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Experimental manipulations of the phenomenology of memory

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We investigated the effects of visual input at encoding and retrieval on the phenomenology of memory. In Experiment 1, participants took part in events with and without wearing blindfolds, and later were shown a video of the events. Blindfolding, as well as later viewing of the video, both tended to decrease recollection. In Experiment 2, participants were played videos, with and without the visual component, of events involving other people. Events listened to without visual input were recalled with less recollection; later adding of the visual component increased recollection. In Experiment 3, participants were provided with progressively more information about events that they had experienced, either in the form of photographs that they had taken of the events or narrative descriptions of those photographs. In comparison with manipulations at encoding, the addition of more visual or narrative cues at recall had similar but smaller effects on recollection.

In recent years, there has been a resurgence of interest in the phenomenology of memory. This can be seen in investigations about whether a memory is believed or not (Johnson, Hashtroudi, & Lindsay, 1993; Johnson & Raye, 1981) or about whether it is remembered or just known (Gardiner & Java, 1990, 1993; Rajaram & Roediger, 1997), as well as in attempts to divide memory up into its natural kinds (Baddeley, 1992; Brewer, 1996; Rubin, 1998; Tulving, 1983, 1985; Wheeler, Stuss, & Tulving, 1997). A common finding of these efforts is that visual imagery is either an essential (Brewer, 1996; Rubin, 1998) or an important (Johnson et al., 1993; Johnson & Raye, 1981) part of autobiographical memory. That is, many studies from different traditions point to visual imagery as being central to the sense that a memory is relived as opposed to just told, remembered as opposed to just known, and of a real event as opposed to of an imagined event. In the extreme, a loss of visual memory, caused by neurological damage to the visual system, can lead to severe amnesia that extends beyond vision to all episodic memories from before the damage (Greenberg & Rubin, in press; Rubin & Greenberg, 1998). However, blindness that leaves past visual memory intact does not have such severe effects on autobiographical memory (Ogden & Barker, 2001). Our aim was to manipulate visual input at encoding (Experiments 1 and 2) and retrieval (Experiment 3) in order to determine whether results expected from these views would occur.

A set of rating scales for measuring different aspects of retrieval was adapted from our earlier work (Rubin, Feldman, & Beckham, in press; Rubin, Groth, & Goldsmith, 1984; Sheen, Kemp, & Rubin, 2001; Talarico & Rubin, 2003). Most of the rating scales of our Autobiographical Memory Questionnaire cover the same basic domains as do the 39 items of the Memory Characteristics Questionnaire developed to understand source monitoring (Johnson, Foley, Suengas, & Raye, 1988). However, our Autobiographical Memory Questionnaire is much shorter, allowing us to obtain data on many memories from each participant in a single session, and it includes rating scales that measure recollection. The three 7-point rating scales used to measure recollection at the time of recall are the following: (1) I am reliving the original event, (2) I travel back to the time when it happened, I am a subject in it again, rather than an outside observer tied to the present, and (3) I can actually remember the event rather than just knowing that it happened. The first scale is a direct measure of the concept of reliving. The second scale was taken from work by Tulving and his colleagues (e.g., Wheeler et al., 1997). The third is taken from Tulving (1985). It has been used in laboratory recognition tasks (e.g., Gardiner & Java, 1990, 1993; Rajaram & Roediger, 1997), including those manipulating reference to the self (Conway & Dewhurst, 1995), as well as in autobiographical memory experiments (Hyman, Gilstrap, Decker, & Wilkinson, 1998; Rybash & Monaghan, 1999). In addition to investigating the sense of reliving, we also queried participants about their belief in their own memories, since this too is a basic and

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important feature of autobiographical memories (Brewer, 1996; Johnson & Raye, 1981).

Several component processes are involved in having and reporting an autobiographical memory (Greenberg & Rubin, in press; Rubin, 1995b, 1998; Rubin & Greenberg, 1998). The most important of these in the psychological and philosophical literatures is visual imagery (for reviews, see Brewer, 1996; Rubin, 1998; and Greenberg & Rubin, in press). In fact, many philosophers treat visual imagery as a defining feature of personal memory (e.g., Hume, 1739/1978; Locke, 1690/1959; see Brewer, 1996, for a review). Visual imagery can be divided on behavioral and neural grounds into two systems: object or descriptive imagery and spatial imagery (Farah, Hammond, Levine, & Calvanio, 1988; Rubin, 1995a). By using a rating scale that asks whether the event could be seen in the mind, we measured visual imagery with an emphasis on its descriptive component. By asking whether the setting or layout could be recalled, we measured visual imagery with an emphasis on the spatial component. We also examined visual perspective by having participants indicate whether they recalled the event from a field (i.e., out of their own eyes) or an observer's perspective (Nigro & Neisser, 1983).

We asked whether the memory could be heard in the mind because of interest in auditory imagery (Reisberg, 1992), because of the role of auditory imagery in language, and to separate visual imagery from imagery in other modalities. Autobiographical memories often contain reports of language, and language is the most common way to communicate autobiographical memories. Hence we used two rating scales about language that included an auditory imagery component: whether people were talking in the memory, and whether the memory came in words. Because of the important role that narrative plays in autobiographical memory (see Rubin, 1995b, 1998, for reviews), and because narrative can be viewed as independent of language (Rubin & Greenberg, 2003), we included one rating scale about the narrative coherence of the memory itself and another about whether the memory could fit into one's life story. Although many aspects of emotion could be queried, our interest in reliving led us to formulate a scale that measured whether the emotions of the original event were reinstated. Finally, we asked about the number of times the participant had previously thought about the memory.

In summary, we attempted an experimental test of the hypothesis that visual imagery has a major effect on recollection and belief by varying visual input at encoding (Experiments 1 and 2) and at retrieval (Experiment 3). In this way, we attempted to facilitate, or disrupt, the participants' having a clearer and more accurate visual image of the event being recalled. This was an initial, somewhat exploratory, attempt. We tried three different manipulations instead of more fully exploring one, in order to increase the generalizability of our findings and to ensure that our results would not be limited by details of our procedures. To allow a comparison among our manipulations, we used a similar set of ratings scales and data analyses across all three experiments.

EXPERIMENT 1

Method

Participants. Eight undergraduates participated in this experiment: 5 males from 18 to 30 years old (M = 22.2 years), and 3 females from 18 to 27 years old (M = 24.0 years). The participants were paid for their time.

Events. Two *events* were scripted for the experiment: *planning a holiday* and *discussion of ideals*. Each event had 8 distinguishable parts, which allowed us to obtain multiple sets of ratings on each event and increase the reliability of our measures. A researcher acted as a discussion leader for each event, ensuring that all parts were played out during the event, and that each part was devoted approximately equal time. Each participant was instructed to let the conversation run for 5 min on an event topic before inserting their line (see below) and thus changing the focus of the group.

For the *planning a holiday* event, the group was told that the objective was to plan a 5-day camping holiday anywhere in New Zealand. They were asked to work as if they were actually going to have the holiday, making lists and rosters as necessary. Each topic of the holiday event formed a phrase for each participant to insert into the group's discussion at the appropriate point. The phrases were the following:

> We need to decide when we are going to go. Let's look at the maps (maps were provided) and work out where to go. Can we bring along a friend—What does everyone think? We need to decide which cars we will take and the route to follow. What camping gear does everyone have—We need a list of what to take. We should put together a shopping list and a cooking roster. What shall we do while there—Is there anywhere nearby worth visiting? I would like to come home a different way—Is there an interesting alternative?

For the *ideals* event each participant was given a question that was addressed to another group member:

> David tell us about your ideal girl friend. Lucy tell us about your ideal husband. Justin tell us about your ideal child. Jason tell us about your ideal flatmate. Meghan tell us about your ideal mother in law. Linda tell us about your ideal parent. Mark tell us about your ideal landlord. Shanon tell us about your ideal holiday.

At the beginning of the event, the discussion leader informed the group that the objective was to have a discussion that would have self-reference for each individual.

> We all have ideals (e.g., an ideal partner). Each person has an ideal in the form of a question to another member of the group. Anyone can ask a follow-up question to anyone else if they wish.

Blindfold conditions. Three rooms were used for this experiment. All participants assembled in Room A and were given their phrase to memorize regarding the planning-a-holiday event. Once all were satisfied that they could remember their lines in such a way that the key meaning would be conveyed, half the participants were blindfolded. The sighted participants then led the blindfolded participants down the corridor to Room B where the planning-a-holiday event discussion took place. At the end of the discussion, the blindfolded participants were led back to Room A, where their blindfolds were removed. The participants then memorized their questions for the ideals event. The sighted participants from the planning-a-holiday event now put on their blindfolds, and they were led by the others to Room C, where the ideals event was conducted. Thus, while not blindfolded the participants saw each other, but they did not see the room in which they wore a blindfold. All the rooms were very different in size, shape, normal function, and location in the building, and all were novel to the participants.

Video taping. Both events were videotaped. A professional camera operator filmed each event, beginning as soon as the blindfolds were in place, following the participants as they moved to each event room (i.e., Rooms B and C), during the event, and finally during the journey back to the preparation room (Room A). Sound was recorded

using radio and fixed microphones. The participants viewed the unedited videotapes at the end of Session 2 of the experiment.

Questionnaire. Two questionnaires were prepared: an event rating booklet and a multiple-choice memory test. The event rating booklet had 16 sections, 1 for each part of the two experimental events. Each section asked for 14 ratings. The order of sections was randomized across participants. Each section began with the exact line or question stated during the experimental events and asked the participant to "think about that segment before answering the questions." The participants were informed that there were no correct answers, and that we were just trying to document the kind of memories that people have. A general description of each rating scale was given, and an example of "actually remembering" versus "just knowing" was given in order to clarify the remember/know distinction.

The first seven items were on a scale from 1 = *not at all* to 7 = *as clearly as if it were happening right now*. They were as follows:

1. As I remember the event, I feel as though I am *reliving* the original event.

2. As I remember the event, I can *hear* it in my mind.

3. As I remember the event, I can *see* it in my mind.

4. As I remember the event, I or other people are *talking*.

5. As I remember the event, I know its *spatial layout*.

6. As I remember the event, I can feel now the *emotions* that I felt then.

7. As I remember the event, I can recall the *setting* where it occurred.

Items 8–11 were on a scale from 1 = *not at all* to 7 = *as much as any memory*. They were as follows:

8. Sometimes people know something happened to them without being able to actually *remember* it. As I think about the event, I can actually remember it rather than just knowing that it happened.

9. As I remember the event, it comes to me *in words*.

10. As I remember the event, I feel that I travel *back to the time when it happened*, that I am a subject in it again, rather than an outside observer tied to the present.

11. As I remember the event, it comes to me in words or in pictures *as a coherent story* or episode and not as an isolated fact, observation, or scene.

Item 12 used a 3-point scale: 1 = *own eyes*, 2 = *observer*, and 3 = *can't tell*. It asked,

As I remember the event, I imagine it again through my own eyes seeing what I would have seen then, or as an observer from a different perspective than the one I had.

Item 13 was on a scale from 1 = *100% imaginary* to 7 = *100% real*:

I believe the event in my memory *really occurred* in the way I remember it and that I have not imagined or fabricated anything that did not occur.

Item 14 was on a scale from 1 = *not at all* to 7 = *as often as any event in my life*:

Since it happened, I have *thought* or *talked about* this event.

The italicized words were underlined and set in bold in the booklet to ensure that the high end of the scale would be noted.

Objective memory questions about what occurred during each event were included to ensure that the participants were paying attention when they were blindfolded and could understand the gist of what was occurring. The questions measured the encoding and retention of information that was available auditorily and provided for an assessment of whether the blindfold manipulation was too severe to allow for interpretation of the phenomenological data. The memory test consisted of 70 multiple-choice questions: 35 for each event (holiday, ideals). Two research assistants generated the questions from the videotapes such that each participant's statements contributed an approximately equal number of questions, questions were taken from all the segments of each event, and questions could not be answered from general knowledge. Examples of the questions include the following: "What was suggested as something different for the last night away? What did the group suggest when one person preferred Waitomo to Paihia? The speaker said their ideal landlord was their?"

Procedure. The experiment involved three sessions. In Session 1, the events took place but no data were collected. The participants arrived at the laboratory and were instructed that they would participate in two events, that they would each have a phrase/question to contribute, and that the group leader would facilitate the discussion. They were also informed that for one of the events they would be blindfolded, and that the entire activity would be videotaped. The participants were asked not to talk about the events with others—or between themselves.

Ten days after Session 1, during which time the multiple-choice memory test was prepared, the participants returned to the laboratory for Session 2. In Session 2, they completed the event rating questionnaire and then the multiple-choice memory test. The participants were then shown the videotape of the experimental events. The participants returned to the laboratory for Session 3 after 7 more days, a time chosen to be similar to the time between Sessions 1 and 2, and completed the event rating questionnaire again.

Results and Discussion

The experiment had a 2 (group) × 2 (event) × 2 (Session 2 vs. Session 3) design. All data were analyzed using this design first, but since there were no effects of event, we collapsed the design into a 2 (blindfold on or off) × 2 (Session 2 vs. Session 3) form, which is easier to report. All of the scales except for field/ observer were 7-point rating scales. To make the binary field/observer scale easier to interpret, we coded observer as 0.0 and field as 1.0. Thus the means for field/observer shown in Table 1 can be seen as the proportion of participants who reported seeing the memory as if they were seeing it again out of their own eyes.

There was no difference in the performance of the participants on the 70 objective memory questions for the event in which they had the blindfold on versus off, with an average of 22.13 items correct in each condition [blindfold on, $SD = 1.73$, range of 19–25; blindfold off, $SD = 3.56$, range of 17–27; $F(1,7) = 0.00$]. Thus, blindfolded participants understood and retained the gist of what was occurring.

Table 1 presents the means and standard errors for all the phenomenological measures, along with the analyses of variance (ANOVAs). To be consistent with the ANOVAs, the standard errors were calculated on the mean score of each participant in each condition. Because separate theoretical issues were raised by the ratings of Session 2 and Session 3, we analyzed each session separately, and then as one combined design. For Session 2, and for the experiment as a whole, there was the expected effect of the blindfold manipulation on the visual and spatial ratings (seeing, setting, and layout); participants reported lower values on the seeing, setting, and layout variables when they had blindfolds on. This finding, in conjunction with the equal

Table 1
Means (With Standard Errors) and ANOVAs for Self-Report Measures for Experiment 1

	Session 2; Visual Input in Session 1					Session 3; Visual Input in Session 1					ANOVA for Both Sessions $F(1,7)$		
	Yes		No			Yes		No			Effect		
Variable	*M*	*SE*	*M*	*SE*	$F(1,7)$	*M*	*SE*	*M*	*SE*	$F(1,7)$	Input	Session	Interaction
Reliving	4.47	.46	4.23	.36	1.91	4.13	.41	3.41	.27	10.09*	6.46*	5.14	12.21*
Back in time	3.85	.64	3.48	.66	3.69	3.28	.53	2.48	.31	9.49*	12.07*	3.08	1.94
Remember/know	5.45	.37	4.34	.33	35.32***	4.78	.43	4.23	.48	6.45*	25.91**	0.74	5.73*
Real/imagine	5.41	.40	5.20	.53	1.08	4.94	.47	4.63	.57	2.97	1.91	1.09	2.11
See	5.08	.32	2.97	.53	11.55*	4.56	.31	3.78	.53	3.83	8.96*	0.37	11.25*
Setting	5.14	.24	2.25	.46	69.71***	5.00	.28	3.88	.47	13.73**	50.13***	6.93*	13.61*
Layout	5.58	.37	1.55	.19	27.71**	5.31	.32	3.34	.57	13.50**	34.18***	7.16*	9.78*
Field/obs.	.80	.11	.65	.17	1.24	.86	.09	.39	.16	5.94	3.13	0.52	1.70
Hear	4.41	.36	4.31	.33	0.07	4.33	.35	3.98	.42	4.63	0.87	0.31	0.67
Talk	4.91	.31	4.55	.37	0.54	4.58	.30	4.16	.41	2.82	1.25	2.32	0.03
In words	3.84	.32	4.02	.39	0.21	3.86	.34	3.64	.34	1.57	0.01	0.79	1.16
Story	3.88	.46	3.27	.36	9.46*	3.03	.26	2.89	.31	.44	8.36*	4.90	2.17
Emotions	3.78	.41	3.54	.40	1.58	3.30	.27	3.06	.24	1.42	1.66	2.60	0.00
Rehearse	2.04	.28	1.91	.22	0.82	1.84	.27	1.98	.27	.97	0.00	0.42	3.89

$p < .05$. $^{**}p < .01$. $^{***}p < .001$.

performance on the objective memory questions, allowed us to look at the questions of more theoretical interest.

For Session 2, although the reliving, back in time, remember, and real/imagine mean ratings all were in the expected direction (lower when visual input was masked), only the remember/know rating showed a significant difference. With the exception of the story rating (which showed a significant difference) and the emotion ratings (which did not) all the remaining *F*s were less than 1. Thus, the only significant differences that resulted from being blindfolded, other than the drop in reports of visual and spatial experiences, were found in the remember/know and story ratings.

At the end of Session 2, the participants viewed the video of both events. There were two possible outcomes of this viewing of the event that took place when the participants were initially blindfolded. The first possible outcome was that the participants would integrate the new information, increasing the ratings of their phenomenological reports. The second possible outcome was that the differences between what was recorded by the video camera and what was initially imagined when wearing a blindfold would cause a decrease in the phenomenological ratings. Thus, the participants might react as people often do after reading a novel and developing a good image of the main occurrences and then seeing a movie version that did not at all fit their image. For the visual and spatial ratings of seeing, setting, and layout, the former was the case; there were increased ratings of visual experience (but not to a level consistent with those of participants who viewed the events when they occurred). In contrast, for the reliving variable, the latter was the case, as can be seen from the interactions in Table 1. A nonsignificant interaction in the same direction as the reliving variable is shown for the back-in-time variable, where there was a significant effect of blindfold on Session 3 but not Session 2. The ratings of reliving and back in time decreased more for the event in which the participants were initially blindfolded. In contrast, the difference in remember/know decreased, and the real/imagine variable had small, nonsignificant differences with our manipulations.

EXPERIMENT 2

The basic strategy of Experiment 2 mimicked that of Experiment 1, except that a video presentation was substituted for an actual experienced event. In Larsen's (1988) terms, Experiment 1 tested *experienced events*, whereas Experiment 2 tested *reported events*. That is, the events of Experiment 2 were "acquired in the rather arbitrary and indistinctive context of an autobiographical message-reception event, and relatively isolated from other pieces of information possessed by the individual" (Larsen, 1988, p. 351). Thus, although we asked our participants to be as involved as possible when they viewed the videos in Experiment 2, they were aware that they were observers of a fixed past event in which they could not take an active role. Because we thought that the reported events of Experiment 2 would not be retained as well as the experienced events of Experiment 1, we made the period between viewing the video and responding to the questionnaire much shorter. In Session 1, participants were presented with the filmed events, half with and half without the visual portion, and in Session 2, participants were shown the entire video with both its visual and auditory components. The change in procedure from Experiment 1 caused four basic changes. First, the time between viewing and rating events was shorter. Second, the participants were not also the actors; that is, the events being remembered were not truly autobiographical. Nonetheless, a video manipulation similar to the one that we used in Experiment 1 did enable source monitoring of even simpler events, such as shuffling cards or crumpling paper (Henkel, Franklin, & Johnson, 2000). Third, the participants received much less spatial information. The participants in Experiment 2 were not surrounded by an environment from which they received

spatial information, or which had to be understood to at least a moderate degree if they were to function. Because the sound was presented monaurally, the auditory spatial information was diminished. Fourth, the second showing of the video was identical to the first; no information changed as it did in Experiment 1 when participants saw a scene first from their own (sometimes blindfolded) eyes and then second from the perspective of the "neutral" observer who held the video camera.

Method

Participants. Twenty-two students participated in Experiment 2: 5 males with a mean age of 33.6 years (range, 19–60 years), and 17 females with a mean age of 28.6 years (range, 18–58 years). They were paid for their time.

Experimental video. A group of 9 students were paid over the 1998/99 summer to allow their activities to be filmed. A total of 60 events were filmed. The students were simply given an envelope at the beginning of each day with an activity description and sufficient funds. The students then took over and performed the event as they wanted. A camera-person provided transport and filmed each event. Six events, involving 5 of the student actors, were used in this experiment (the total corpus of events was used in other autobiographical memory research): playing Trivial Pursuit at the apartment, baking cookies, looking for a car to buy, going to Willow Bank Wild Life Park, wine tasting at Rose Bank Winery, and, in the evening, going to the horse races at Addington. We chose these 6 events because they were different from each other, each was approximately the same length, and they involved the same actors over a single day. The event video was preceded by a short segment in which the actors introduced themselves and spoke about what they had done the day before. The duration of the video, including the introduction segment, was 40 min.

Design. Two groups of 11 participants were formed. Group 1 was shown both sound and picture for Video Events 1, 3, and 5, and only sound for Events 2, 4, and 6. In contrast, Group 2 was given only sound for Events 1, 3, and 5, and shown picture and sound for Events 2, 4, and 6. Both groups saw or heard the video in the same theater and saw the initial segment, in which the student actors introduced themselves, with both picture and sound.

Questionnaire. A questionnaire with two sections was prepared. Section 1 asked three questions: (1) How well did you manage to imagine you were taking part in the event? (1 = *not at all* to 7 = *it was just like being there*). (2) Have you been to the location where the event occurred, and if so how frequently? (1 = *never* to 7 = *very frequently*). (3) Did you recognize anyone in the video, and if yes how well do you know them? (1 = *just seen them around* to 7 = *good friend*). The first two questions were answered in relation to each of the six video events.

Section 2 contained the event rating scales, which included the 14 scales used in Experiment 1 (worded identically and with the same response scales), as well as 3 more scales. These new scales, which were rated on a 7-point scale from 1 = *not at all* to 7 = *as much as any memory*, were (1) My memory of the event is *fragmented* into specific details with missing bits. (2) My memory of the event is only as detailed as the *general* knowledge of this type of event that I would expect most people to have. (3) My memory of the event has a *personal* coherence that fits easily into a story I would tell about that part of my life. The 17 event rating scales were repeated six times, once for each of the six video events. Each of these sections was headed with an instruction indicating the video event (e.g., "Please think about the *baking cookies* event and answer the questions below in relation to your memory for that event.").

Procedure. The experiment had two sessions. During Session 1, participants were shown the video events. The participants were told that they would be shown a short video about the day in the life of five students. They were told that for half of the videos the picture would be turned off and only the sound played. They were instructed that they should imagine taking part in the events: "Think about what you would be doing if you were actually there. How would you contribute to the conversation? How would you feel about what was happening? What would you actually do?" Immediately after the video screening, the research questionnaire was completed. Each scale in the questionnaire was explained to the participants. They were asked to carefully read the event description at the top of the page and think about that segment of the video before completing the ratings.

The participants returned to the laboratory 1 week later for Session 2. The entire video, except for the introduction segment, was shown with picture and sound for all events. Immediately following this, the participants once again completed the research questionnaire and answered the question: "During the past week have you been to any of the locations shown in the video?"

Results and Discussion

Before examining the results of the rating scales on the properties of memories, we examined Section 1 of the questionnaire, which was about the participant's knowledge of and reaction to the manipulation. The actors were not well known to the participants. Over the course of the experiment, 4 participants indicated they recognized a video actor, 3 rated their knowledge as 1 and the other as 2, where 1 was *just seen them around* and 7 was *good friend.* In contrast, on the average, people had visited 1.7 of the 6 event locations. For the question "How well did you manage to imagine you were taking part in the event?" the data from Session 1 for events viewed with and without picture were compared. The average "manage to imagine" rating was calculated for each participant for the three events "experienced" with picture and audio (mean of means = 4.77, $SD = 1.10$), and for the three events "experienced" with audio only (mean of means = 3.43, $SD = 1.00$) [$F(2,20) = 189.72$, $p < .0001$]. Clearly the participants found it much easier to imagine that they were taking part in the events when they could "see" the event.

Following the analyses done in Experiment 1, all data (from Section 2 of the questionnaire) were submitted to a visual input 2 (video picture on or off) × 2 (session) ANOVA. Table 2 presents the means and standard errors for all the phenomenological report measures along with ANOVA analyses. For Session 1, and for the experiment as a whole, there was the expected effect of the visual input manipulation on the visual and spatial ratings: Participants reported lower values on the seeing, setting, and layout variables, and they had fewer memories judged as seen out of their own eyes, when only the sound portion of the video was played. The effects on the visual and spatial rating scales for Session 1 had the largest effect sizes of the experiment and the field/observer differences were consistent with those that approached significance in Experiment 1. This manipulation check allowed us to look at the questions of more theoretical interest. For Session 1 of this experiment, which had more participants and thus more power than Experiment 1, the reliving, back-in-time, remember/know, and real/imagine variables all showed large and significant differences in the expected direction.

As in Experiment 1, the story variable showed a significant difference that was as large as the four variables just mentioned.

As with Experiment 1, there were two possible outcomes for Session 2 for the video segments that were only heard in Session 1. The first was that the difference in phenomenological reports would decrease. The second was that any differences would be increased because of the differences between what was shown by the video and what was initially imagined. For the seeing, setting, and layout variables, the former was the case, both here and in Experiment 1; adding visual information increased ratings of visual experience. Presenting visual information in Session 2 increased ratings of reliving, back in time, remember/know, and real/imagine. This was in contrast to Experiment 1, where the trend was in the opposite direction with a significant interaction for the reliving variable.

Experiment 2 had more variables with significant main effects of visual input than did Experiment 1. One was the personal coherence variable, which was not present in Experiment 1. Conceptually similar to the story variable, personal coherence showed similar effects. For the variables present in both experiments, part of the increase in the number of significant effects of visual input could have been due to the greater number of participants in Experiment 2, which increased the statistical power. In particular, the overall magnitude of the difference in field/observer was not larger in Experiment 2 but was significant only in Experiment 2. With more visual input, participants were more likely to remember events as if seen out of their own eyes. Here, field/observer was measured as a dichotomous variable. In other work investigating more emotional situations, we have used a rating scale varying from field to observer, which appears to be more sensitive (Berntsen, Willert, & Rubin, 2003; Talarico & Rubin, 2003).

Another possible reason for the increase in the number of significant effects in Experiment 2 was that the magnitude of the effects (i.e., effect size) could have been greater. With the blindfolds on in Experiment 1, there was information from senses other than audition and there was considerable spatial information that was not available in the monaural sound presentation of Experiment 2. Thus, when only the auditory portion of the video was presented in Experiment 2, the situation was more impoverished than the blindfold condition of Experiment 1. This could have resulted in visual input's having more of an effect in Experiment 2. For both the talk and the emotion variables, the magnitude of effect of visual input was greater in Experiment 2. The effect of visual input on the talk variable did not extend to the hear variable and thus was not present for all auditory imagery. Thus, the effect on the talk variable might have been caused by the participants' having difficulty in assigning voices to actors when only the audio was presented.

EXPERIMENT 3

In Experiment 3, we manipulated the amount of visual information available at retrieval, as opposed to encoding. Participants took digital photographs of significant personal events over nearly 1 year. Thus, unlike in the earlier two experiments, all the events were experienced visually at encoding. Unlike in more laboratory-based studies using photographic cues (e.g., Schacter, Koutstaal, Johnson, Gross, & Angell, 1997), the photographs were of important personal events. A year after the photographs were taken, we incrementally increased the number of photographs (or narrative descriptions of the photographs) used to cue the autobiographical memories, in order to see whether the increase in sensory information would change the phenomenological properties of the recall. Thus, in Experiments

Table 2
Means (With Standard Errors) and ANOVAs for Self-Report Measures for Experiment 2

	Session 1; Visual Input in Session 1					Session 2; Visual Input in Session 1					ANOVA for Both Sessions $F(1,21)$		
	Yes		No			Yes		No			Effect		
Variable	*M*	*SE*	*M*	*SE*	$F(1,21)$	*M*	*SE*	*M*	*SE*	$F(1,21)$	Input	Session	Interaction
Reliving	4.74	.34	2.70	.23	53.30***	4.86	.39	4.20	.34	7.22*	31.32***	32.47***	48.03***
Back in time	4.56	.36	2.71	.33	24.43***	4.67	.35	3.86	.40	8.19**	21.57***	8.00*	9.82**
Remember/know	5.50	.30	3.61	.34	30.46***	5.32	.35	4.61	.37	6.26*	22.31***	4.11	14.84***
Real/imagine	5.60	.37	4.30	.40	24.42***	5.62	.39	5.09	.43	3.99	15.57***	5.11*	5.04*
See	5.73	.26	2.68	.24	110.63***	5.58	.31	5.08	.27	3.75	59.86***	37.72***	71.07***
Setting	5.70	.25	2.85	.36	75.06***	5.64	.27	4.98	.32	5.32*	48.66***	32.92***	37.88***
Layout	5.36	.23	2.02	.19	198.43***	5.41	.30	4.79	.34	4.45*	81.72***	44.78***	79.45***
Field/obs.	0.68	.09	0.49	.09	5.22*	0.77	.09	0.61	.09	5.39*	8.16*	6.69*	0.21
Hear	4.35	.36	4.09	.26	0.56	4.82	.33	4.41	.26	1.96	1.62	4.60*	0.17
Talk	5.02	.34	4.11	.27	10.28**	5.14	.30	4.59	.30	4.77*	10.26**	3.16	1.67
In words	3.97	.37	3.88	.35	0.09	4.14	.33	3.79	.33	3.14	0.97	0.05	0.99
Story	4.65	.27	3.11	.26	28.45***	4.86	.29	4.15	.25	5.16*	19.06***	10.09**	7.16*
Personal	4.77	.29	3.33	.32	13.38**	4.64	.36	3.89	.29	5.33*	11.21**	1.07	5.18*
Emotions	4.59	.33	3.20	.26	14.50***	4.47	.36	3.89	.33	3.25	10.31**	1.94	7.92*
Fragmented	4.35	.29	4.46	.31	0.08	3.55	.38	3.55	.34	0.00	0.04	10.70**	0.08
General	3.70	.39	4.33	.33	2.35	3.89	.44	3.62	.32	0.71	0.30	2.71	7.04*

*$p < .05$. **$p < .01$. ***$p < .001$.

1 and 2, the visual aspects of half of the events were withheld at the initial encoding, whereas in Experiment 3, no visual aspects were withheld at encoding; rather, visual aspects of the events were actually accentuated at encoding via the photographic procedure.

Method

Participants. Nine volunteers, 2 males aged 23 and 33 and 7 females ranging in age from 24 to 59 (mean age, 30.5 years), participated in Experiment 3. They were reimbursed with a cash payment of $10. Each participant had participated in Experiment 3 of Burt, Kemp, Conway, and Grady (2003), and the photographs that they provided for that experiment were used in this experiment.

Photograph archive. Each participant used a Kodak DC50 digital camera over a 10-month period to take photographs of his/her own personal events. The time and date of each photograph was recorded by the camera. The participants visited the laboratory whenever their cameras were full, and the photographs were downloaded into their photograph archives. The participants were instructed that their photographs should be of "significant personal events" such as parties, picnics, weekend trips, or sporting events, and that they should take the photographs themselves. A total of 2,737 photographs were collected; the mean was 304 per participant (range, 209–442).

Each participant's photograph archive was examined for events that had at least five photographs (e.g., five photographs of a picnic) for use as test stimuli. Such events were easily identified by the experimenters on the basis of the content, as well as the time and date stamp of the photographs. This produced a total of 160 event sets, each of which contained five photographs (mean = 17.8 event sets per participant, range = 10 to 29). The retention interval, which was calculated from the date when the photographs were taken until the trial date in this experiment, had a mean of 450 days, and ranged from a minimum of 340 days to a maximum of 620 days. In the Burt et al. (2003) study, the participants' ability to order the photographs in each of their sets was examined. Thus all the participants had seen their photographs at least once in an experimental setting that occurred an average of 376 days before the present Experiment 3. In addition, at the end of the Burt et al. study, participants were given a CD containing their entire set of photographs for taking part in the study. The photographs used in the present study, as either pictures or descriptions, were not identified on that CD, and they represented about 16% of the entire corpus.

Ten event sets from each participant were used for this experiment. For five event sets, each photograph in the set was printed on a color Laser printer and measured 135 × 90 mm. For the other five event sets, a 35- to 45-word narrative description was generated for each photograph on the basis of its observable content by an independent judge who did not know the purpose of the experiment. For example, one picture was described thus: "A group of young women and a camera man are standing behind a camera pointed at a woman who is standing in front of them at the edge of a rock-covered hilltop. The woman has wings attached to her back." Selection of an event set as either a photograph or narrative trial was based on equating the retention interval of the two types of trial (the mean retention interval was 444 days for photographs and 455 days for narratives).

Questionnaire. The first 17 rating scales used were identical to those used in Experiment 2. The final item was new and listed three response alternatives (1 = *once*, 2 = *merging*, and 3 = *extended*). It asked, "To the best of your knowledge, is the memory of an event that occurred *once* at one particular time and place, a summary or *merging* of many similar or related events, or for events that occurred over a fairly continuous *extended* period of time lasting more than a day." This question is based on work by Williams (1996). It resulted in two dichotomous scales: whether the memory was for an event that occurred once within a single day (*once/many*), and if not, whether it was a summary or merging of similar events, or whether it was for an event that extended for a period greater than one day (*merged/extended*).

Testing procedure. Trials were presented in blocks (either photographs or narratives). Half of the participants completed their photograph trials first; the other half completed their narrative trials first. The participants were told that they would be shown five sets of photographs that they had taken (with each set containing 5 photographs) and 5 sets of narratives (with each set containing five 35- to 45-word descriptions) generated from the photographs that they had taken. Thus, the participants saw 25 photographs and 25 descriptions of photographs out of an average of 304 photographs that each had taken.

On photograph trials, participants were given the photograph that occurred first in the event sequence and instructed to think about the event from which the scene came. They examined the photograph for 20 sec, at which time they were asked to complete an event rating questionnaire. They were then provided with the photograph that occurred next in the event sequence, examined it for 20 sec, and completed another event rating questionnaire. The remaining three photographs were then provided (now all five photographs from the set were in front of the participant, in their correct sequential order), and after a further 60 sec they again completed an event rating questionnaire. The procedure for narrative trials was identical except that one, two, or five narratives were examined (read), as opposed to photographs viewed.

Results and Discussion

Experiment 3 differed from Experiments 1 and 2 in that it manipulated the amount rather than the total presence or absence of visual information and did so at retrieval rather than at encoding. Overall, this had a much smaller effect. Table 3 presents the means (and standard errors) for all conditions along with the ANOVAs for all variables. The only significant effect of whether the memory was reinstated with pictures or with their verbal descriptions was that pictures produced memories that were more likely to be judged as being for single events rather than for the combination of several similar events. The pictures tended to narrow the event portrayed to a single instance. Increasing the amount of information by using more pictures (or descriptions of more pictures) had significant effects on 4 of the 20 variables: remember/know, see, setting, and story. These four variables also showed significant differences in both Experiments 1 and 2. Thus the increased information had effects on the visual and spatial variables as well as on remember/know and narrative coherence. Because the number of pictures (or descriptions of them) was increased, the effects should be greater for the visual and spatial measures. Because the pictures and descriptions were presented in sequential order, more of a narrative sequence of events was portrayed with more pictures. That is, because the first and the second pictures presented were the first and second pictures of the event and because all five pictures on the last trial were presented in the correct sequential order, the addition of pictures (or their description) also included information about the narrative sequence of event components. Thus, in general, the information added by the cues was appreciated by the participants and served to increase the ratings on scales that measured that information, but it did not spread to other properties of memory, except for remember/know.

Table 3
Means (With Standard Errors) and ANOVAs for Self-Report Measures for Experiment 3

	No. Pictures						No. Descriptions						ANOVAs		
	1		2		5		1		2		5		Effect		
Variable	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	Type *F*(1,8)	Number *F*(2,16)	Interaction *F*(2,16)
Reliving	3.93	.39	3.91	.58	4.27	.52	3.51	.50	3.80	.52	4.07	.63	0.29	2.26	0.46
Back in time	4.04	.44	3.91	.53	4.53	.60	3.76	.61	3.73	.58	4.00	.61	0.54	2.69	0.41
Remember/know	4.33	.47	4.07	.55	4.82	.41	4.53	.57	4.58	.52	4.91	.52	0.26	3.64*	0.63
Real/imagine	5.47	.42	5.16	.46	5.78	.33	5.49	.37	5.69	.25	5.62	.32	0.10	1.69	2.27
See	4.22	.35	4.20	.51	4.62	.39	4.13	.52	4.33	.47	4.80	.48	0.02	4.95*	0.60
Setting	5.29	.61	5.18	.59	5.67	.41	4.93	.45	5.47	.41	5.56	.35	0.01	4.09*	1.92
Layout	4.98	.50	4.91	.54	5.31	.47	4.40	.50	4.71	.41	5.00	.51	0.46	3.32	1.89
Field/obs.	0.88	.06	0.85	.09	0.90	.07	0.84	.09	0.90	.05	0.94	.04	0.09	1.42	1.10
Hear	2.82	.46	2.73	.61	3.13	.63	2.58	.44	3.00	.56	3.31	.58	0.30	2.64	2.49
Talk	2.71	.41	2.62	.46	3.09	.60	2.80	.40	2.71	.41	3.04	.52	0.03	2.16	0.18
In words	2.09	.56	1.93	.45	2.18	.56	1.80	.44	1.89	.34	2.16	.43	0.38	2.12	1.31
Story	3.84	.44	3.71	.46	4.58	.32	3.93	.60	3.73	.50	4.27	.50	0.20	5.01*	0.48
Personal	4.76	.53	4.64	.57	5.27	.41	4.78	.54	4.62	.50	4.62	.56	0.17	1.60	3.11
Emotions	3.16	.42	2.96	.41	3.36	.40	3.16	.52	3.09	.50	3.34	.62	0.01	1.78	0.14
Rehearse	2.51	.46	2.44	.53	2.71	.49	2.60	.43	2.58	.48	2.76	.59	0.09	3.00	0.12
Fragmented	4.64	.26	4.29	.39	4.89	.37	4.83	.45	5.20	.49	5.16	.53	1.22	1.29	2.77
General	3.60	.40	3.84	.38	4.22	.42	4.31	.46	4.20	.49	3.93	.48	0.39	0.13	3.28
Specific	0.49	.09	0.53	.09	0.44	.09	0.67	.08	0.64	.09	0.69	.11	9.48*	0.06	1.26
Merge/extend	0.42	.13	0.39	.16	0.45	.15	0.31	.16	0.36	.16	0.36	.18	0.17	0.46	0.45

*$p < .05$.

GENERAL DISCUSSION

In all three experiments, we varied the amount of visual input. In Experiment 1, events were experienced with and without visual input. In Experiment 2, videos were presented with and without visual input. In Experiment 3, the amount of visual input at retrieval was varied. Given the major differences in experimental procedures, the similarities in the results are noteworthy, though the differences in the results are harder to interpret. We begin, therefore, with the similarities. If we look at the main effect of visual input in Tables 1, 2, and 3, the results are strikingly similar. As a manipulation check, we expected that with less visual input there would be less visual imagery (our see variable) and less knowledge of setting (our setting and layout variables). This occurred in all three experiments, except that the effect on the layout variable was only marginal in Experiment 3. According to past results and theory, we expected that with less visual input, and with the resulting lower level of visual imagery, there would be lower values on our phenomenological measures of recollection and belief. The remember/know variable was lower in Experiments 1, 2, and 3, the reliving and back-in-time variables were lower in Experiments 1 and 2, and the real/imagine variable was lower in Experiment 2. An unanticipated result was that our story variable was affected by the degree of visual input in all three experiments. This is reasonable if the narrative coherence of the events recalled was increased by more visual and spatial input. These findings exhaust the significant differences caused by varying visual input that were common to all three experiments. They also exhaust all those that were present in Experiments 1 and 3.

The effects of varying visual input were smallest in Experiment 3 (which varied visual input at retrieval as opposed to encoding), moderate in Experiment 1, and largest in Experiment 2 (which had the most participants and therefore the most statistical power). All variables that had a significant main effect of visual input in Experiment 3 also had a significant main effect in Experiment 1, and all variables that had a significant main effect of visual input in Experiment 1 also had a significant main effect in Experiment 2. This pattern would be expected if varying the visual input had the same effects in all three experiments, but the experiments varied in their ability to detect differences, owing to differences of either power or effect size. Thus, varying visual input affected the same variables relating to visual and spatial imagery, recollection, belief, and narrative coherence in all three experiments. Further differentiation among the four measures of recollection and belief is difficult, given the differences in the experimental procedures of the three experiments.

Two major differences among the experiments should be noted. First, adding visual information in Session 2 of Experiment 1 decreased phenomenological ratings, whereas in Experiment 2 it increased them. Our best speculation is that in Experiment 1 a rich enough image was formed that it conflicted with the later video, whereas in Experiment 2 there was no strong conflicting image. We selected the three rooms of Experiment 1 so that they would be very different from each other, and none were standard classrooms. Thus, any image formed when a participant was blindfolded was almost certainly wrong. Moreover, given that Experiment 1 used real events in which the participants took an active role, there was more need to construct an image of the surroundings and nonverbal cues such as fa-

cial expressions. The second major difference is that the magnitude of changes was smaller for the visual input manipulation of Experiment 3. This may be because the manipulation occurred among 1, 2, and 5 pictures, whereas in Experiments 1 and 2, it occurred between no visual input and visual input. A more interesting alternative is that visual input at retrieval is less important than at encoding. Given the many differences in procedure among the experiments, such interpretations remain speculative until further work can be done.

As outlined in the introduction, autobiographical memories can be viewed as constructed at retrieval from component processes, with visual imagery being a central component in this integration (Greenberg & Rubin, in press; Rubin, 1995b, 1998; Rubin & Greenberg, 1998). Under this view, ratings of recollection and belief are not component processes but, rather, metacognitive judgments that follow the formation of a memory. This view is supported here by the change in recollection and belief caused by having, or not having, visual input at encoding in conjunction with the absence of many changes in the rating scales of component processes that did not directly measure visual or spatial imagery. Similarly, the effects of increased detail in the cue at retrieval should be small once the cues provide enough information to lead to the retrieval of a memory (Conway & Rubin, 1993; Damasio, 1989; Greenberg & Rubin, in press; Rubin & Greenberg, 1998).

The most detailed model of autobiographical memory retrieval is Conway and Pleydell-Pearce's (2000). If we ignore differences among the various sensory components and view our manipulations of visual input as manipulations of the amount of detailed information presented about each event, then our results are consistent with what would happen if event-specific knowledge were varied in the Conway and Pleydell-Pearce model. Because their model uses a search to construct memories and explicitly does not assume a fixed memory that needs to be retrieved, it is able to handle the differences we found between varying information in the memory itself in Experiments 1 and 2 and in the retrieval cues in Experiment 3. If enough information is given, a memory can be formed. Giving more will not change the basic memory constructed. This approximates what occurred in Experiment 3. The model can also explain the drop in recollection that occurred when the video was shown in Experiment 1 if we assume that two different and somewhat conflicting events could then be constructed so that the participants found each of their two constructions less convincing. In Experiment 2, there may not have been enough information when only the sound portion of video was presented to construct a memory detailed enough to conflict with the later showing of the video. Because the events that we used were from one life period and were neutral with respect to the participants' goals, most of the model's constructs cannot add to our understanding of the data at hand. Moreover, because in Experiment 2, in which the participants were not the actors, we asked the participants to try to imagine that they were involved, the role of the self in any explanation of differences is clouded.

Here we have been examining the role of visual input in the autobiographical memory of real events rather than the formation of false memories or errors in source monitoring. Nonetheless, our results are consistent with the source monitoring framework used to understand confusions among sources and how they produce errors in memory (Johnson et al., 1993; Johnson & Raye, 1981). In particular, with more visual input at encoding, the ratings of our phenomenological variables were higher, and when possible conflicting information arose from imagining and then later viewing an event in Experiment 1, the ratings of our phenomenological variables decreased.

Although our experimental methods were developed to examine the effects of visual input at retrieval and encoding, restriction of visual input at encoding and subsequent reinstatement of an event's visual character via video could potentially be used to study memory encoding and, in particular, false memories. The participants that experienced the experimental events blindfolded (Experiment 1), which was our closest approximation of an autobiographical event situation with restricted visual input, did not appear to use the later video input to elaborate the event memory that they had constructed while they were blindfolded. It was as if they wanted to maintain their imagined experience as the veridical representation of the experience. Of course, for the participants, what they imagined when blindfolded was the experience that they had—even if it later turned out to be inconsistent with the visual "facts."

Cognitive psychologists have a long tradition of manipulating experimental conditions, under highly controlled conditions, to study easily quantifiable measures such as amount recalled and reaction time. Here we extend this tradition of manipulation to more complex environments and measures. Because we used three very different experimental settings and manipulations, we cannot distinguish between alternative explanations as well as we would like. But the results of this exploratory work support both the importance of visual input in the recollection and belief of autobiographical memories and the efficacy of using experimental manipulation of real life events to study the phenomenology of memory.

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