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Part set cuing of texts, scenes and matrices

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Abstract

In four experiments we extended the study of part-set cuing to expository texts and pictorial scenes. In Experiment 1 recall of expository text was tested with and without part-set cues in the same order as the original text; cues strongly impaired recall. Experiment 2 repeated Experiment 1 but used cues in random order and found significant but reduced impairment with cuing. Experiments 3 and 4 examined the part-set cuing of objects presented in a scene or matrix and found virtually no effect of cuing. More objects were recalled from the scene than from the matrix, indicating that the scene's organization aided memory, but the cues did not assist recall. These results extend the domains in which part-set cues have either impaired or failed to improve recall. Implications for education and eye-witness accounts are briefly considered.

Part-set Cuing of Texts, Scenes and Matrices

Conventional accounts of memory assume that associations among memorized items will cue recall (e.g. Anderson, 1983; Ebbinghaus, 1885/1913; Raaijimakers & Shiffrin, 1981) and the benefits of cues in aiding memory are well established (e.g. Eich & Metcalfe, 1989; Godden & Baddeley, 1975; Tulving & Pearlstone, 1966; Tulving & Thomson, 1971). At some level, remembering must depend upon cues because for memory to aid us, specific relevant information has to be retrieved and reconstructed from among the myriad possible memories. However, the extent to which cues from within a set of learned material aid recall was brought into question when part-set cuing impairment was observed, initially by Brown (1968) and Slamecka (1968), for recall from both episodic and semantic memory. The effect proved to be robust for the free recall of word lists and was then demonstrated across a range of materials and retention tests (see Cole, Reysen & Kelly, 2013; Muntean & Kimball, 2012; and Nickerson, 1984, for reviews) The purpose of the experiments reported here was to further extend the investigation of part-set cuing to two different types of experimental material: expository text and pictorial scenes.

Part-set cuing involves tests accompanied by a subset of the material from the set that is to be recalled, providing the opportunity for this subset to cue recall of the rest of the material. Since Aristotle (Morris, 1994), people have believed that our memory is, at least in part, guided by associations between items, with these associations depending upon their contiguity in time and their similarity in meaning. Because the cues are a subset of the tested material, they are at least weakly associated with the other items in that set. Through these associations, cues could be expected to facilitate the recall of the other items. A common outcome, however, is that recall in the absence of these cues is often better than recall in their presence. This pattern arises with both newly studied sets (e.g., Slamecka, 1968, 1969) and members of semantic categories such as the states of the United States of America (e.g., Brown, 1968).

Part-set cuing impairment seems inconsistent with very long standing views about the nature of memory, associations and cuing. If members of a set have inter-item

associations and these associations can act as cues for recall, why does providing part of a set fail to facilitate recall of additional items from that set? Slamecka (1968, 1969) concluded from his demonstrations of the failure of part-set facilitation that this traditional view was incorrect and proposed that the words learned in free recall studies are not stored associatively, but are stored independently.

Early reports of part-set cuing impairment stimulated considerable research and theorizing, well reviewed by Cole et al. (2013), Marsh, Dolan, Balota and Roediger (2004), Muntean and Kimball (2012), and Nickerson (1984). Brown's (1968) and Slamecka's (1968) findings have been extensively replicated and extended and the effect has become better described. One approach to understanding the phenomenon is to identify its limits - documenting when part-set cues facilitate rather than impair recall. For example, part-set cues can facilitate the recall of categorized lists, but only where they cue the recall of categories that would otherwise have been forgotten; recall within remembered categories is not aided by the cues (e.g., Hudson & Austin, 1970). Serial recall is another situation in which part-set cues can be beneficial. Serra and Nairne (2000) found that serial reconstruction of word lists was facilitated by presenting part-set cues in their original list positions but impaired when the cues were presented in different positions. Basden, Basden and Stephens (2002) extended this research to serial and free recall: Serial recall was sometimes facilitated by consistent cues but impaired with inconsistent cues; for free recall there was little influence of cuing condition. This research suggests that in serial recall the associations between consecutive items are important, and when alternating items (i.e. odd or even positions) are provided as cues these inter-item associations can facilitate recall (as in Kelley & Bovee, 2007). When Cole et al. (2013) examined part-set cuing of spatial information using Snap Circuit objects, the cues facilitated reconstruction of the circuits.

Part-set cuing impairment (or lack of facilitation) is not limited to memory. Peynircioğlu (1987) demonstrated effects that resembled part-set cuing impairment in a range of non-memory tasks, including: constructing words from a lengthy word, identifying differences between pictures, recognizing blurred pictures, and making sense of nonsense

figures. Similarly, Sloman (1991) reported part-set cuing impairment when generating category instances and when generating reasons.

Although part-set cues might be expected to benefit recall, but often impair recall, it is noteworthy that in some circumstances they appear to have little or no effect on the level of recall performance. Watkins, Schwartz and Lane (1984) found that providing both tournament and casual chess players with the positions of half of the pieces from partly played chess games that they had studied neither facilitated nor inhibited the reconstruction of the remaining pieces (see also Huffman, Matthews and Gagné, 2001). A similar failure to find either impairment or facilitation has sometimes been reported for free recall following the study of word lists (e.g. Experiments 2 and 3 of Basden et al., 2002; Slamecka, 1969) and when the measure of recall is fragment completion, an indirect word association task, or a cued recall task with extra-list associates as cues (Basden, Basden, Church & Beaupre, 1991).

Several attempts have been made to account for the part-set cuing impairment often observed. The cue-overload principle (Watkins & Watkins, 1975) offered an explanation by considering the cues as additional items in the set—the larger set size for cued sets overloads the high level cue (to recall the set) thereby predicting poorer performance (Mueller & Watkins, 1977). The competition-at-retrieval hypothesis (Rundus, 1973) assumed that presenting the cue items strengthens the representation of these items making them more likely to be recalled and interfering with recall of the relatively weaker items outside of the cue set. Rundus hypothesized that associations within word lists are hierarchical rather than involving associations between items. With the additional assumptions that recall of an item strengthens its representation and that cued and recalled items remain a part of the pool accessed for further retrieval, the model predicts poorer performance with part-set cuing. The associative sampling-bias hypothesis (Raaijmakers & Shiffrin, 1981) focused on inter-item associations and based its explanation on the clusters of associated items that are sampled in the recall attempt. It assumed that both part-set cued and control participants sample the same number of clusters but that when some items are used as cues fewer

items remain for report. In cases where people are asked to recall the complete set, including the previously practiced part of the set that might act as cues, Anderson and Neely (1996) and Bauml and Aslan (2006) explain the part-set cuing impairment as functionally equivalent to retrieval-induced forgetting (Anderson, Bjork, & Bjork, 1994). Their explanation is similar to Roediger's (1973, 1974) suggestion that output interference could account for reduced recall of the items from the set that were not studied as cues. Efforts to retrieve members of the set lead first to the recently studied or practiced items. Having retrieved these items, recall of the remaining items suffers.

These attempts to explain part-set cuing predict impairment but in some circumstances facilitation or a lack of effect has been observed. For example, serial recall with consistent cues is sometimes facilitated by part-set cues (Basden et al., 2002, Experiment 1) and free recall of uncategorized lists is sometimes not influenced by part-set cues (Basden et al., 2002; Slamecka, 1969). Similarly, recall of chess positions is also unaffected (Huffman, Matthews, & Gagné, 2001; Watkins et al., 1984).

The strategy disruption hypothesis is an alternative approach predicting both impairment and facilitation. Proponents of this hypothesis (e.g., Basden et al., 2002; Basden & Basden, 1995; Brown & Hall, 1979; Sloman, Bower, & Rohrer, 1991) argue that the presented cues interact with the organization and/or the retrieval strategy of the participants. Although there is evidence against this explanation (e.g., Peynircioğlu, 1989), this hypothesis is quite successful at explaining the variations in impairment and facilitation: When the cues are consistent with the retrieval strategy they facilitate recall; when they disrupt the strategy they impair recall and when they are merely superfluous they have no effect. So, for example, serial recall with consistent cues will support the appropriate retrieval strategy, thereby facilitating recall, but inconsistent cues (i.e. words in the wrong positions) will disrupt the retrieval strategy and lead to impaired serial recall (Basden et al., 2002). Where neither impairment nor facilitation occurs, the hypothesis might explain that the cues neither disrupt nor support the retrieval strategies or that the cues both impair and benefit retrieval in equal measure.

Bäuml and Aslan (2006) argued for a two mechanism account of part-set cuing, with retrieval strategy disruption and retrieval inhibition potentially playing parts, depending upon the specific experimental situation. Bäuml and Samenieh (2012) added context reactivation as a third mechanism, and Cole et al. (2013) interpreted their finding of facilitation when using Snap Circuit stimuli as potentially consistent with either the two or the three mechanism accounts.

Research on part-set cuing of recall has largely concentrated on word lists (with the exceptions described above). If the phenomenon is of general interest it should be examined in other situations, including those that may be closer to situations in which recall regularly occurs in everyday life. Bovee, Fitz, Yehl, Parrott and Kelley (2009) extended the conditions under which part-set cuing was examined by studying cuing of shopping lists and campus building with real-world visits, demonstrating inhibition with free recall and facilitation with reconstruction.

We examined part-set cuing in two situations that extend the domains in which the phenomena has been explored: recall from expository text and from pictures of scenes. For theoretical reasons it is useful to know whether, and in what form, part-set cues influence recall in a wider set of situations than those studied so far. How far do part-set cuing effects extend? This question has practical as well as theoretical implications. Expository text is often studied and tested in educational settings and eyewitnesses may be asked to recall the contents of a scene as in the Bovee et al. (2009) studies. It would, therefore, be useful to know whether providing part of a to-be-remembered text or scene will influence recall.

Positive effects of cuing might be expected both for expository text and pictorial scenes, as Serra and Nairne (2000) and Basden, Basden and Stephens (2002) have found for serial list recall. Expository text and pictures of scenes both provide coherent, integrated stimuli within which there are inter-associations among the elements of the material. Furthermore, reading a text leads to the creation of a schema (Bartlett, 1932) or situation model (e.g. Kintsch, 1998) that will guide retrieval. Although categorized word lists may be organized in the vertical fashion discussed by Rundus (1973) and Nickerson (1984) it is

unlikely that either expository texts or pictures of scenes are so simply organized. These types of material would seem to involve interrelations between items if the text or the picture is to be understood and remembered.

Experiment 1

Experiment 1 examined the influence of part-set cues on recall from two expository text passages. A practical reason for our interest in the influence of part-set cues upon expository text passages is that expository texts are often studied for later recall in formal settings (e.g., at school and college) and informally (e.g., in conversations about news reports from newspapers or magazines). From an educational perspective, it would be useful to understand the effect of setting exams that provide a substantial amount of the studied information as an adjunct to questions.

Expository texts are of theoretical interest as well because their complex processing goes considerably beyond the circumstances for which many of the theoretical accounts of part-set cuing impairment and facilitation have been developed. Given the differing patterns of part-set cuing impairment and facilitation that have been observed with various materials, it is reasonable to predict any of three outcomes for part-set cuing with expository texts. People are not, typically, well-practiced at studying word lists in their routine activities, whereas they are well-practiced at reading for information and at reading to learn. When participants are asked to study lists of words, the task is a challenging and unusual one and they presumably engage in specific, conscious strategies to improve their memory for the list. Reading expository text, on the other hand, is an everyday task, so participants are likely to rely more on their well-developed, somewhat automatic skills and less on specific mnemonic strategies.

When reading texts participants are likely to develop higher-level, more integrated representations of the contents, as in Kintsch's (e.g., 1998) situation model. The model constructed by the reader would be influenced by the form and content of the text and by prior, relevant knowledge. Because participants had little prior knowledge on the topics we selected, it is reasonable to assume that their situation models would strongly reflect the

content and organization of the text. Some of the information in the model would be hierarchically organized and connected, so that recall might be somewhat like a serial recall task, in that information has a logical 'place' in the stream. Basden et al. (2002) observed that serial recall benefited from consistent cues (i.e., cues presented in the proper order and place), explaining that these cues supported rather than disrupted participants' retrieval strategies. In some ways, expository text might be thought to resemble the Snap Circuits studied by Cole et al. (2013) in that both have a level of interconnection that is missing from many word lists. Cole et al. found part-set facilitation for their materials. Applying the retrieval-strategy-based explanation leads to a prediction that properly ordered part-set cues will facilitate text recall because the part-set cues will be compatible with the original learning and with the structure of the higher-level representation of the text that was formed during study. This approach, coupled with the results from Basden et al. (2002), lead to a further prediction relevant to Experiment 2: If the cues are presented in a random order, as with their serial recall with inconsistent cues, orderly access to the situation model would be disrupted, leading to impaired recall.

Another alternative is that the presentation of properly ordered cues will impair recall, perhaps because of competition at retrieval or output interference. The outcome of part-set cuing of a text passage is, therefore, difficult to predict, and the results provide additional material to further the development of hypothetical accounts.

Two expository text passages were studied and recalled; the design counterbalanced cuing within and between them. The topics were chosen to be interesting to engage the participants but also unfamiliar. We avoided topics that might have been more familiar because of the powerful influence of existing knowledge upon new learning (e.g. Morris, Tweedy, & Gruneberg, 1985). The cues consisted of half of the statements from the passages; in Experiment 1, they were presented in the same order as they appeared in the passages.

Method

Participants. Forty-one participants at a UK university were each paid £4 for taking part in the study. Testing took place during the summer vacation for undergraduate students, so most of the participants were students working on postgraduate (usually Masters) degrees. Two participants failed to complete the recall of both passages, leaving data from 39 people for analysis.

Design. The presence of part-set cues was manipulated within participants; each participant was tested on one text with and on the other text without part-set cues. The order of the test conditions was varied so that the cued test occurred first for half of the participants and second for the other half. The order of the texts was held constant for all participants; thus, having crossed test condition and order, test condition and text were also crossed. The cues provided at test time were a randomly selected half of the statements from the original texts, using wording identical to, or almost identical to, the original text. Each cue set contained one-half of the target items and was ordered on the test page in the order matching the original study text. A complementary set of statements was also prepared so that half of the cued participants were given one set of statements as their cue and the other half were given the complementary set, ensuring that all items were tested in both conditions and were counterbalanced to control for difficulty.

Materials. Short expository text passages were assembled into booklets for the participants to study. Two passages were used: 'The History and Uses of Garlic' and 'Neandertals'. (The text passages and the specific items scored in recall are provided in the Appendix.)

The items identified for scoring purposes occurred in pairs which usually appeared in the same sentence. These pairs were scored as two separate items, but were assembled as a sentence and treated as a unit for the purposes of constructing cuing sets. These sentences were randomly allocated to one of two cuing sets.

The first page of each booklet contained general instructions. The second page contained the text of the Garlic passage along with instructions to read and study it; the instructions specified that recall of the information, but not the exact words would be tested

later. The third page contained the text of the Neandertal passage with instructions identical to those for the Garlic passage. The fourth and fifth pages repeated the Garlic and Neandertal passages, with instructions to read and study the text again. These instructions assured the participants that the text was exactly the same text as previously presented. Again, the instructions specified that recall of the information rather than the wording would be required. The sixth page asked the participants to recall the information from the Garlic passage. There were three versions of this page: one without cues and two with cues, one from each of the two cuing sets. The pages with cues provided a list of the cues for the participants to read over and a large blank area for the participants to write whatever else they could recall from the text. The seventh page asked the participant to recall the information from the Neandertal passage. There were three versions of this page as well: one without cues and two with cues, one from each of the two cuing sets. Each booklet included one test without cues and one test with cues. The final page of the booklet provided debriefing information. The ordering of the pages in the booklets ensured that each study session was followed either by a session studying a different passage, or by recall of a different passage thereby eliminating the need for activities to reduce short term recency effects.

Procedure. Participants were tested in small groups in a quiet classroom setting. The set of booklets was systematically ordered to alternate among the conditions; the first booklet from the set of remaining booklets was allocated to each participant upon arrival.

To begin, the experimenter reviewed the general instructions with the participants before proceeding on a timed basis. Participants were instructed to turn pages in the booklet only when asked to do so by the experimenter. Two minutes were allowed for each of the four study pages; this was more than adequate time to thoroughly read the text. Participants were allowed as long as they needed for each test page; when everyone present had finished recalling the Garlic information, the experimenter asked everyone to proceed to the next page which contained the Neandertal test. Each test page usually took

about 5-6 minutes. After the second test page, participants were asked to read the debriefing page and to ask any questions they might have before leaving.

Results

An alpha level of .05 was adopted for all statistical tests reported in this paper.

Participants' recalls were transcribed into a spreadsheet as statements for scoring. The statements were then grouped so that recall attempts for each item were scored together without awareness of the testing condition, preventing bias. These were scored independently by the two authors; no disagreements arose. A recall score was calculated for each condition for each participant by counting the number of correctly recalled target items. Analysis was based upon the percentage of possible items that were recalled. For cued recall, only the 20 items that were not cued in the participant's recall condition were scored; where recall was not cued, all 40 items were scored. This analysis was appropriate because all items were cued in one or the other of the two cuing conditions and the within-participant design meant that, for each participant, their cued performance was compared with their performance on the other, non-cued, passage. Mean recall with cues was 26.9% (SD = 12.8%) and without cues was 45.1% (SD = 17.6%). A t test indicated that this difference was significant, $t(38) = 7.31$, $p < .001$; Cohen's $d = 1.20$.

Discussion

The results demonstrate very powerful part-set cuing impairment in the recall of expository text. Recall without the cues was 1.7 times that observed when cues were presented. The demonstration of this powerful part-set cuing impairment with expository text extends to a new type of material the conditions under which part-set impairment has been demonstrated, and raises new questions about the phenomenon.

Previous research with memory for chess positions (e.g. Watkins et al., 1984) found that part-set cues neither enhanced nor impaired recall performance, while that for Snap Circuits was facilitated (Cole et al., 2013). Like chess positions and Snap Circuits, expository text is better organized and draws upon more practised and automatic processes than word lists. Unlike those materials, memory for text was substantially impaired by the presence of

part-set cues. What other differences between the materials and circumstances might be responsible for the difference in the effect of the cues? One obvious difference is the verbal nature of the text material in contrast with the more image-based nature of the chess positions and Snap Circuits. This aspect of the materials is pursued in Experiments 3 and 4.

We had speculated that the recall of text with part-set cues might be similar to the recall of serial lists observed by Basden et al. (2002, exp. 1) where cues that were consistent with the original presentation order facilitated recall. Our results do not replicate theirs, but a closer look at both sets of research may explain the different outcomes. The cues for serial recall in Basden et al. were presented in the correct order and constituted alternating items from the list (i.e., either odd- or even-numbered items); between cues were blank spaces, indicating exactly where the missing items should appear. Our cues were presented in the correct order, but were randomly rather than alternately selected and did not indicate where missing information had originally appeared. Another difference is that Basden et al.'s serial recall participants were instructed to recall items in order, whereas our participants were not. Furthermore, Basden et al. found that the advantage for consistent cues only arose when a strict, serial recall scoring metric was used; when a lenient, free recall metric was used there was not a significant difference between consistent cues and no cues. The third experiment from Basden et al., however, offers a better match and perhaps more useful insights: For some lists the cues were not interleaved with blanks, but were listed, in order, separate from the spaces for recall, in a manner similar to our test pages. In addition, some people were given free recall instructions rather than serial recall instructions. Comparing performance on a free recall scoring metric between segregated, consistent cues and no cues, they found that with free recall instructions there was no effect of cuing but with serial recall instructions there was significant loss in performance when cues were provided. Thus our results map neatly onto theirs if we assume that when people attempt to recall text they engage, at least to some degree, in serial recall. This assumption seems reasonable if recall is guided by the situation model and if the situation model, in the absence of much prior knowledge, is constructed in an orderly manner based upon the text. So, our results appear to be

consistent with those of Basden et al.: Part-set cuing with consistent, segregated cues, reduces the proportion of target items recalled when people engage in activities similar to serial recall. Basden et al. argue that segregating the cues impairs recall performance by disrupting the serial retrieval strategy.

It is clear that the part-set cues interfere powerfully with free recall of material from expository text. Our results appear consistent with some conjectural accounts for impairment such as those based on disruption of the retrieval strategy (e.g., Basden et al., 2002), associative sampling-bias (Raaijmakers & Shiffrin, 1981), and competition at retrieval (e.g., Rundus, 1973). Part-set cuing impairment with text is also consistent with Watkins et al.'s (1984) observation that having organized materials does not lead to part-set facilitation. The results from this experiment are discussed further with those of Experiment 2.

Experiment 2

In Experiment 1 the part-set cues were presented in the same order as they occurred in the original text. Experiment 2 is identical to Experiment 1 except that the cues were randomly ordered. It seems reasonable to predict greater disruption when the cues are presented in a random order, inconsistent with the text and therefore with a situation model constructed without substantial prior knowledge. Thus, we might expect to observe greater impairment when the cues were presented in a random order.

In their third experiment, Basden et al. (2002) found that the order of segregated cues (consistent or inconsistent with the original material) did not influence the degree of memory impairment: in both cases people recalled significantly fewer target words than when no cues were provided. They argued that segregating the cues disrupted the retrieval strategy in both cases, so the order of the cues did not influence performance further. Based on their data and reasoning, we would predict impairment from the cues again, as in Experiment 1, either at a similar level or perhaps more substantially if the retrieval strategy is more disrupted.

Some other speculations about the source of part-set cuing impairments are not concerned with cue order. These include the competition-at-retrieval hypothesis (e.g.

Rundus, 1973), the associative sampling-bias hypothesis (Raaijmakers & Shiffrin, 1981), and application of the cue-overload principle (Mueller & Watkins, 1977). For each of these ideas, the order of the cues appears to be unimportant because it is the effect of the individual cues at retrieval that leads to the impairment. Therefore, from all of these hypotheses we predicted that recall would be inhibited by similar amounts whether the cues were in the same order as in the original text, or a random order.

Method

Participants. Forty-eight university students participated; each was paid £3. Three participants were excluded from the analysis: one failed to attempt recall of the second passage and two included recall of more than 40% of the cues despite the instructions to recall only information not provided as cues. For these two people it appeared that they did not look through the cues prior to their recall effort and so were not part-set cued. The final analysis was, therefore, based upon 45 participants.

Materials. The booklets used in the study resembled those used in Experiment 1, except that the cue sentences were presented in a random order rather than the order in which they had appeared in the original passage.

Design and Procedure. With the exception of the ordering of the cues, the design and procedure were the same as in Experiment 1.

Results

Recall was scored as in Experiment 1. Mean recall with cues was 48.6% (*SD* = 19.6%) and without cues was 53.6% (*SD* = 15.8%); this difference was significant, $t(44) = 2.18$, $p = .035$ (two-tailed test); Cohen's $d = 0.28$.

The size of the part-set cuing effect in the two experiments differed substantially. Impairment was substantial in Experiment 1 ($d = 1.20$) but far smaller here ($d = .28$). To test this difference, the effect of cuing was calculated for each participant in both experiments by subtracting their cued performance score from their performance without cues. The mean difference in percent recall for Experiment 1 (same order cues) was 18.2% (*SD* = 15.6) and

for Experiment 2 (random order cues) was 5% (*SD* = 15.3); the difference between the experiments was significant, $t(82) = 3.92$, $p < .001$.

Discussion

Presenting randomly ordered part-set cues from the expository texts led to impaired recall of the remaining target information, but the size of the impairment was substantially and significantly smaller than when the cues were presented in their original order. These results are puzzling; none of the explanations for part-set cuing impairment that we have considered appear to predict that randomly ordered cues would be less harmful than properly ordered ones. The competition-at-retrieval explanation, the associative sampling-bias hypothesis and the application of the cue-overload principle all led to the prediction that the impairment created by part-set cues when they were randomly ordered would not differ from that created when they were in the same order as originally presented. The data do not support these predictions, casting doubt on the applicability of these theories in the present context.

The strategy disruption hypothesis appeared to predict that random ordering of the cues would be as or more disruptive to any recall strategy than the proper ordering of the cues in Experiment 1 had been. However, the actual impairment we observed was considerably less. Post-hoc deliberation led us to a line of reasoning that is consistent with the idea that the impairment results from disruption of a retrieval strategy. Properly ordered part-set cues may encourage participants to use the cues to reconstruct the original text, whereas randomly ordered cues might be read and then mentally set aside as disorganized and therefore less helpful. In this way, the experience of recalling with randomly ordered cues would be less influenced by the cues than when recalling with properly ordered cues. But the pattern of our results does not match that from Basden et al. (2002). In the comparable cells of their third experiment (i.e., segregated cues with recall scored on a free recall metric), properly ordered and randomly ordered cues led to very similar levels of impairment. Their materials, though, were short (8 item) word lists, so the set of material that had been studied as well as the cue set was smaller and less complex. It seems reasonable

that this difference in length and complexity could lead people in the shorter, simpler case (Basden et al.'s 4 word cues) to make greater effort to use the cues, whereas in the longer more complex case (our 10 statement cues) they might disregard the cues as being disorganized and unhelpful.

Another possible explanation for the unexpected difference between the experiments lies in the source that people select to guide their memory. When the cues are in the same order as the text (and the situation model), people are likely to more successfully retrieve the situation model of the text that is formed when it is first studied and to draw upon that model to guide their recall. Applying fuzzy trace theory (e.g., Brainerd & Reyna, 2002), the model provides gist rather than details. Because recall was scored on the presence of details, reliance upon gist might have reduced the amount of detail reported. On the other hand, if jumbled cues reduce the ease of access to the situation model, people might rely more upon memory for the recent episodes studying the text, and this episodic memory might provide more detail because episodic details are not as subordinate to the meaning of the text.

Whatever the explanation for the observed pattern of recall, Experiments 1 and 2 demonstrate that the part-set cuing "enigma" (Nickerson, 1984) becomes curiouser and curiouser. When recalling details from expository text, properly ordered cues strongly impair recall performance and randomly ordered cues impair recall performance, but less so. The large size of the effect when the cues are in the same order as the original text suggests that it could be important to consider part-set cuing in educational settings where selected information is provided with the intention of supporting students' recall. Such cues appear to strongly inhibit rather than aid recall.

In Experiment 1 and 2 we observed inhibitory effects of part-set cuing for expository texts. In the following experiments we explored part-set cuing with pictures.

Experiment 3

This experiment investigated the part-set cuing of pictures of objects presented either in a pictorial scene or as individual objects in a two dimensional matrix. In both cases, recall was cued by presenting half of the objects in their original positions in either the pictorial

scene or the matrix. The effect of part-set cues on such material has not been investigated before. The nearest equivalent has been recall of Snap Circuits (Cole et al. 2013), but they, although having a visual/spatial layout, do not draw upon the semantic knowledge that participants associate with the objects that we pictured in Experiments 3 and 4. It is possible to predict any of three alternatives for recall of pictures presented in scenes.

One possibility is that recall will be facilitated by the part-set cues. The objects in the scenes can be associated as words (graphemically, phonetically), as concepts (semantically) and/or as objects (in terms of spatial relationships or physical similarity or difference). Some associations are likely to occur in either the matrix or the pictorial setting (e.g., table and chair) but others should benefit from the coherent setting (e.g., lamp *sits on* table, or clock *near* suitcase suggests time to leave). Thus, a room setting seemed more likely than a matrix to encourage participants to make and use more associations between items. In a room setting more items have salient spatial relationships with several other items (e.g., chair *is next to* table and purse, *behind* umbrella; *contains* book; *is on the floor with* purse, etc.). In a matrix, the spatial information is less complex in terms of the numbers of objects participating in salient relationships (e.g., chair *is right of* television, *left of* hat, *below* clock, *above* basket). Recall is known to be poorer when images are processed in isolation than when they are processed in combination with other images in the set (e.g., Morris & Stevens, 1974); it seemed likely that sets of associations would be less developed in the matrix layout than in the more interrelated setting of the room. Thus, we predicted a main effect of setting, with the room producing better recall than the matrix when no cues are provided. This predicted advantage for the room setting, when observed, supports the argument that more or better inter-item associations are formed in that setting.

If there are more inter-item associations in the room scene than the matrix, then the part-set cues to recall of the room scene might facilitate recall. There is a similarity here with the research on serial learning reported by Basden et al. (2002) and their finding that part-set cues facilitated serial recall when they were consistent with the original presentation order and presented in their original locations to cue memory for the missing elements.

Similarly, the facilitation from part-set cues observed by Cole et al. (2013) for their spatially arranged Snap Circuits might be expected to occur with pictures of real objects, especially when presented in scenes.

However, cuing of a meaningful scene might resemble the cuing of a meaningful text passage, as in Experiments 1 and 2, so that impairment would be predicted. The influence of part-set cuing with a subset of the objects might be to inhibit recall as has so often been observed in part-set cuing research with word lists.

Finally, it may be that the part-set cues do not have an influence on recall. Recalling items in a room scene is somewhat similar to recall of chess board positions (Watkins et al., 1984), where part-set cues led to neither facilitation nor impairment.

Method

Participants. Sixty-four adults recruited at a UK university participated in the study. They were each paid £2. Participants included students, staff, and visitors to the university.

Design. Two test conditions (with and without cues from the study set) were contrasted and crossed with two presentation conditions (room and matrix). Both factors were varied between groups.

Materials. Booklets were used to present the pictures and to test for recall. Each booklet contained a cover page, a study page, two distractor pages which each contained a maze, a test page and a debriefing page. The cover page was identical in all cases; it provided general instructions regarding the experiment.

For 32 booklets, the study page contained a line drawing of a room filled with 16 items as shown in Figure 1; most of the drawings were taken from Snodgrass and Vanderwart (1980) and the remainder drawn by ourselves. The selection and placing of these objects required some care. It was important that the scene should appear plausible but it was a essential that it should not be possible at the recall test to guess too many of objects. In the other 32 booklets the study page contained the same 16 objects presented in a 4 x 4 matrix, as shown in Figure 2. The next two pages contained mazes which provided a

brief visual activity interposed between the study and test phases to reduce short term recency effects.

For the test page there were 6 different formats: 32 booklets contained tests in the room setting and 32 tested in the matrix setting; the test setting always corresponded to the study setting. For 16 booklets the test page depicted an empty room, that is, three lines suggesting the intersections of walls and floor. For 16 booklets the test page showed a room with one-half of the items in their original locations; eight of these booklets showed a randomly selected one-half of the items and the other eight booklets showed the other eight items (see Figure 3 for an example). Similarly, in the matrix setting there were 16 booklets which provided an empty matrix and there were 16 booklets with half the items (alternate columns in the matrix were filled with items in their original positions); 8 booklets providing each half. All test pages included instructions to recall the items by writing their names anywhere on the page. Spoken and written instructions explicitly stated that there was no need to draw the objects nor to identify their positions.

Items were assigned to the cuing sets by randomly allocating items to positions in the matrix and then selecting alternate columns to form the two sets. The same cue sets were used for the room condition and the matrix condition.

Procedure. Participants were tested individually or in small groups in various venues on campus. The experimenter distributed booklets and explained the sequence of activities to follow. One minute was allowed for study of the items; three minutes were allocated to working on the mazes. Unlimited time was allowed for recall of the items; participants generally required about 3 to 4 minutes.

Results

Recall was scored by counting the items correctly recalled and calculating the percentage of the maximum number that could have been recalled. For cued recall, the percentage was based on the eight items not presented as cues; where recall was not cued, all 16 objects were scored.

The means and standard deviation for the four conditions are reported in the upper part of Table 1. Recall with the room setting was significantly better than r with the matrix $F(1, 60) = 14.78$, $MSE = 226.56$, $p < .001$, $d = 0.9$. There was virtually no effect of cuing, $F(1, 60) = 0.04$, $MSE = 226.56$, $d = 0.04$.

Discussion

Presenting objects in a room setting, with its suggestions of coherence, led to very considerably improved recall performance relative to a baseline established by presenting the same objects in the, matrix setting. The effect size was greater than the 0.8, classified by Cohen (1988) as large and by Morris and Fritz (2013) as large in comparison with published memory effects. As the objects were the same in both conditions, we conclude that the observed difference was the result of our manipulation and that the room setting encouraged associative processing of the objects.

In the matrix condition there was clearly no evidence for part-set cuing facilitation or impairment. The means were identical and well away from the maximum possible recall. However, the high level of performance in the scene condition makes interpretation problematic. On average, over 80% of the objects were recalled. The lack of observed difference for the room setting could be an artifact of ceiling effects. We, therefore, carried out Experiment 4 to increase the difficulty of the task.

Experiment 4

This experiment addressed the possible ceiling effect in Experiment 3 by adding objects to the room scene, making the task more difficult. The results of Experiment 3 were quite clear with respect to the successfulness of the coherent, room setting in facilitating recall relative to the matrix setting and in the lack of part-set cuing in the matrix condition, so Experiment 4 only investigated the room setting condition.

Method

Participants. Sixty adults recruited at a UK university participated in the study. They were each paid £2. Participants included students, staff and visitors to the university who had not taken part in Experiment 3.

Design. The design was a between-groups contrast between two test conditions (cued and not-cued). For the cued condition, half of the participants were cued with one randomly selected set of objects and the other half with the complementary cue set.

Materials. The booklets were similar to those used for the room condition in Experiment 3 except that the room scene contained 24 rather than 16 objects (see Figure 4), and the room scenes presented for the cued tests contained 12 rather than 8 objects.

Procedure. The procedure was identical to that in Experiment 3 for the room pictures.

Results

Recall was scored by counting the number of objects correctly reported and calculating the percentage of possible recall. For cued recall, only the 12 objects that were not cued were scored; where recall was not cued, all 24 objects were scored.

The means and standard deviations are reported in the lower part of Table 1. It is clear that cuing did not influence recall: the very small observed difference did not approach significance, $t(38) = 0.24$, $d = 0.08$.

Discussion

Once again, for the pictorial scene, part-set cues failed to influence recall. In Experiment 3 we established that the room setting led to better recall than when the same items were presented in a matrix, presumably because of greater inter-item associations. Even so, in both Experiments 3 and 4, performance in the cued condition was no better than in the absence of cues. When introducing Experiment 3 we discussed grounds for predicting facilitation, impairment or no influence from part-set cues for the pictorial recall. Unlike part-set cuing for expository text (Experiments 1 and 2), or for Snap Circuit objects (Cole et al., 2013), part-set cuing of objects pictured in either a pictorial scene or a matrix does not appear to influence recall. On the other hand, this lack of effect may be related to the spatial nature of the task. Our findings for the pictorial scenes and the matrices resemble those of Watkins et al. (1984) and Huffman et al. (2001) for the recall of of pieces on chess boards who found no influence of part-set cues.

General Discussion

In Experiment 1 we observed powerful impairment of recall from expository text when part-set cues were provided. Recall without cues was 1.7 times greater than recall with cues. Therefore, part-set cuing can substantially impair recall from expository text. This has practical implications for education: Prompting students with the equivalent of part-set cues is likely to be counterproductive in terms of students' ability to call related information to mind. Students' motivation might also suffer from an incorrect belief that their cued recall is the best they can do.

In Experiment 2, randomly ordered part-set cues impaired recall of the expository text, but to a lesser extent than when the cues were in original text order. Taken with the results of Experiment 1, this finding is problematic for many accounts of part-set cuing which would not predict this difference. We considered two explanations: one based on differential disruption to the retrieval strategy and one based on a difference in what was being recalled. Although the most obvious predictions from a strategy disruption hypothesis would be that the random cues would lead to even more impairment than the consistent cues, the less obvious prediction – based upon participants strategically ignoring the jumbled part-set cues – is consistent with the data. The other explanation consistent with our results proposes that ordered cues reinstate the situation model constructed as the text was read. The situation model is likely to be more concerned with gist or general meaning than with specific details, so recall on that basis would include fewer details. Disordered cues are less likely to cue the situation model, and more likely to lead to reliance on recent episodic memory which would yield more access to details from the text. We suspect that the reduced but nevertheless significant impairment with jumbled part-set cues stems from reduced reliance on the situation model or gist of the text, which is then supplemented from episodic memory. We offer these as possible explanations, but believe that the important outcome of Experiments 1 and 2 is that powerful and unexpected consequences of part-set cuing have been demonstrated. Further research is necessary to clarify the basis of the cuing effects when recalling information from text.

When people briefly studied and were asked to recall line-drawings of objects, a pictorial scene led to much better recall of the objects than did the matrix but in neither case did the part-set cues influence recall. Accounts of part-set cuing based on other types of materials led to predictions of every possible outcome. In our experiments the cues did not influence recall of the objects in either the scene or the matrix. Better recall of objects from the scene suggests that memory benefits from inter-item associations within scenes that are lacking in a matrix. However, associations between presented cues and missing items did not further facilitate recall when part-set cues were provided. These results were similar to the recall of the layout of chess pieces in chess games (non-verbal, spatial material), where total recall was not influenced by part-set cues. Nevertheless, meaning seems to play a role as well, as evidenced by the improved memory for objects from room scenes over those studied in matrices. So people could recall objects (or chess pieces) in many ways: based on meaningful organization, images, or words. This potential flexibility in retrieval strategies may have limited the often disruptive effects of part-set cues.

These experiments illustrate that enigmas associated with part-set cuing remain; proposed explanations of the effect did not predict the observed effects on memory for information from text and for pictures of objects. Our intention is not to add to the speculative accounts of part-set cuing, but to provide further grist for the theoretical mills as well as to offer evidence of the effects of part-set cuing with the sorts of information people often try to recall. Educationalists will, we hope, be cautious in providing cues when teaching or assessing learning. On the other hand, our results suggest that pictorial prompts do not disrupt peoples' memory for details from a scene, but that partial descriptions of the scene and events might impair recall because descriptions of events are similar to text. Both situations deserve further research to better define their parameters for applied purposes and to inform the search for a coherent, comprehensive explanation of part-set cuing effects.

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Appendix

Texts studied and items scored in Experiment 1 and 2

The History and Uses of Garlic

Sanskrit writings from 5,000 years ago refer to garlic and 3,000 year old Chinese manuscripts mention garlic. Islamic tales place garlic in the Garden of Eden. In Homer's Odyssey garlic plays a role when Ulysses fights off black magic using garlic.

Workers building the Great Pyramid at Giza consumed 1.5 million pounds of garlic and the first recorded labour strike occurred when pyramid builders were denied their garlic. The ancient Romans fed garlic to the gladiators since garlic was believed to give strength and courage.

The Phoenicians are believed to have taken garlic to sea with them and evidence suggests that the Vikings had garlic with them on their ships. The Crusaders are believed to have brought garlic to Europe and Britain.

The Babylonians are known to have used garlic for medicinal purposes. An ancient Egyptian medical record lists 22 garlic prescriptions. Garlic has been used as an antidote for intestinal disorders and respiratory infection were also believed to respond to garlic.

In fact, garlic bulbs contain medically active sulfur compounds. Garlic is high in vitamins A, B1, B2, and C. Scientific studies have confirmed garlic's effectiveness as an antiseptic. Also, research suggests that garlic is effective in reducing blood pressure.

Items scored from recall of 'Garlic' text

Sanskrit; 5000 years ago / Chinese; 3000 years ago / Islamic; Garden of Eden / Odyssey; Homer / Ulysses; black magic / Great Pyramid (or Giza); 1.5 million pounds of garlic / labour strike; pyramid builders / Romans; gladiators / gives strength; gives courage / Phoenicians; garlic taken to sea / Vikings; took garlic on ships / Crusaders; garlic to Europe/Britain / Babylonians; medicinal purposes / Egyptian; garlic prescriptions / antidote; intestinal disorders / respiratory; infections / medically active; sulfur / vitamins; A/B1/B2/C / scientific studies; antiseptic / research; blood pressure

Neandertals

Neandertals appeared first in Europe about 120,000 years ago and, later, Neandertals also lived in Asia 70,000 years ago. Neandertals are so called because the first bones were found in a valley named after Joseph Neander. The first Neandertal bones were found in 1856 in Germany when limestone quarrymen who discovered the bones thought they were those of a bear.

Neandertals' bodies were big and strong, but otherwise very much like modern humans. Neandertals' faces had heavy browridges and big noses. The middle of their faces protruded and their teeth were enormous. Neandertals' brains were slightly larger than the brains of modern humans.

Neandertals made stone tools and used fire to cook their food. Neandertals' stone tools have been classified into many different types based on the shape of the stone and the nature of the edge(s). Some Neandertal skeletons are of disabled individuals, suggesting that the group helped to support each member. There is evidence to suggest that Neandertals buried their dead, perhaps with ceremony.

Neandertals were often considered to be the ancestors of modern humans, with their European origin making Europe the cradle of humanity. However, DNA evidence suggests that Neandertals are not the ancestors of modern humans; the human lineage is purported to have begun in Africa at least 142,000 years ago. Scientists are divided about whether or not the humans killed the Neandertals.

Unlike hunter-gatherers of today, Neandertal tribes did not have much contact with one another. Analysis of leg bone structure tells us that Neandertals did not normally walk long distances. The data from food remains suggest that Neandertals were poor planners. For example, seasonal fish migrations represent a bonanza food source—which bears seem to have capitalized upon far better than did Neandertals!

Items scored from recall of 'Neandertals' text

first in Europe; 120,000 years ago / later in Asia; 70,000 years ago / found in a valley; named after Neander / found in Germany; 1856 / big/strong bodies; otherwise like humans

heavy browridges; big noses / mid-face protrusion; big teeth / brains; larger than humans / made/used tools; cooked food / tools classified by shape; tools classified by nature of edges / disabled members; group support / buried dead; ceremony/funeral / were considered human ancestor; European origin / DNA evidence; not human ancestor / Africa was human origin; at least 142,000 year ago / scientists divided; humans killed Neandertals / unlike today's hunter-gatherers; little contact between groups / leg bones; not long distance walkers / food remains; poor planners / seasonal migrations as food source; bears better than Neandertals

Table 1

Experiments 3 and 4: Mean percentage of items recalled with standard deviations.

	Mean percentage recalled		Standard deviations	
	Cued	Not cued	Cued	Not cued
Experiment 3, *N* = 64				
Room	82.5	81.3	16.3	10.0
Matrix	67.5	67.5	16.3	16.3
Experiment 4, *N = 60*				
Room	61.7	62.5	14.2	13.3

Figure Captions

Figure 1. Experiment 3: The scene used to present 16 items for study in the room condition.

Figure 2. Experiment 3: The matrix used to present 16 items for study in the matrix condition.

Figure 3. Experiment 3: One of the two room scenes used to test recall with cues in the room condition. The 8 items were shown in their original positions.

Figure 4. Experiment 4: The scene used to present 24 items for study in the room condition.