, C. (1996). Producing high-dimensional semantic spaces from lexical co-occurrence. *Behavior Research Methods, Instruments, & Computers, 28*, 203–208.

Mandler, G. (1969). Input variables and output strategies in free recall of categorized lists. *The American Journal of Psychology, 82*, 531–539.

Masson, M. E. J. (2011). A tutorial on a practical Bayesian alternative to null-hypothesis significance testing. *Behavior Research Methods.*

McDaniel, M. A., & Bugg, J. M. (2008). Instability in memory phenomena: A common puzzle and a unifying explanation. *Psychonomic Bulletin & Review, 15*, 237–255.

McDaniel, M. A., DeLosh, E. L., & Merritt, P. S. (2000). Order information and retrieval distinctiveness: Recall of common versus bizarre material. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 1045–1056.

McDaniel, M. A., Dornburg, C. C., & Guynn, M. J. (2005). Disentangling encoding versus retrieval explanations of the bizarreness effect: Implications for distinctiveness. *Memory & Cognition, 33*, 270–279.

McDaniel, M. A., & Einstein, G. O. (1986). Bizarre imagery as an effective mnemonic aid: The importance of distinctiveness. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12*, 54–65.

McDaniel, M. A., Einstein, G. O., DeLosh, E. L., May, C. P., & Brady, P. (1995). The bizarreness effect: It's not surprising, it's complex. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 422–435.

McDaniel, M. A., Einstein, G. O., & Lollis, T. (1988). Qualitative and quantitative considerations in encoding difficulty effects. *Memory & Cognition, 16*, 8–14.

McDaniel, M. A., & Geraci, L. (2006). Encoding and retrieval processes in distinctiveness effects: Toward an integrative framework. In J. Worthen & R. R. Hunt (Eds.), *Distinctiveness and memory* (pp. 65–88). New York: Oxford University Press.

Merritt, P. S., DeLosh, E. L., & McDaniel, M. A. (2006). Effects of word frequency on individual-item and serial order retention: Tests of the order-encoding view. *Memory & Cognition, 34*, 1615–1627.

Mulligan, N. W. (2000). Perceptual interference and memory for order. *Journal of Memory and Language, 43*, 680–697.

Nairne, J. S., Riegler, G. L., & Serra, M. (1991). Dissociative effects of generation on item and order retention. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17*, 702–709.

Navon, D., & Gopher, D. (1979). On the economy of the human processing system. *Psychological Review, 86*, 214–255.

Postman, L. (1972). A pragmatic view of organization theory. In E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp. 3–38). New York: Academic Press.

Raftery, A. E. (1995). Bayesian model selection in social research. In P. V. Marsden (Ed.), *Sociological methodology 1995* (pp. 111–196). Cambridge, MA: Blackwell.

Rajaram, S. (1998). The effects of conceptual salience and perceptual distinctiveness on conscious recollection. *Psychonomic Bulletin & Review, 5*, 71–78.

Schmidt, S. R. (1991). Can we have a distinctive theory of memory? *Memory & Cognition, 19*, 523–542.

Sederberg, P. B., Howard, M. W., & Kahana, M. J. (2008). A context-based theory of recency and continguity in free recall. *Psychological Review, 115*, 893–912.

Serra, M., & Nairne, J. S. (1993). Design controversies and the generation effect: Support for an item-order hypothesis. *Memory & Cognition, 21*, 34–40.

Toglia, M. P., & Kimble, G. A. (1976). Recall and use of serial position information. *Journal of Experimental Psychology: Human Learning and Memory, 2*, 431–445.

Tzeng, O. J. L., Lee, A. T., & Wetzel, C. D. (1979). Temporal coding in verbal informationprocessing. *Journal of Experimental Psychology: Human Learning and Memory, 5*, 52–64.

Waddill, P. J., & McDaniel, M. A. (1998). Distinctiveness effects in recall: Differential processing or privileged retrieval? *Memory & Cognition, 26*, 108–120.

Wagenmakers, E.-J. (2007). A practical solution to the pervasive problems of *p* values. *Psychonomic Bulletin & Review, 14*, 779–804.

Julie Bugg was supported by National Institute on Aging Grant 5T32AG00030 during this project. We are grateful to Dan Burns, Suparna Rajaram, and Gerry Tehan for helpful comments on an earlier version of the manuscript.