

Examining Hypermnnesia in Free and Serial Recall

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The present study was designed to further examine the relationship between hypermnnesia and order retention. The experiment examined free- and serial-recall performance while using more ecologically-valid stimuli (20 actions that might occur in a park—throwing a Frisbee, reading a newspaper, etc.) than are typically used in hypermnnesia studies (i.e., words and pictures). Three successive free-recall tests revealed positive hypermnnesia, whereas 3 successive serial-recall tests displayed no change in performance across tests.

We frequently encounter situations in which we are prompted to remember information, but we are unable to access a correct response at that moment; in such cases, we would report that we have forgotten the to-be-remembered information. Often, however, if we attempt retrieval at a later time, the information becomes accessible and we are able to provide an accurate reply. This common experience is referred to as reminiscence and can be defined as the process of remembering “forgotten” material in the absence of relearning (Ballard, 1913). Experimentally, reminiscence can be revealed through the retrieval of items on later tests that were not recalled on initial tests. When there is an overall increase in retrieval performance across experimental tests, hypermnnesia is present (Madigan & Lawrence, 1980; Payne, 1987; Roediger & Challis, 1989). That is, hypermnnesia occurs when intertest recovery (reminiscence) is greater than interest forgetting.

Generally, repeated testing experiments involve participants remembering a list of items (e.g., words, sketches, pictures) for subsequent recall tests (Erdelyi & Becker, 1974; Erdelyi & Stein, 1981; Madigan & Lawrence, 1980). Participants are typically shown a large collection of items (e.g., 40–80 items) and are

instructed to remember all of the material. A sizeable quantity of items is used to prevent ceiling effects and to provide opportunity for recall performance to increase—a requirement for hypermnnesia. Participants are usually told to expect one memory test so that they are surprised when they receive at least two more tests on the same material. On average, each test is 7 minutes in length and all three tests occur successively. Typically, researchers examine how performance changes from Test 1 to Test 2 (early tests) and from Test 2 to Test 3 (late tests).

Early studies of reminiscence and hypermnnesia examined whether the type of to-be-remembered material affected performance in a repeated testing paradigm. Cumulative recall levels have consistently been shown to be greater with pictures than with words (Madigan & Lawrence, 1980; Payne, 1986). For exam-

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ple, in an experiment conducted by Payne, participants viewed either a series of 55 sketches of common objects, or the names of those objects typed in lowercase. After the participants had completed three successive free-recall tests, Payne found that although both pictures and words produced reliable reminiscence and hypermnesia, picture stimuli yielded higher cumulative recall and greater hypermnesia. In a second experiment, Payne discovered that even after equating cumulative recall levels, pictures produced a significantly larger hypermnesic effect. Furthermore, pictures have produced less intertest forgetting, and generally lead to hypermnesia levels that typically exceed that of words (Erdelyi & Kleinbard, 1978; Madigan & Lawrence, 1980; Payne, 1986).

Recent studies have expanded their exploration of reminiscence and hypermnesia beyond basic laboratory stimuli (pictures and words) and have examined memory for real life events (Bluck, Levine, & Lauhere, 1999). In the Bluck et al. study, participants who had viewed the O. J. Simpson trial verdict announcement were questioned regarding the event. In a series of three interviews occurring within an hour-long experimental session, participants were asked to recall information regarding the verdict. They were assessed on their recall of two different types of information regarding the verdict announcement: events occurring on the television (TV aspect) and memories of their reactions (personal aspect). As with standard to-be-remembered materials, both types of real-life events yielded both hypermnesia and reminiscence.

In addition to varying the to-be-remembered stimuli, researchers have manipulated the type of processing that participants are instructed to use while encoding the presented items (McDaniel, Moore, & Whiteman, 1998; Otani & St. Louis, 1995; Otani & Whiteman, 1994). For example, Otani and Whiteman examined the influence of item-specific and relational processing on repeated recall performance. Item-specific processing focuses upon characteristics of the to-be-remembered material that are unique to those particular items (e.g., thinking about the meaning or pleasantness of a target item). Conversely, relational processing centers upon finding associations among items, which promotes recall of item sets (e.g., categories, such as body parts, animals, etc.). In their study, participants were randomly assigned to one of these two processing conditions. Participants engaging in item-specific processing were asked to rate the pleasantness of the 36 word pairs, whereas those assigned to relational processing sorted the pairs according to their category affiliation. This study, as well as numerous others, found greater recall and hypermnesia

across early tests with relational processing, whereas item-specific processing produced greater recall and hypermnesia on later tests (McDaniel et al., 1998; Otani & St. Louis, 1995; Otani & Whiteman, 1994).

Researchers have also examined the influence of retrieval variables on repeated testing performance (Otani & Whiteman, 1994; Payne, Hembrooke, & Anastasi, 1993; Payne & Roediger, 1987). One important retrieval variable that has received a great amount of attention is the type of test administered to the participants. Reminiscence and hypermnesia have regularly been found through the use of free-recall (Erdelyi & Becker, 1974; Roediger & Payne, 1982) and cued-recall tests (Otani & Hodge, 1991; Otani & Whiteman, 1994). In a free recall test, participants are asked to remember as many of the target items as possible without any assistance, whereas in a cued recall test participants are given cues (e.g., category names) to help them recall the target items. Alternatively, recognition tests, in which participants have to distinguish target items from foils, have generally led to reminiscence without the presence of hypermnesia (Otani & Hodge, 1991; Payne & Roediger, 1987).

Although an abundance of research has explored the influence of type of test, most of the studies have been limited to examining memory for item information (how many new items were recalled on Test 2 that were not recalled on Test 1?). Indeed, the tests of recognition, free recall, and cued recall are typically described as being tests of item information (Healy, 1974). Until recently, memory for the order of events had not been examined experimentally. Typically, memory for order is tested by using either a reconstruction of order test or a serial-recall test. In a reconstruction test, participants are presented with each of the target items in a new random order and must place the items back into their original ordinal positions, whereas in a serial-recall test, participants must both recall the target items and subsequently place them in their appropriate ordinal positions.

Kelley and Nairne (2003) conducted a series of experiments to investigate the role of repeated testing on memory for order. Their methodology replicated classic procedures, as participants viewed a set of either 25 words or pictures and were subsequently given three consecutive memory tests. Half of the participants received free-recall tests (in an attempt to replicate standard findings) and the remaining half received reconstruction of order tests. In their study, Kelley and Nairne replicated the standard findings in free recall as hypermnesia was found for both words and pictures. Interestingly, the reconstruction of order tests yielded a different pattern of performance: reminiscence was present across tests but hypermnesia

was not. These findings revealed disparate effects of item and order information, with respect to overall performance, as free recall yielded an increase in performance, whereas reconstruction performance decreased across tests. However, in regards to reminiscence, additional item and order information was remembered across successive tests for free recall and reconstruction, respectively. That is, participants recovered additional items across tests, but intertest forgetting exceeded intertest recovery. Kelley and Nairne's research provided the foundation for the current investigation, which further explored the effects of repeated testing on memory for order.

Theories of Reminiscence and Hypermnesia

Currently, two separate theories have attempted to account for the findings in the reminiscence and hypermnesia literature. The cumulative recall hypothesis (e.g., Payne, 1986; Roediger & Payne, 1982) suggests that hypermnesia is due to the relationship between initial test performance and the asymptotic level of recall. The theory posits that hypermnesia will be present when first-test recall is significantly lower than the asymptotic (ceiling) level of recall, so that during subsequent tests, there is sufficient room for recall improvement. Hypermnesia is thought to occur when initial test item recovery does not limit potential recall on later tests and as result, recovery of additional items on subsequent tests is feasible.

Alternatively, the retrieval dynamics account of hypermnesia (e.g., Payne et al., 1993) focuses upon shifts in retrieval processes over time and suggests that reminiscence and hypermnesia are the direct results of (a) an incrementing process and (b) the presence of alternate retrieval routes. Payne et al. suggested each time that an item is successfully retrieved, an incrementing process increases both the strength of the retrieved item, as well as the strength of the association between the item and its retrieval cues. Typically, this process is displayed through the increase in relative speed of individual item recovery during each additional test. Payne et al. also suggested that the presence of additional retrieval routes plays an important role. The idea is that those items not recalled with initial retrieval cues may be recalled on later tests if the cues are modified (e.g., presence of alternative associations that serve as additional cues for remembering the forgotten items, such as "red," "fruit," "Newton" for the target word "apple").

Although these theories can successfully account for much of the reminiscence and hypermnesia data, neither of these theories has clearly addressed memory for order retention, and thus they are currently incomplete. Before a complete and unified theory of

reminiscence and hypermnesia can be established, more research must explore the effects of repeated testing on order retention.

The current experiment was designed to assess the effects of repeated testing on serial-recall performance as compared to free recall. In the experiment, participants watched a video depicting a series of 20 actions commonly seen while visiting a park. Following the final action, participants completed either a series of three successive free-recall or serial-recall tests. The free-recall tests were scored using standard free-recall scoring criteria, where an action is marked as correct if it appeared anywhere in the video. The serial-recall tests were scored using three different methods (see Methods for detailed descriptions) that allowed the experimenters to examine order retention using a fine-grained analysis (strict-order criteria), a medium-grained analysis (relative-order criteria), and a coarse-grained analysis (lenient-free).

Based upon research that has shown hypermnesia with to-be-remembered material consisting of a video of real-life events (Bluck et al., 1999), it is expected that hypermnesia will be present within the free-recall condition of this experiment. Expanding upon the research of Kelley and Nairne (2003), if we assume that serial recall and reconstruction engage similar mnemonic processes to access order information, then we might expect no hypermnesia and an overall decline in performance across the serial-recall tests. Of course, one could argue that serial recall contains elements of both free recall (need to remember items) that usually produces hypermnesia and reconstruction (need to remember order) that usually produces overall reduction in performance. Thus, in this hybrid conception, the positive and negative hypermnesic effects might balance one another and produce no overall change in performance across tests.

Method

Participants

Participants were 48 Lake Forest College undergraduates who participated for extra credit in an introductory psychology course. Groups of 20 or fewer participants were tested together in a classroom in sessions lasting approximately 35 minutes.

Materials and design

The experiment employed a 2 (test type: free-recall vs. serial-recall) x 3 (test number: 1, 2, 3) mixed-factor design, in which test type was varied between-subjects test number was varied within-subjects. Participants were randomly assigned to one of two experimental conditions (free-recall or serial-recall).

In all, there were 24 participants assigned to each of the two conditions. In both conditions, participants viewed a video of 20 actions that could occur while in a park (e.g., reading a newspaper, throwing a Frisbee, listening to music). To ensure generality, two random orders of the actions were created and were used in each of the two conditions. Following the video presentation, all participants received the same recall test sheet, which consisted of a column of 20 blanks (numbered 1 through 20, located on the left margin). Stimuli were presented and controlled with an IBM-compatible computer and a standard VCR.

Procedure

Participants were asked to remember 20 actions in a video for a subsequent memory recall task. They were instructed about the exact nature of the memory test (free- or serial-recall) prior to list presentation, but they only expected one test. The stimuli were projected onto a screen at a rate of one action every 5 seconds. Participants were instructed to pay close attention to each action as it was presented and to think of the actions in terms of short statements (e.g., reading a newspaper, throwing a Frisbee). Following the final item, participants in the free recall condition received the first test sheet and were asked to place the actions on any of the blank spaces. Participants in the serial-recall condition received the first test sheet and were asked to place the actions back into their original order of appearance by writing the action in its appropriate ordinal position along the numbered column. Participants were given 7 minutes to complete the test. Immediately following the first test, the recall sheets were collected and Test 2 was administered, following the same procedures as Test 1; Test 3 occurred immediately after Test 2.

Scoring Criteria

The free-recall tests were scored using a standard free recall scoring. The actions were marked as correct, regardless of their order, if they had been included during the presentation. The serial-recall tests were scored according to three different methods (strict-order, relative-order, and lenient-free). According to the strict-order method, the words were marked as correct if they were recorded in their appropriate ordinal position (if *bronze* had been the second word presented, it would be scored as correct if it were written in the second column of the first row). For relative-order scoring, the words were marked as correct if the words immediately preceding and immediately following were presented relatively before and after (for *bronze* to be scored as correct, the word given directly before must have been presented sometime before

'*bronze*' and the word directly after must have been presented sometime after *bronze*). For lenient-free scoring, the words were scored using standard free-recall criteria; that is, an item was scored as correct if it was written down anywhere on the list. In addition, for all of the scoring methods, the experimenter allowed minor variations in the desired responses to be scored as correct. For example, if the action was "throwing a Frisbee," responses such as "tossing a Frisbee," and "throwing a disc" were also scored as correct; to ensure consistent scoring, these instances of acceptable responses were recorded by the experimenter.

Results

Table 1 displays the net recall levels for each test and scoring criterion. Separate 2 (test type: free-recall vs. serial-recall) X 3 (test number: 1, 2, 3) mixed-factor analysis of variance (ANOVA) tests were performed for each of the three separate scoring criteria for serial recall.

As expected, with strict-order scoring, the ANOVA revealed a significant main effect of test type, $F(1, 46) = 233.90, p < .01$, where free recall yielded greater performance than serial recall. A significant main effect of test number was present, $F(2, 92) = 4.50, p < .05$, as was a significant interaction between test type and test number, $F(2, 92) = 3.40, p < .05$. A series of Newman-Keuls post-hoc tests revealed significant positive hypermnesia for free recall ($[T2=T3] > T1$) and no change in performance across tests for serial recall ($T1=T2=T3$).

With relative-order scoring, the ANOVA revealed a main effect of test type, $F(1, 46) = 161.40, p < .01$, where free-recall performance exceeded that of serial recall. No main effect of test number was present $F(2, 92) = 1.42, p > .05$. However, the interaction between

TABLE 1

Net Recall Levels Following Test 1 and Test 3 as a Function of Recall Task and Scoring Criterion for Actions

	Test 1	Test 2	Test 3	Change (T1-T3)
Serial Recall				
Strict	.22	.22	.22	(.00)
Relative	.35	.33	.33	(-.02)
Lenient	.62	.63	.65	(+.03)
Free Recall	.68	.73	.74	(+.06)

test type and test number was statistically significant, $F(1, 46) = 5.79, p < .01$. As with strict-order scoring, a series of Newman-Keuls post-hoc tests revealed significant positive hypermnesia for free recall ($[T2=T3]>T1$) and no change in performance across tests for serial recall ($T1=T2=T3$).

With lenient-free scoring, both the main effect of test type $F(1, 46) = 4.64, p < .05$ and of test number, $F(2, 92) = 9.49, p < .05$ were significant. Although the interaction between test type and test number was not statistically significant, $F(2, 92) = 1.31; p > .05$, a series of Newman-Keuls post-hoc tests revealed significant positive hypermnesia for free recall ($[T2=T3]>T1$) and no change in performance for serial recall ($T1=T2=T3$).

The experiment revealed several important findings. First, with all three scoring criteria, free-recall performance exceeded that of serial recall, which is the standard result (Healy, 1974). It is important to note that although the same scoring criteria were used in the free-recall condition as in the serial recall with lenient-free scoring condition, the mental processes involved these two conditions were completely different; participants in the serial-recall condition were instructed to order their recall, whereas participants in the free-recall condition did not receive this constraint. Second, reliable interactions were obtained using the strict- and relative-scoring criteria. Although the lenient-scoring interaction failed to reach significance, the post-hoc tests revealed a similar pattern of performance across all three scoring conditions—positive hypermnesia in free recall and no change in performance for serial recall. The lack of hypermnesia following serial recall provides some evidence for the assertion that serial recall may engage processes similar to both free recall (which produces positive hypermnesia) and reconstruction (which produces negative hypermnesia). When these positive and negative processes are combined, the net result is no overall change in performance.

Discussion

Prior the current experiment, no published research has examined how repeated testing affects performance in a serial-recall task. The present results revealed that free-recall performance exceeded that of serial recall across all experimental conditions. The lower performance of serial recall is likely due to the additional retrieval demands associated with recalling ordinal information. Consistent with standard hypermnesia research (e.g., Payne, 1987; Roediger & Challis, 1989), we also anticipated that hypermnesia would be present in free recall and this finding was

replicated, as free-recall performance improved across successive tests.

The present research also established that participants' net order retention remained stable across successive tests. These results suggest that serial recall may utilize a combination of free recall and reconstruction processes. In other words, the experiment provided some evidence for a hybrid explanation of serial recall, where the positive hypermnesia of free recall balances out with the negative hypermnesia of reconstruction. As a result, serial recall performance displays no overall change across successive tests.

The current findings have several important implications for real-world situations, specifically related to eyewitness testimony. When a person witnesses a crime and is later questioned about the details of that crime, the questioning process closely resembles serial recall in that eyewitnesses are repeatedly questioned regarding both the events observed and their order of occurrence. In the present experiment, we discovered that serial-recall performance does not improve across successive tests. Indeed, if serial recall is a hybrid of free recall and reconstruction, then one might expect a person to remember more details across repeated tests but the order or sequence of those details may become less accurate. This implies that repeated interrogation may not be the most effective way of obtaining additional information about witnessed crimes; the benefit of remembering more details may be balanced by the loss of order accuracy. Additional research should be dedicated to investigating the effects of repeated testing on serial recall for video of real events and further for the observation of live events.

In summary, the current experiment replicated past findings (e.g., Payne, 1987) and provided new data that will significantly influence our understanding of serial recall and repeated testing. These new findings will need to be taken into account when revising the current theories of hypermnesia (e.g., Payne et al., 1993; Roediger & Payne, 1982) or when developing a new comprehensive theory of reminiscence and hypermnesia. In regards to future research, it is imperative that more ecologically valid stimuli and procedures be used to investigate the effects of repeated testing on serial recall. In doing so, data can be collected and analyzed that more closely resembles real-world situations, thus leading to more reliable and influential findings.

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