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Effects of Presentation Format on Memory for Order

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Abstract

Memory for order is important in everyday settings, for example in eyewitness testimony about who started a conflict. Although current theories claim that memory for order is different from memory for the to-be-remembered items themselves, many of the same manipulations that affect item memory also affect order memory. One manipulation that has shown effects in item memory, but that has not been tested in order memory, is presentation format. The hypothesis tested here is that order memory will be better for actions described as pictures than for actions described by text. The hypothesis is not supported by a main effect. However, presentation format does interact with serial position, suggesting that format effects are analogous to modality effects across auditory and visual presentation. Moreover, primacy is greater than recency, undermining Estes's (1997) perturbation model of memory for order.

Introduction

Suppose that several witnesses to a knife fight agree that two knives were pulled, that a fight ensued, and that one person was killed. However, the witnesses' recollection of who drew a knife first is less exact. Although the to-be-remembered items are not in question, the recollection of order spells the difference between life in prison and acquittal on grounds of self-defense. If we can understand under what conditions people are most likely to be accurate about the order in which things happened, it could help us make better decisions about when to believe eyewitness and other accounts of history.

Understanding order memory also has important implications for our understanding of memory in general. Order memory is central to skill and language acquisition, both of which depend on sequence information. Also, order memory underlies the construct of episodic memory. For example, in some models of forgetting, people do not forget the word "bird", they only forget that "bird" was presented to them in a particular temporal window (Nairne, 1990b).

Memory for order is often claimed to be separate from memory for to-be-remembered items themselves (Bjork & Healy, 1974; Nairne, 1990a). Indeed, Whiteman, Nairne and Serra (1994) go so far as to say that order memory operates in a way that is fundamentally different from processes seen in both item recall and recognition. However, many manipulations that affect item memory have similar effects on order memory (Glenberg & Swanson, 1986; Nairne, 1990b; Naveh-Benjamin, 1990), even when the manipulation was designed to factor out the effects of item memory (Neath, 1997). For example, Glenberg and Swanson (1986) found that auditory presentation produces higher accuracy than visual presentation, especially for the last items in a list. This pronounced recency effect for auditory modality is similar to the effect seen in item memory. Similarly, Neath (1997) showed that set-size, presentation modality, and word concreteness all have similar effects on order memory as they do on item recognition and recall.

If order memory is similar to item memory, one might expect it to differ across other manipulations that produce differences in item memory. One such difference is between pictures and text. In recall and recognition tasks, pictorial presentation of items produces higher accuracy than verbal presentation (Baggett, 1979; Snodgrass, Wassner, Finkelstein, & Goldberg, 1974). Dual-coding theory provides one possible explanation for these results. People usually encode pictures verbally as well as pictorially, but may or may not encode verbal material pictorially. This dual encoding of pictures creates a stronger memory trace, which leads to better item recall or recognition (Snodgrass et al., 1974).

Further evidence that memory for pictures is better than memory for text comes from Baggett (1979), who compared memory for a story across presentation formats. The story was presented either as a movie or as text, and was structurally equivalent in both formats. After subjects saw or read the story, they were asked to free-recall as much detail as they could about a specific episode, either immediately after study or after seven days. For those who saw the movie, still pictures were used to cue the beginning and end of the to-be-recalled episode. For those who read the story, textual cues were given. Although there was no effect of format in the immediate recall condition, participants in the seven-day condition recalled significantly more detail if they had seen the movie (Baggett, 1979).

This paper examines the effects of presentation format – pictures versus text – on accuracy of order memory. Our hypothesis is that memory for order should be better when items are presented as pictures. This hypothesis is primarily based on the findings cited above that suggest that item memory is better for pictures than for text. However, the hypothesis is also based on the intuition that order information is fundamental to how people function in the world. In particular, as we suggested in the knife-fight scenario above, order memory is a cornerstone of causal inference. Similarly, a picture is often worth a thousand words because it can make functional inferences easier to generate (Larkin & Simon, 1987). Thus, there is reason to ask whether order memory, given its basic nature, is facilitated by presentation formats more primitive than language.

Experiment

The most common way to test order memory, while factoring out the effects of item memory, is to show participants a sequence of items at study time, and then show them the same items at test time in scrambled order. Their task is then to place the items back in their original order. Nairne (1992) claims that this type of task can be seen as a pure test of position memory without being confounded by item memory processes because all of the item information is made available at the time of recall.

The current study follows Nairne (1992) in testing incidental memory for order. In that study, subjects were asked to make pleasantness ratings on each word in five lists of five words each. The purpose of the rating task was to ensure that subjects would not be expecting any type of memory test and that the learning of order would be incidental. This type of deception is necessary because if participants are expecting any kind of memory test, even if they do not know that it will be a test of order, it is not truly incidental learning (Naveh-Benjamin, 1990). Tests of incidental memory for order have the highest ecological validity for assessing how order memory functions in everyday life.

Nairne's participants were brought back at time intervals ranging from 30 seconds to 24 hours and were then given a surprise test on the order of the items. The time delay variable is important to study not only to see the effects of decay over time, but also to be able to generalize any findings across short and long term memory. We adopted the three intervals (30 seconds, 4 hours and 24 hours) that Nairne cites as being the most representative of decay of order memory over time.

Method

Participants

The participants were 76 undergraduates at George Mason University who participated in the experiment for course credit in psychology classes. One subject's data were excluded due to failure to follow instructions. The experimental sessions were conducted in small groups ranging from four to fourteen participants each with four singletons.

Materials and Design

The experiment consisted of 30 actions arranged into six thematic groups. The themes were primarily place-oriented; for example, things that might happen in an office setting, or buying items at a supermarket. Care was taken to ensure that actions had no logical or causal sequence of order (e.g. having to knead the dough before baking the bread). All actions in a group were presented either in picture format or in text format. Order of groups, and order of actions within groups, was determined randomly by sampling without replacement. The picture format consisted of a silent, color video segment that depicted an actor performing the target action. The actor's gender for each group was determined randomly before shooting and the same actor in the same clothing was used for each picture within a group. A text group consisted of a set of one-to-three-word phrases that described the actions in a corresponding picture group.

Black and white still shots representative of the video sequences and the corresponding text phrases are given in the Appendix.

Both text and picture actions were presented on videotape played on 27 to 35 inch standard televisions. Phrases were presented in large white block letters against a black background. Participants saw a video with three groups presented in picture format and three groups presented as text. Two different videos were used, each with a different mapping of groups to format. That is, if group was presented as text in one video, it was presented as pictures in the other, and vice versa. The purpose of this counterbalancing was to control for any interaction of format and the theme of the group.

Delay between presentation and test was manipulated between groups at levels of 30 seconds, 4 hours and 24 hours of delay. The within-subject manipulations of format and serial position combined with the between-subject manipulation of delay to produce a 2x5x3 mixed factorial design.

Procedure

Participants were asked to watch the video and make pleasantness ratings about each picture or phrase they saw on a scale ranging from 1 (unpleasant) to 3 (pleasant). The rating task was used as a decoy to make intentional learning of the items or of the order unlikely. Each picture and phrase was visible for five seconds and was followed by 2.5 seconds of black screen. Between each group of five items, five seconds of blue screen was shown. Participants were not informed about the subsequent memory test, nor were they given any information as to why some of the items were presented as pictures and others as text. They were simply led to believe that they were participating in a rating task evaluating their affect toward everyday actions. Participants wrote their ratings on a response sheet containing six rows of five blanks; one row was designated for each group.

After completing the rating task, participants in the 4 and 24 hour delay groups were excused and instructed to return at the designated time for further rating exercises. Participants in the 30-second condition were asked to turn their rating sheets over and write down numbers counting backwards from 100 by threes. After thirty seconds, they were told to stop and their rating sheets were collected as test sheets were handed out. At the time of test, participants in all delay conditions were handed a response sheet that corresponded to the videotape that had been presented to them. Each test sheet consisted of six rows of five blanks labeled 1st, 2nd, 3rd, 4th and 5th in that order. Above each row of blanks were the items that had been presented, but in a new random order. For groups presented as text, phrases were typed with the letters A through E to the left of each phrase. For groups presented as pictures, black and white still pictures representative of the action were presented and were labeled A through E directly above each picture. Participants were told that each group on the text sheet contained all five actions that were in that group at study. They were then asked to put the letter corresponding to each action in the correct blank to reconstruct the original order of presentation. Because all of the to-be-remembered actions were presented at test time, this type of free reconstruction task can be seen as a pure test of position or order memory

Results

The measure we focus on in this analysis is the proportion of items placed correctly in their original order. These data are shown in Figure 1 (by format, aggregated over delay) and Figure 2 (by format and delay). All analysis of variance (ANOVA) was repeated measures on the format variable.

There was a significant effect of delay ($F(2,73) = 19.4$, $p < .0001$). However, there was no main effect of format ($F(1,73) < 1$), nor was there an interaction between presentation format and delay ($F(3,72) = 1.9$, $p > .05$).

Characteristic primacy and recency effects are reflected in a main effect of position ($F(3,72)=41.0$, $p < .0001$) and a significant quadratic trend ($F(1,73) = 115.0$, $p < .0001$). However, the linear trend was also significant, ($F(1,73) = 21.2$, $p < .0001$), and a post-hoc comparison of accuracy on the first and last items shows that primacy is greater than recency ($t(75)=3.0$, $p < .005$). The linear trend and post hoc comparison were significant for five out of six combinations of format and delay, the exception being 24 hour text. There was no significant interaction between position and delay time ($F(2,73) = 2.7$, $p > .05$), indicating that the curves were roughly the same shape at each level of delay.

Although format did not have a main effect, it did interact with position ($F(3,72) = 3.2$, $p<.05$). As Figure 1 shows, the difference between primacy and recency is more pronounced in the picture format (that is, the serial position curve for pictures is rotated slightly clockwise compared to the curve for text). This interaction remains significant across all of the three time delays, as shown in Figure 2.

Discussion

The hypothesis that pictures produce more accurate memory for order than text was not supported. This surprised us, given that pictures are consistently better than text in memory for items (e.g. Baggett, 1979; Snodgrass et al., 1974) and that many item-memory manipulations transfer to order memory (Naveh-Benjamin, 1990; Neath, 1997).

Our results point to a possible confound in how the effects of presentation format have been interpreted with respect to item memory. Another variable that may be correlated with format is whether sequential information is im-
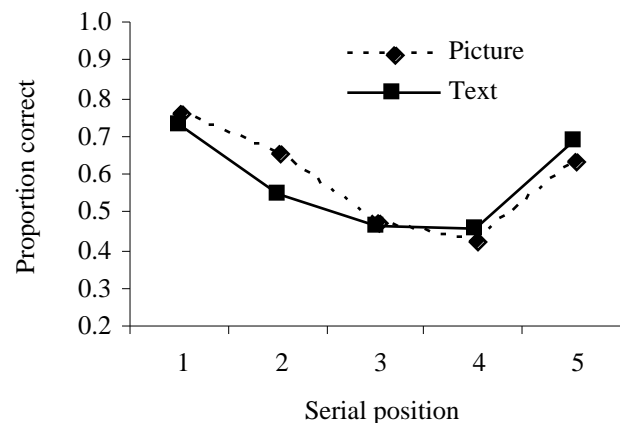

Figure 1: Accuracy as a function of format and serial position.
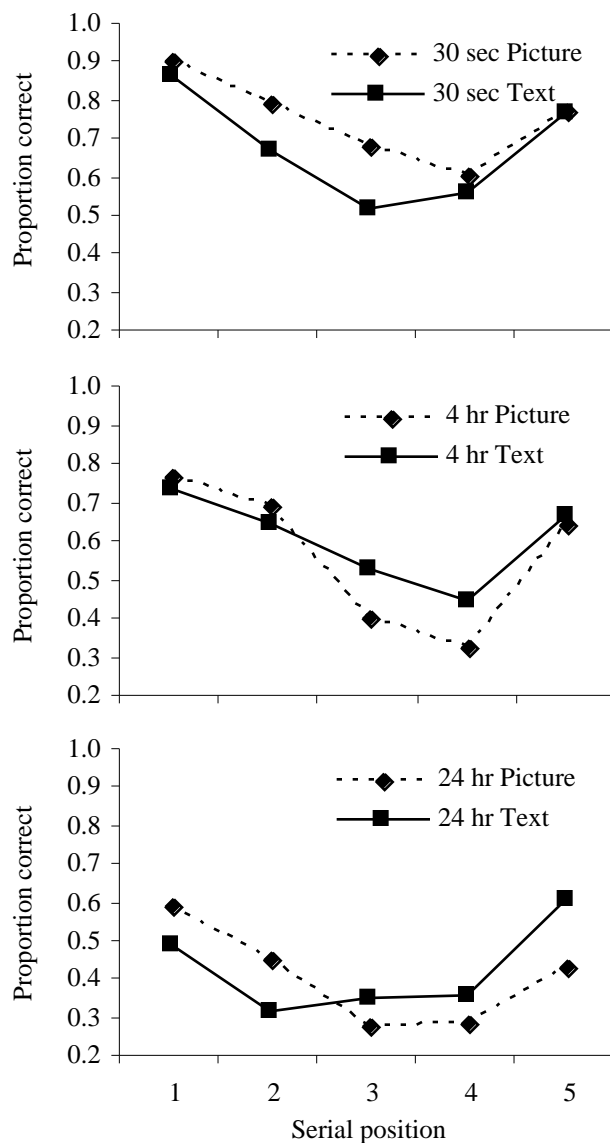

Figure 2: Accuracy as a function of format and serial position, by delay (panels).

portant in understanding the stimulus. For example, Anderson (1976) found that order retention for linguistic materials (spoken words) was actually higher than for static pictures. Anderson's explanation for this superiority in his study depended on the sequential properties of the stimuli. In his view, language (in particular, the verbal stimuli in his study) is highly dependent on sequential information, and is therefore processed sequentially. In contrast, Anderson argued that the line drawings he used as pictures were not dependent on sequential processes for interpretation. He maintains that this sequential processing of linguistic material is robust enough to continue even when strings of non-related words are presented as stimuli. Thus, whether pictures are remembered better than words, or vice versa, may depend on the sequential structure (or other structure) of the stimuli across the two conditions.

The sequential structure of stimuli could easily be confounded with presentation format. For example, actions

presented as movies may be perceived to be more coherent than stills of the kind used by Anderson, because they fill in the details of natural action. If movies do communicate sequential structure more effectively, and if sequential structure facilitates memory, then our null effect is consistent with Anderson because the benefit of movies works against the benefit of text. However, the benefit of pictures in other studies (e.g., Baggett, 1979; Snodgrass et al., 1974) then becomes a puzzle. Our results suggest that these studies should be re-examined for other structural aspects of stimuli that may confound the effect of presentation format.

Another factor that may explain our null effect of format is that participants may use the same dual codes to represent both formats. An informal debriefing of participants after the experiment supports this view. Most of those questioned reported that they not only thought about the actions verbally while watching the video, they also visualized themselves doing the actions when they were presented textually. When asked why they had visualized the textual material, participants indicated it was because they needed to see it in their minds to be able to judge its pleasantness. Changing the distracter task used at study time (for example, asking for frequency counts rather than pleasantness ratings) may produce the asymmetrical recoding (pictorial to verbal) seen by Snodgrass et al. (1974). Thus the nature of the distracter task will have to be manipulated in future studies to isolate its effects on memory for order.

Despite the null effect of format, there was an interaction between format and serial position. A similar interaction has been observed between modality (visual and auditory) and position (Glenberg & Swanson, 1986; Neath, 1997), raising the possibility that these interactions are related. In the modality interaction, auditory presentation produces better order memory than visual presentation, but only for last one or two items (Neath, 1997). Early theories of this interaction implicated differences in sensory storage mechanisms across modalities. However, Gardiner and Gregg (1979) showed that the interaction was still pronounced when auditory distracter information was presented during the retention interval. These findings suggest that the modality interaction is caused by a variable that was confounded with echoic memory in earlier studies. The implication for our results is that the format interaction and the modality interaction may in fact stem from the same underlying process.

The interaction between format and serial position could also be due to a primacy benefit for pictures that is related to release from proactive interference. As we noted above, participants reported visualizing themselves performing the actions across all of the text groups. This may have made the text groups less distinct from one another than the picture groups, which each had a new actor and a new context. If a new picture group is more distinct by virtue of these visual cues, one would expect a stronger release from proactive inhibition and hence improved memory immediately afterwards. Thus the format interaction could stem from a recency benefit for text (similar to a modality effect), from a primacy benefit for pictures, or from some combination.

The difference between primacy and recency in our data helps to distinguish among formal models of order memory (see Brown, 1997, for a review of such models). The most widely discussed is the perturbation model (e.g., Estes, 1997; Nairne, 1992). In this model, primacy and recency occur because there is only one direction in which the first and last items can "perturb", namely toward the middle of the list. In contrast, middle items can drift in both directions, increasing the likelihood that they will be placed incorrectly at test. Importantly, the model predicts that primacy and recency should be symmetrical, because there is no difference between the two ends of the list. Although Estes (1972) presented this model as pertaining to short-term order memory, Nairne (1992) applied this model to the study of long-term, incidental learning for order memory, with fair results. What the model fails to predict, however, is the difference between primacy and recency effects, in which the first item in a group is placed more accurately than the last item. Nairne (1992) suggested that this difference may prove significant, and the support for this result found in our data raises a substantial problem for the perturbation model.

Two later models do make the prediction that primacy should be greater than recency in memory for order. The primacy model (Henson, Norris, Page, & Baddeley, 1996) is based on the ad hoc assumption that items earlier in a list have higher activation levels. These items are then suppressed by another ad hoc mechanism as they are output at test time. Recency arises from this model because there are fewer remaining choices nearer the end of the list, and therefore fewer chances to make an error based on noise in the activation levels. In addition to being largely ad hoc, this model makes the problematic assumption that participants place items in forward order at test time. However, informal debriefing of several participants in our study suggests that items are often placed in orders other than strictly forward. Indeed, others have observed a pattern in which participants initially place the first and last items, and only then place the middle items (Lee & Estes, 1977). Because sequential placement of order is a basic assumption of the primacy model, further study on the order in which participants actually place items is necessary.

The second model that predicts greater primacy than recency is the dual-code associative model (Altmann, in press). This model represents each item with two codes – one for the item itself and one for its location – and links them together in a chain at encoding time. Errors in linking codes produce order errors at test. Items at either end of a list have an advantage in that they can only be linked to an incorrect code in one direction. However, items at the start of the list have a greater advantage, because they suffer less interference at encoding time (Altmann, 2000). This model has the benefit of explaining how memory for order is encoded, an issue that the primacy model fails to address.

To advance our theoretical understanding of order memory, follow-up studies will have to differentiate among the primacy and dual-code associative models. In addition, existing models fail to account for modality, set-size, presentation format or any of the other effects that appear in studies of both item and order memory. Our goal should be to integrate these phenomena across item, order, short-term, long-term, semantic, episodic and all of the other pigeonholes in which we classify memory, into one unified theory.

Conclusion

We expected that pictures would produce better memory for order than text, based on similar effects in memory for items and on considerations of the foundational nature of memory for order. This hypothesis was not supported, but we did find an interaction between format (picture vs. text) and serial position. Recency effects were greater for text across a range of retention intervals, an effect that may be related to the modality interaction observed by others. We also found that primacy was greater than recency in aggregate, and, in a finer-grain analysis, in almost all combinations of presentation format and time delay. This finding, foreshadowed by Nairne (1992), suggests that the perturbation model is incorrect and lends credence to models that capture directional processing of items at study.

References

Altmann, E. M. (in press). Memory in chains: A dual-code associative model of positional uncertainty. In N. Taatgen and J. Aasman (Eds.), *Proceedings of the 3rd international conference on cognitive modeling.*

Altmann, E. M. (2000). The strength of chains: Why primacy dominates recency in memory for order. *Manuscript submitted for publication.*

Anderson, R.E. (1976). Short-term retention of the where and when of pictures and words. *Journal of Experimental Psychology: General, 105*, 378-402.

Baggett, P. (1979). Structurally equivalent stories in movies and text and the effect of the medium on recall. *Journal of Verbal Learning and Verbal Behavior, 18*, 33-356.

Bjork, E. L., & Healy, A.F. (1974). Short-term order and item retention. *Journal of Verbal Learning and Verbal Behavior, 13*, 80-97.

Brown, G. D. A. (1997). Formal models of memory for serial order: A review. In M. A. Conway (Ed.), *Cognitive models of memory* . Cambridge, MA: MIT Press.

Estes, W.K. (1972). An associative basis for coding and association in memory. In A.W. Melton & E. Martin (Eds.), *Coding Processes in Human Memory*. Washington D.C.: V.H. Winston & Sons.

Estes, W. K. (1997). Processes of memory loss, recovery, and distortion. *Psychological Review, 104*, 148-169.

Gardiner, J.M., & Gregg, V.H. (1979). When auditory memory is not overwritten. *Journal of Verbal Learning and Verbal Behavior, 18*, 705-719.

Glenberg, A.M., & Swanson, N.G. (1986). A temporal distinctiveness theory of recency and modality effects. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12*, 3-15.

Henson, R.N.A., Norris, D.G., Page, M.P.A., & Baddely, A.D. (1996). Unchained memory: Error patterns rule out chaining models of immediate serial recall. *The Quarterly Journal of Experimental Psychology, 49A (1)*, 80-115.

Larkin, J. H., & Simon, H. A. Why a diagram is (sometimes) worth ten thousand words. *Cognitive Science, 11*, 65-99.

Lee, C. L., & Estes, W. K. (1977). Order and position in primary memory for letter strings. *Journal of Verbal Learning & Verbal Behavior, 16*(4), 395-418.

Nairne, J.S. (1990a). A feature model of immediate memory. *Memory & Cognition, 18(3)*, 251-269.

Nairne, J.S. (1990b). Similarity and long-term memory for order. *Journal of Memory and Language, 29*, 733-746.

Nairne, J.S. (1992). The loss of positional certainty in long-term memory. *Psychological Science, 3*, 199-202.

Naveh-Benjamin, M. (1990). Coding of temporal order information: An automatic process? *Journal of Experimental Psychology: Learning, Memory and Cognition, 16*, 117-126.

Neath, I. (1997). Modality, concreteness and set-size effects in a free reconstruction of order task. *Memory & Cognition, 25(2)*, 256-263.

Snodgrass, J.G., Wassner, B., Finkelstein, M., & Goldberg, L.B. (1974). On the fate of visual and verbal memory codes for pictures and words: Evidence for a dual-coding mechanism in recognition memory. *Journal of Verbal Learning and Verbal Behavior, 13*, 27-37.

Whiteman, H.W., Nairne, J.S., & Serra, M. (1994). Recognition and recall-like processes in the long-term reconstruction of order. *Memory, 2(3)*, 275-294.

Appendix

Pictures (representative stills taken from video) and corresponding textual phrases for the six groups of actions.

Group1
Picture Presentation Format

Text Presentation Format
Wash Dishes
Take Out Trash
Vacuum Floors
Make Bed
Dust Cabinet

Group 2
Picture Presentation Format

Text Presentation Format

Buy Bread	Buy Potato Chips	Buy Soup	Buy Eggs	Buy Milk

Group 3
Picture Presentation Format

Text Presentation Format

Type Document	Talk On Phone	File Document	Copy Document	Dial Fax Machine

Group 4
Picture Presentation Format

Text Presentation Format

Rest In Bed	Take Temperature	Eat Soup	Drink Medicine	Sneeze

Group 5
Picture Presentation Format

Text Presentation Format

Hug Teddy Bear	Change Diaper	Drink Bottle	Read Story	Throw Ball

Group 6
Picture Presentation Format

Text Presentation Format

Highlight Text	Daydream	Take Notes	Study Flashcards	Read Text