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SenseCam Reminiscence and Action Recall in Memory-Unimpaired People

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Abstract

Case studies of memory-impaired individuals consistently show that reminiscing with SenseCam images enhances event recall. This exploratory study examined whether a similar benefit would occur for the consolidation of memories in memory-unimpaired people. We tested delayed recall for atypical actions observed on a lengthy walk. Participants used SenseCam, a diary, or no external memory aid while walking, followed by reminiscence with SenseCam images, diary entries, or no aid, either alone (self-reminiscence) or with the experimenter (social reminiscence). One week later, when tested without SenseCam images or diary entries, prior social reminiscence produced greater recall than self-reminiscence, but there were no differences between memory aid conditions for action free recall or action order recall. When methodological variables were controlled, there was no recall advantage for SenseCam reminiscence with memory-unimpaired participants. The case studies and present study differ in multiple ways, making direct comparisons problematic. SenseCam is a valuable aid to the memory impaired, but its mnemonic value for non-clinical populations remains to be determined.

Key Words: SenseCam Reminiscence, Memory for Actions, Memory Aids

SenseCam Reminiscence and Action Recall in Memory-Unimpaired People

Miniature automatic cameras offer the promise of effortlessly recording life experiences into e-memories for later reminiscence. Originally developed by Microsoft, SenseCam is a small, lightweight camera that is worn around the neck by a lanyard. It has a large memory and takes fish-eye, wide-angle pictures of the environment, either manually or automatically every 30 seconds, from the perspective of the wearer. At the end of the day, the camera images can be uploaded into a computer and used for reminiscence viewing. Research employing this camera has shown beneficial effects on recall for select individuals with organic memory impairments.

Berry et al. (2007), for example, used SenseCam in their study of a 63-year-old woman named Mrs. B who demonstrated mild to moderate retrograde amnesia and marked anterograde amnesia due to limbic encephalitis. Following her brain infection, she had difficulty remembering past experiences, including recent experiences shared with her husband. When Mrs. B's husband kept a written diary of shared events for nightly reminiscence with his wife, little change was observed in Mrs. B's recall. Later, Mrs. B wore a SenseCam for several weeks, and her husband uploaded the images into their computer. Together, they reminisced nightly about their shared experiences while viewing the SenseCam images. Mrs. B was able to recall approximately 80 percent of the recent images, and her episodic recall was maintained three months after viewing the pictures. Berry et al. added that Mrs. B was not simply recalling the images; she provided details of past events that were not captured in those pictures.

Similar memory enhancing effects with SenseCam have been observed with individuals suffering from anterograde amnesia - including a 47-year-old woman with herpes simplex viral encephalitis (Loveday & Conway, 2011), a 21-year-old man with acquired brain injury (Brindley, Bateman, & Gracey, 2011), a 13-year-old boy with a brain tumor (Pauly-Takas,

Moulin, & Estlin, 2011), and a 55-year-old woman with mild cognitive impairment (Browne et al., 2011). In each case, reminiscence with SenseCam images produced greater recall and a greater sense of well being than reminiscence with verbal diaries. Loveday and Conway (2011) stated that SenseCam images can cue a "Proustian moment" in which individuals experience intense recollections of past events, even accessing memories of formerly inaccessible events not captured in the SenseCam pictures, a finding also reported by others (Berry et al., 2007; Brindley et al., 2011; Browne et al., 2011).

Although these case studies show that SenseCam aids episodic recall, they were conducted under conditions where experimental controls were necessarily less stringent than those typically observed in laboratory testing. In Berry et al.'s (2007) study of Mrs. B, for example, her husband determined which activities to record in a daily diary, he wrote the diary entries after they occurred, he conducted the reminiscence sessions, and he graded his wife's memory performance. This study and other SenseCam case studies have typically included a small number of recorded events that were confounded with the type of reminiscence used for each event (e.g., one event had SenseCam reminiscence; a different event had diary reminiscence). These methodological caveats in no way diminish the importance of the SenseCam case studies for demonstrating the benefits of a new technology with memory-impaired individuals. In fact, the similarity of the findings from the case studies suggests that Mr. B, for one, performed in a highly effective fashion. Still, the limited control of potentially important methodological variables in these studies leaves open the issue of what specifically led to enhanced episodic recall following SenseCam reminiscence.

Additionally, only a few studies have explored the use of SenseCam with memory-unimpaired people to determine if it has wider application. St. Jacques, Conway, and Cabezza (2011) measured brain activation patterns from SenseCam images or verbal cues with fMRI,

Silva, Pinho, Macedo, and Moulin (2013) observed better performance on a neurological test battery for people who previously reviewed their SenseCam images of everyday events than their diary entries, and Finley, Brewer, and Benjamin (2011) found better recognition of SenseCam images and enhanced recall of their depicted activities for previously reviewed than not reviewed images. The present research extended these studies by testing whether SenseCam offered any mnemonic advantage for memory-unimpaired people in recalling previously seen actions in a natural setting.

Specifically, we examined how well memory-unimpaired participants recalled actions they previously saw performed one week earlier on a structured walk following reminiscence with SenseCam images, a written diary, or no external memory aid. Control of potentially important methodological variables was achieved in several ways. First, all participants observed the same sequence of actions performed in the same locations on a campus walk so that experiences were not confounded with type of reminiscence. Second, immediately after the walk, participants reminisced with either their SenseCam images taken during the walk, their diary entries written during the walk, or what they remembered from the walk on their own. All participants engaged in either social or self-reminiscence. Social reminiscence was designed to approximate the reminiscence discussions reported in the case studies between a memory-impaired person and spouse, whereas self-reminiscence had participants reminisce alone for the same length of time.

If a memory camera can aid memory-unimpaired people, the recall of previously observed actions should be better for participants who used SenseCam during reminiscence than those who used their diary or had no external memory aid. Additionally, social reminiscence should produce greater delayed recall than self-reminiscence based on studies of collaborative recall that show that accurate information from another person enhances memory

(e.g., Roediger, Meade, & Bergman, 2001; Wright, Self, & Justice, 2000) and studies of the testing effect (e.g., Roediger & Karpicke, 2006) where retesting enhances retention. In the present context, if immediate reminiscence after a walk constitutes a practice recall test, experimenter-based cueing with corrective feedback provides a relearning opportunity and should produce better recall than self-based cueing with no feedback.

Method

Participants. The participants were 144 Wesleyan University students, between 17 and 23 years of age, who received introductory psychology credit or served as paid volunteers. None had taken part in any related memory research.

Materials. The SenseCam memory camera used in this study was sold commercially as the Vicon Revue. The walk and accompanying actions were similar to those used by Seamon et al. (2006; 2009). We chose 43 distinct, physical locations involving five campus buildings in close proximity. All locations were indoors to permit testing in varied weather conditions (e.g., an elevator door in a hallway; a Pepsi machine in a snack area). Because SenseCam is deemed best suited for recording non-mundane events, we used an atypical action at each location (e.g., *Press the elevator button with one elbow*) to minimize pre-experimental associations between locations and actions (The action-location list is available from the first author). No location or action was used more than once.

Procedure. We employed a 3 x 2 design with Memory Aid during the walk and reminiscence period (SenseCam vs. Diary vs. No Aid) and Reminiscence Type after the walk (social vs. self-reminiscence) as between-participants variables. The participants were randomly assigned to one of six groups. Two groups used the memory camera, two groups wrote in a diary, and two groups had no external memory aid. After the walk, one group within each memory aid condition socially reminisced with the experimenter, whereas the other group

reminisced alone. The six groups were SenseCam/Social (n = 25), SenseCam/Self (n = 24), Diary/Social (n = 23), Diary/Self (n = 25), No Aid/Social (n = 24), and No Aid/Self (n = 27). Because our research was novel and different from the case studies in participants and procedures, no estimate of effect size was possible. The sizes of our six groups are typical of memory research, and pooling over the two reminiscence conditions yielded 49, 48, and 51 participants for the three memory aid conditions, group sizes that should provide an adequate test of any meaningful memory aid effect.

The individually tested participants were told that this two-session experiment involved memory for actions to be observed on a campus walk. They were informed that the walk would take approximately 1 hour, with stops at 43 locations where the experimenter would state an action and perform it. All participants were instructed to try to remember those actions for an unspecified, delayed memory test. They could talk with the experimenter during the walk, but they could not engage in any activities other than those that were part of the study.

Participants in the two SenseCam groups wore the camera and it took pictures automatically, approximately once every 30 seconds. At each location where an action was stated and performed, the experimenter maintained that action until the camera recorded it. Participants in the two diary groups wrote the name of the location and the action performed during each stop in a diary booklet that contained one page for each location-action pair. Similar to the memory camera, the diary ensured that all location-action pairs were recorded in their correct sequential order. Finally, participants in the two no aid groups observed the same locations and actions for the same length of time, approximately 20 - 30 seconds per stop, but they had to rely solely on their memory for retention.

Upon completing the walk, all participants received a 5-minute distraction task of finding Waldo characters in a *Finding Waldo* book. This task gave the experimenter sufficient time to upload the images from a SenseCam participant into the computer.

Following the distraction task, all participants engaged in social or self-reminiscence for 25 minutes. One group of participants from the SenseCam, Diary, and No Aid Conditions (Groups 1, 3, & 5) engaged in social reminiscence. For the SenseCam participants, the experimenter sequentially reviewed the images on the computer by skimming quickly through the irrelevant images, stopping and focusing on the action images, and asking the participant to recall each action as it was displayed. For the diary participants, the experimenter sequentially reviewed their diary entries, asking the participant to state each written action. For the no aid participants, the experimenter asked them to recall the actions from the walk in sequence. In each condition, the experimenter sat with the participant and engaged in an open, but structured conversation, helping to guide the participant's oral recall of the action sequence. Monitoring the participant's recall, the experimenter provided corrective feedback for missing actions, incorrect actions, or action sequencing errors. During the reminiscence period, all participants discussed and reviewed all actions at least twice at their own pace with the experimenter.

The other participants in the SenseCam, Diary, and No Aid Conditions (Groups 2, 4, & 6) engaged in self-reminiscence for the same length of time. Participants who used the camera were presented with their images on the computer and shown how to toggle through the images sequentially, participants who wrote in a diary were given their diaries and instructed to review their diary entries, and participants in the no aid condition were asked to remember the walk on their own over the interval. All participants were informed that the reminiscence period was important for long-term retention and that they should review the walk's locations and actions several times at their own rate. Observed from a distance, the participants complied with this

instruction. Following reminiscence, all participants were scheduled for a follow-up session one week later, plus or minus one day.

Two memory tests were given in the second session. The first test was a written free recall test of the 43 actions observed previously during the walk. The participants were given 12 minutes to recall as many actions as they could remember, without regard to order. Next, the participants were given a test of action order in which they were given 5 note cards, each with the name of a campus building used on the walk, and a shuffled deck of 43 cards, each containing a previously observed action. After sorting the actions by their campus buildings, the participants were asked to place them in their correct sequential order on a display board that was numbered from 1 to 43. They had 15 minutes to sort the actions by building and put them in their sequential order, guessing if they were unsure.

Results

We scored the free recall data in two ways: first by a strict criterion in which the recalled action had to be essentially the same as the action that was performed during the walk; second by a lenient criterion in which the gist of action was recalled with no inaccuracy. For example, for the action *Rub the cheek of Olin's bust in the Olin Library Rotunda*, a correct recall by the strict criterion could be *Rubbed the cheek of the statue in Olin*, whereas a correct lenient recall could be *Touched the statue in Olin*. The same statistical analyses were applied to all recall data from the strict and lenient criteria, and these analyses yielded identical outcomes in each instance. To conserve space, we will provide only those analyses based on the lenient scoring criterion.

Free Recall. Table 1 shows that participants produced greater delayed free recall following social reminiscence than self-reminiscence (.78 vs. .64) F (1, 142) = 13.26, MSE = .70, $\eta_p^2 = .09$, $p < .001$, but their recall was unaffected by the memory aid conditions. Action

recall was not reliably different for the SenseCam (.74), diary (.69), and no aid (.68) conditions, $F < 1$, and there was no interaction between memory aid and reminiscence type, $F < 1$. Because eight people scored low on the free recall test (.30 or less), we also applied an *arc sine* transformation to the data but this transformation did not change the outcome. There remained a main effect of reminiscence type, $F\ (1, 142) = 14.79$, $MSE = 1.27$, $\eta_p^2 = .09$, $p < .001$, but no effect of memory aid, $F < 1$, and no memory aid by reminiscence type interaction, $F < 1$. Because these eight outliers were not evenly distributed across conditions (1 from SenseCam/Social, 2 from Diary/Self, and 5 from No Aid/Self), we did not remove them from the analyses.

Insert Table 1 about here

Order Recall. We calculated a Spearman rank-order correlation based on each participant's recalled action order and the actual order from the walk and performed the same two-factor analysis of variance on the correlations that we used with the free recall data. These results (absent the correlations from six participants that were lost) are also shown in Table 1. Participants in all conditions demonstrated strong action order memory by producing high positive correlations. There was no difference between the three memory aid conditions, $F < 1$, the two reminiscence types, $F\ (1, 126) = 1.81$, $MSE = .06$, $\eta^2 = .01$, $p > .10$, and no interaction of these variables, $F\ (2, 126) = 1.13$, $MSE = .04$, $\eta^2 = .02$, $p > .10$. Our participants' general familiarity with the campus buildings may have contributed partly to their strong action order memory.

In summary, social reminiscence was better that self-reminiscence for delayed action recall, but reminiscing with SenseCam images or diary entries was not better than unaided reminiscence. Although the camera images captured all actions visually and the diary entries, scored by the strict (.95) or lenient (.99) recall criteria, were virtually verbatim copies of all

stated actions, we found that faithful representations of the actions for reminiscence, whether by SenseCam images or diary entries, did not enhance action recall relative no external aid.

General Discussion

Our comparison of reminiscence conditions showed no memory consolidation benefit from prior reminiscence with SenseCam images or diary entries for the recall of unrelated, atypical actions, observed one-week earlier by memory-unimpaired people. Participants with unaided memory remembered the actions just as well as those previously armed with a memory camera or diary. Social reminiscence immediately after the walk did lead to better recall than self-reminiscence, likely reflecting a testing effect with experimenter-based cueing and corrective feedback better than self-based cueing and no feedback.

Given that SenseCam has consistently enhanced recall in memory-impaired individuals, our finding of no difference between SenseCam, Diary, and No Aid reminiscence was surprising. Our use of memory-unimpaired participants is likely a contributing factor, as the camera was designed to assist memory-impaired people. It may be that our memory-unimpaired participants revealed no SenseCam benefit because their cognitive resources were generally sufficient for the present task. Although the free recall results did not exhibit a ceiling effect in any condition, more demanding tasks might show a SenseCam advantage over the diary and no aid conditions.

Equally surprising was our finding that participants in the no aid condition recalled as much as participants in the two aid conditions. It may be that the no aid participants, knowing that the only source of the actions for a later test was their memory, focused harder on remembering the actions during the walk than participants with the memory camera or diary that provided a record of those actions. Sparrow, Lui, and Wegner (2011) found that people tend to forget information that they believe is available, but remember information they think is

unavailable. A similar effect might have operated in the present study minimizing potential differences between our memory aid conditions.

Direct comparisons between the case studies that have consistently shown beneficial effects of SenseCam reminiscence and the present study remain problematic for several reasons. First, memory-impaired individuals may benefit more from SenseCam reminiscence than memory-unimpaired people because the camera, in augmenting diminished cognitive function, is a more useful prosthetic device for the memory impaired. Second, the data scoring procedures for the case studies and the present experiment were different. In the case studies, recall was scored in terms of how well an event was subsequently recalled from either the memory-impaired person's immediate recall (Brindley et al., 2011; Loveday & Conway, 2011) or the recall of the memory-impaired person's spouse (Berry et al., 2007; Browne et al., 2011). In either instance, the number of details could vary with each event. In our study, recall was scored in terms of how many actions the participants in each condition recalled from the same campus walk. Third, the memory-impaired individuals in the case studies wore the memory camera for special events, and they often reminisced multiple times with the images in different sessions (e.g., Berry et al., 2007; Browne et al., 2011; Pauly-Takacs et al., 2011). In our study, the actions from the walk were reminisced several times in a single session, shortly after the actions were observed. Differences in massed vs. distributed reminiscence and the amount of reminiscence (cf., Cepeda, Pashler, Wixted, & Rohrer, 2006) may influence SenseCam's effectiveness.

In addition, our use of unrelated actions on the campus walk made it difficult for SenseCam images to trigger memories of other actions because our atypical actions were arbitrary and independent. The actions on the walk lacked a coherent schema that linked them into a larger, meaningful episode. Unlike the present study, the SenseCam images in the case

studies were obtained from recording meaningful events - such as a visit to a museum or the beach – where recalling one aspect of an event could trigger related aspects of the event that the memory-impaired person previously experienced (see Hodges, Berry, & Wood, 2011; Loveday & Conway, 2011). SenseCam memory enhancement may be sensitive to the coherence of an event.

Finally, unlike the present study, the case studies have provided SenseCam images to individuals at test to trigger memories of events that are captured in the images as well as aspects of those events not explicitly shown. Memory-impaired people may or may not recall the events depicted in the images at test. The same procedure cannot be used with memory-unimpaired people. If we had given our memory-unimpaired participants either their SenseCam images or diary entries at test, we would not know whether they were recalling the actions from those aids or their memory. Most likely, they would merely state what was shown in the image or diary entry. Consequently, we offered no aid to our participants on the delayed memory test to determine how well our study and reminiscence conditions influenced their long-term recall. Future testing might consider providing partial information via SenseCam images or diary entries to determine the effectiveness of each aid for cueing the remaining uncued material.

In closing, when methodological variables were controlled across memory aid conditions, we found that SenseCam provided memory-unimpaired people no consolidation benefit in recalling atypical actions observed by on a campus walk. SenseCam is a valuable aid to the memory impaired, but its value for non-clinical populations remains to be determined.

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Note.

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Table 1: Delayed Action Free Recall and Action Order Recall

	Memory Aid and Type of Reminiscence		
	SenseCam	Diary	No Aid
Action Recall - Lenient Criterion			
Social Reminiscence	.79 (.22)	.75 (.20)	.78 (.18)
Self Reminiscence	.68 (.21)	.64 (.23)	.59 (.30)
Action Recall - Strict Criterion			
Social Reminiscence	.75 (.26)	.71 (.22)	.75 (.19)
Self Reminiscence	.62 (.21)	.59 (.24)	.56 (.31)
Action Order Recall - Correlations			
Social Reminiscence	.92 (.15)	.85 (.19)	.93 (.15)
Self Reminiscence	.87 (.18)	.86 (.20)	.84 (.19)

Notes. Recalls are mean proportions correct; order recalls are mean rank-order correlations. Standard deviations in parentheses.