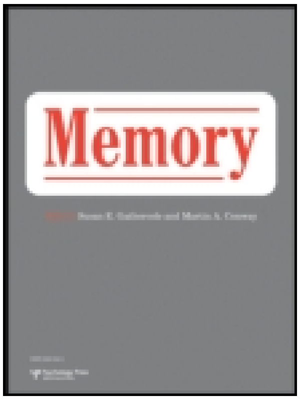

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SenseCam, imagery and bias in memory for wellbeing

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SenseCam, imagery and bias in memory for wellbeing

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Identifying and modifying the negative interpretation bias that characterises depression is central to successful treatment. While accumulating evidence indicates that mental imagery is particularly effective in the modification of emotional bias, this research typically incorporates static and unrelated ambiguous stimuli. SenseCam technology, and the resulting video-like footage, offers an opportunity to produce training stimuli that are dynamic and self-relevant. Here participants experienced several ambiguous tasks and subsequently viewed SenseCam footage of the same tasks, paired with negative or positive captions. Participants were trained to use mental imagery to inter-relate SenseCam footage and captions. Participants reported increased levels of happy mood, reduced levels of sad mood, and increased task enjoyment following SenseCam review with positive versus negative captions. This shift in emotional bias was also evident at 24-hour follow-up, as participants recollected greater task enjoyment for those tasks previously paired with positive captions. Mental imagery appears to play an important role in this process. These preliminary results indicate that in healthy volunteers, SenseCam can be used within a bias modification paradigm to shift mood and memory for wellbeing associated with performing everyday activities. Further refinements are necessary before similar methods can be applied to individuals suffering from subclinical and clinical depression.

Keywords: SenseCam; Cognitive bias modification; Emotion; Mental imagery.

Cognitive biases play a central role in the development and maintenance of depressed mood (Beck, 1979; Teasdale, 1988). Individuals suffering from depression tend to interpret information they encounter in their everyday physical and social worlds in a negative way. Targeting and modifying these maladaptive interpretations is central to successful treatments, such as cognitive therapy. Bias modification can reduce the propensity for a person's thoughts and negative interpretations of events to result in new depressive episodes or to relapse from recovered states (Segal, Williams, & Teasdale, 2002). More recently this idea has been developed in a variety of computerised "cognitive bias modification" (CBM) paradigms (MacLeod, Koster, & Fox, 2009).

Empirical research on computerised CBM has identified a range of strategies that offer the potential to modify or eliminate cognitive biases. Strategies that involve mental imagery have been a particular focus of research attention. For example, CBM training studies have shown that when healthy volunteers listen to auditory descriptions of emotional events, they report greater changes in self-reported mood when instructed to

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form mental images than when instructed to verbally process the same events. This effect has been demonstrated for both negative (Holmes & Mathews, 2005) and positive (Holmes, Mathews, Dalgleish, & Mackintosh, 2006) resolutions of ambiguous verbal stimuli, and recent work has extended these findings to ambiguous pictorial stimuli (Holmes, Mathews, Mackintosh, & Dalgleish, 2008). Taken together, the results indicate that positive and negative emotional responses are significantly enhanced following training that relies specifically on mental imagery processes rather than verbal representations of ambiguous stimuli.

These findings have major implications for mood change and modification of cognitive bias in the context of psychological therapies. Indeed, research has already begun to explore the limits of positive and negative mental imagery in non-clinical samples, with an emphasis on depressed and anxious self-reported mood (Holmes, Lang, Moulds, & Steele, 2008; Stöber, 2000). Both studies reported a specific association between dysphoric mood and a reduced ability to vividly imagine positive but not negative future events. However, a potential limitation of the ambiguous training stimuli typically used in such CBM studies is that the verbal and pictorial stimuli are not only static and unrelated to one another, but also low in personal ''relevance''. Appraisal theorists have attempted to identify various criteria upon which the antecedent conditions of different emotional experiences and reactions are appraised, and a number of these emphasise the significance or relevance of an event to the individual (Scherer, 1999). A strong case can be made for using ambiguous training stimuli that exhibit higher levels of self-relevance and that are rich in dynamic visual content. Encouraging depressed individuals to use imagery-based processes to resolve these ambiguous stimuli in a positive way could facilitate engagement of attention and trigger recall of more positive autobiographical memories. This is because imagery is believed to be extremely important for the recall of specific episodes from autobiographical memory (Conway, 1990), as is evident in the term ''sensory-perceptual episodic memory'' (Conway, 2001). There is also evidence for overlapping mechanisms for remembering episodes from the past and imagining them in the future (D'Argembeau & Van Der Linden, 2006). Learning to use imagery-based processes to resolve ambiguous stimuli could thus have considerable training potential for the modification of maladaptive self-schemas and cognitive biases.

SenseCam is one of a class of devices that offers the opportunity to capture experiences with more dynamic, integrated, and realistic material that is self-relevant. SenseCam is an unobtrusive wearable camera that automatically captures sequences of images of activities and events undertaken by the wearer (Hodges et al., 2006). The wearer can subsequently review a SenseCam ''movie'' on his or her personal computer. Review of these SenseCam images has already been shown to improve autobiographical recollection in patients with severe memory impairment following limbic encephalitis (Berry et al., 2007) and also with mild cognitive impairment (Browne et al., 2011). In this latter study, SenseCam review was also found to have secondary benefits on the individual's confidence and quality of life. Given that depressed mood states and clinical depression are associated with difficulties in accessing specific autobiographical information (Moore, Watts, & Williams, 1988; Williams et al., 2007; Williams & Scott, 1988) and with reduced quality of life, guided SenseCam review could offer clinically useful application. In line with previous CBM studies, dynamic and integrated image sequences of personally experienced events could be paired with negative or positive captions in an effort to experimentally shift negative interpretations to more positive ones — were such shifts to be of useful magnitude, this approach could provide a platform for developing new interventions.

Here we report preliminary findings from a study that used SenseCam recordings of a range of simple structured tasks in a community sample. All performed these tasks, and then viewed the corresponding SenseCam footage with added captions to bias interpretation. Given evidence that mental imagery is important in the modification of individuals' interpretation bias, our participants were trained to produce a mental image to inter-relate SenseCam footage with positive and negatively valenced captions. The primary aim of the study was thus to assess the magnitude of any immediate and delayed effects on reported well-being of associating experienced events with positive and negative meanings. The secondary aim was to explore the extent to which any effects were dependent on participants' pre-existing mood and/or tendency to use mental imagery.

METHOD

Participants

A total of 13 women and 7 men participated for a small fee; 18 of the participants were students. The sample had a mean age of 19.8 years ($SD = 1.8$). The specific mood and individual difference measures used are described below. The Positive and Negative Affect Schedule (PANAS) (Watson, Clark, & Tellegen, 1988) and Stress-reactive Rumination Scale (SRRS-hopelessness) (Alloy et al., 2000) were also administered but are not reported here in the interests of brevity.

Materials

Beck Depression Inventory–second edition (BDI-II). Self-reported depression was measured using the 21-item BDI-II, known to have strong internal consistency (Beck, Steer, & Brown, 1996). Participants rated depression-related symptoms during the past 2 weeks on a scale with endpoints *0* to *3*. The mean self-reported depression score in our sample was 10.8 ($SD = 9.0$).

State Trait Anxiety Inventory–Trait (STAI-T). Trait anxiety was measured using the 20-item STAI-T (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Each item was rated on a 4-point scale (*almost never* to *always*). Our sample had a mean trait anxiety score of 42.6 ($SD = 12.4$).

Spontaneous Use of Imagery Scale (SUIS). Tendency to use mental imagery was measured with the SUIS (Reisberg, Pearson, & Kosslyn, 2003). This questionnaire contains 12 items, for example, "When I think about a series of errands I must do, I visualise the stores I will visit". Each item is rated on a scale from 1 (*never*) to 5 (*always*). The mean score in our sample was 39.0 ($SD = 8.8$).

Tasks

All participants completed 12 "ambiguous" tasks. These included activities such as writing a shopping list, making a collage or greeting card from materials provided by the experimenter, finding a route on a map, spotting the differences between two almost identical pictures, selecting outfits from a clothing catalogue, and folding a pile of crumpled laundry. The 12 activities were selected on the basis that they were relevant beyond the laboratory setting, yet sufficiently ambiguous that participants' judgements of how enjoyable they were could potentially change following exposure to pairings of negative versus positive captions with SenseCam footage of someone else completing these tasks.

SenseCam and SenseCam Image Viewer

SenseCam is a small digital camera that takes photographs automatically without user intervention. It has a wide-angle fish-eye lens that maximises its field-of-view. There is also special SenseCam image viewing software that relies on rapid serial visual presentation to display images on a PC at the user's chosen speed up to approximately 10 images per second. Details of the operation of the most recent version of SenseCam hardware and software are reported in Hodges et al. (2006).

Although participants actually completed the tasks individually. In order to control for sequence content and allow prepared captioned versions to be in place, a standard SenseCam record was created for each task. SenseCam was worn by one of the researchers to capture image sequences for the 12 ambiguous tasks described above. During the task review phase participants viewed these standard sequences on a PC monitor using the SenseCam Image Viewer. Each task sequence included presentation of 113 photographic frames on average, presented at a rate of 1 frame per second. The footage for each task was simultaneously paired with presentation of a series of six consecutive negative or positive captions that were presented in the lower left corner of the SenseCam Image Viewer (see example below).

Procedure

On arrival participants completed the BDI-II, STAI-T, and SUIS. All participants then spent 3.5 minutes completing each of the 12 ambiguous tasks described above (performance phase). The order in which tasks were completed was randomly determined for each participant. Immediately following completion of each task participants completed 100-mm visual analogue scales, with end points "not at all" to "extremely", according to how they were feeling (sad, happy) and how enjoyable they had found the task. Completion of all 12 tasks was followed by a filler task that required participants to rate a number of classical music sound files.

Participants then received extensive mental imagery training (training phase). First, they completed a practice task in which they were asked to imagine cutting a lemon. This task has been used routinely in our studies to clarify what is meant by mental imagery and to provide a context for the intentional generation of a mental image (Holmes et al., 2006). Participants were also given a practice image that included presentation of a picture (e.g., a crowd) that was accompanied by a negative or positive caption (e.g., "get out of my way!" or "celebration time!"); participants were asked to close their eyes and form a mental image, in any sensory modality, of the caption and picture combined. An important distinction has been drawn between a "field" perspective, in which one imagines the situation from one's own perspective as though actively involved, and a "bystander" or "observer" perspective, in which one imagines the situation from a detached perspective as though looking at oneself from the outside (McIsaac & Eich, 2002). This distinction between field and bystander imagery was explained to participants and the experimenter emphasised that participants try to form mental images from a field, rather than a bystander, perspective (as in Holmes, Coughtrey, & Connor, 2008).

The performance and training phases were followed by the SenseCam review phase in which participants watched the standard SenseCam recordings of the 12 tasks they had themselves carried out in the performance phase described above. The 12 tasks were divided into two sets of 6 tasks each, such that these sets were as similar as possible. For half of the participants, six tasks (Set A) were paired with negative captions, while the remaining six tasks (Set B) were paired with positive captions. For the remaining participants, Set A tasks were paired with positive captions and Set B tasks with negative ones. So for example, while some participants viewed standardised SenseCam footage of the shopping list task paired with the captions "incapable", "disorganised", "inefficient", "overwhelmed", "unprepared", "daunting list" (negative captions), others viewed that same footage paired with the captions "capable", "organised", "efficient", "on top of it", "prepared", "thinking ahead" (positive captions). Participants were instructed to view the SenseCam footage and associated captions while at the same time producing a mental image that incorporated the combination of the footage and caption. It was emphasised that participants should imagine her/himself in the situation, as though present and actively involved. As for the performance phase, participants completed visual analogue scales following SenseCam review of each of the 12 tasks to indicate how they were feeling (sad, happy) and how enjoyable they found each task at that moment. To promote a field imagery focus, following SenseCam review of each task participants also rated the extent to which the mental image they had formed was through their own eyes (field imagery) or from a detached perspective (bystander imagery); this was done on 5-point scales with endpoints 1 (not at all) to 5 (extremely). Participants were given practice with additional SenseCam footage and negative/positive captions before completing the actual SenseCam review phase. Determination of which task set was paired with negative versus positive captions, and the order in which negative or positive captions were presented was done by random assignment.

Participants were contacted by telephone 24 hours later. They were asked to think back to their participation in the experiment and to rate each task for how vividly they could remember it and how enjoyable it had been on 100-point scales with endpoints 1 (not at all vividly/enjoyable) to 100 (extremely vividly/enjoyable). Participants were debriefed and thanked for their participation.

RESULTS

Unless specified otherwise, an alpha level of 0.05 was used for all statistical tests.

Effects of SenseCam captions on mood ratings

Mean mood ratings in the three phases of the study are presented in Table 1. To determine whether self-reported mood differed according to whether SenseCam task review was done with

TABLE 1
Mean (*SD*) mood visual analogue ratings in the three phases of the study: Performance, SenseCam review, and 24-hour follow-up

		SenseCam review		*24-hour follow-up*	
	Performance	*Positive captions*	*Negative captions*	*Positive captions*	*Negative captions*
Sad	25.5 (5.9)	25.2 (5.8)	39.4 (5.8)	–	–
Happy	56.8 (4.4)	54.6 (5.0)	36.8 (3.8)	–	–
Enjoyable	50.8 (2.9)	55.1 (4.6)	28.3 (2.9)	56.8 (3.1)	52.9 (3.3)
Vividly	–	–	–	68.5 (3.3)	69.0 (2.9)
Field imagery	–	3.65 (0.22)	3.54 (0.15)		
Bystander imagery	–	1.92 (0.77)	1.90 (0.55)		

For sad and happy mood, participants were asked to rate how they were feeling in the present moment, immediately following completion of each task in the performance phase, or immediately following SenseCam review of each task in the review phase. Participants were asked to rate how enjoyable they found each task in the same way. At follow-up, participants were asked to rate how enjoyable they had found each task during the performance phase and how vividly they could remember each task. Sad and happy mood, enjoyable ratings, and how vividly remembered were made on scales ranging from 1 (not at all) to 100 (extremely). Field and bystander imagery were rated on a 1 to 5 scale.

negative or positive captions, paired *t*-tests were used to analyse the effects of caption valence on sad mood, happy mood, and task enjoyment ratings. Following SenseCam review with negative, relative to positive, captions, sad mood ratings were significantly higher, $t(19) = 4.10$, $p = .001$, $d = 0.55$, happy mood ratings were significantly lower, $t(19) = 5.12$, $p < .001$, $d = 0.89$, and enjoyment ratings were significantly lower, $t(19) = 6.13$, $p < .001$, $d = 1.57$. These mood change results were in the expected direction in all three cases. However, relative to performance phase mood ratings, it was the negative, and not positive, captions that were producing these mood effects (see Figure 1). Thus, for sad mood, ratings following negative captions were significantly higher than performance phase ratings, $t(19) = 3.93$, $p = .001$, $d = 0.53$, whereas ratings following positive captions and baseline performance did not differ, $t(19) < 1$, *ns*. Similarly, for happy mood, ratings following review with negative captions were significantly lower than performance phase ratings, $t(19) = 7.51$, $p < .001$, $d = 1.08$, whereas ratings following review with positive captions and baseline performance did not differ, $t(19) < 1$, *ns*. Enjoyment mood ratings were also significantly lower following review with negative captions than following baseline performance, $t(19) = 8.67$, $p < .001$, $d = 1.74$, whereas enjoyment ratings following review with positive captions and baseline performance were not significantly different, $t(19) < 1$, *ns*.

To assess the part played by levels of depressed mood the data were re-analysed using a repeated measures analysis of variance (RMANOVA) with BDI-II scores as a covariate. The valence effects reported above remained significant in all three cases: sad mood, $F(1, 18) = 6.25$, $MSE = 126.6$, $p < .05$, $\eta_p^2 = 0.26$; happy mood, $F(1, 18) = 15.33$, $MSE = 123.0$, $p = .001$, $\eta_p^2 = 0.46$; task enjoyment, $F(1,18) = 20.34, MSE = 193.06$, $p < .001$, $\eta_p^2 = 0.53$. Similarly, to assess the role of imagery skills during SenseCam review we also analysed the data using RMANOVA with SUIS imagery scores as a covariate. The significant effect of caption valence on sad and happy mood ratings as well as task enjoyment were no longer significant after controlling for the trait measure of imagery, $F(1, 18) < 1$, *ns*, in all three cases. Trait imagery may thus be an important factor in determining the extent to which individuals report mood change following SenseCam review with negative or positive captions. Given that participants' reported changes in mood were no longer significant after controlling for trait imagery, experimenter demand is unlikely to provide a complete account of these effects.

Self-reported imagery following exposure to SenseCam captions

Participants were asked to rate the extent to which they adopted field and bystander forms of imagery following each task during performance and review phases of the study. As previous research has reported associations between different mood states and type of imagery, we sought

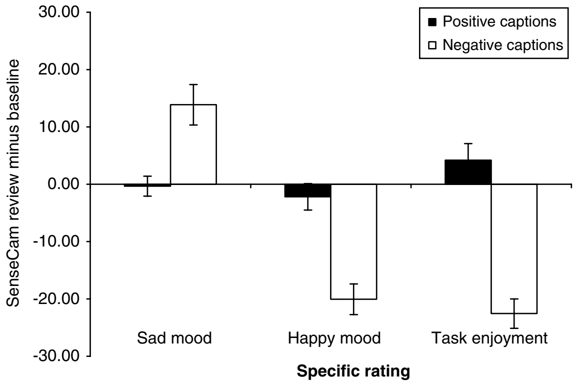

Figure 1. Change in sad mood, happy mood, and task enjoyment ratings following exposure to SenseCam review with positive versus negative captions. Change scores were calculated by subtracting baseline mood and task enjoyment ratings from the same ratings following task review. Thus a positive score indicates an increase in mood ratings from baseline to the review phase, whereas a negative score indicates a decrease in mood ratings. All ratings were made on visual analogue scales ranging from 1 (not at all) to 100 (extremely).

to establish whether field and bystander imagery ratings changed as a function of negative versus positive SenseCam review (Table 1, bottom two rows). Across all participants, field imagery ratings did not differ significantly following SenseCam review with negative versus positive captions, $t(19) < 1$, *ns*. The same was true for bystander imagery ratings, $t(19) < 1$, *ns*.

24-hour follow-up

From a clinical vantage, it is important to consider the extent to which any observed changes in mood or bias persist beyond the immediate experimental context. At 24-hour follow-up, participants were asked to rate the extent to which they enjoyed and how vividly they remembered each of the 12 tasks they had completed the day before. Even at follow-up, enjoyment ratings were significantly higher for tasks that had been paired with positive, relative to negative, captions, $t(19) = 2.1$, $p = .05$, $d = 0.27$ (see Table 1). Thus SenseCam review with both positive and negative captions produced the predicted effects on participants' recall of task enjoyment at 24-hour follow-up. However, the magnitude of this effect was reduced relative to the same effect immediately following SenseCam review, as indicated by the significant interaction term obtained in a 2 (caption: negative, positive) × 2 (phase: SenseCam review, follow-up) RMANOVA, $F(1, 19) = 22.2$, $p < .001$, $\eta_p^2 = .54$ Further, as for the review phase above, the effect of valence was no longer significant after controlling for the effect of trait imagery ability measured via the SUIS at baseline $F(1, 18) < 1$, *ns*.

It is noteworthy that, relative to task enjoyment ratings during the initial performance phase of the study prior to caption presentation, follow-up enjoyment ratings for those tasks that had been paired with positive captions were significantly higher, $t(19) = 1.8$, $p < .05$, one-tailed, $d = 0.45$, whereas follow-up enjoyment ratings for those tasks that had been paired with negative captions were not significantly different, $t(19) < 1$, *ns* (see Table 1). Vividness ratings were taken only at follow-up and did not differ for tasks paired with negative versus positive captions, $t(19) < 1$, *ns*. Thus, the increased enjoyment for those tasks paired with positive captions at SenseCam review cannot simply be explained in terms of how vividly participants remembered those same tasks.

Correlations

To further clarify the contributions of individual differences, Pearson correlations were computed between the mood ratings following negative or positive SenseCam review and individual difference measures (BDI-II, STAI-T, SUIS). As would be expected, the general pattern to emerge here was that strong associations were evident between self-reported mood on arrival at the lab and later ratings of sad mood, happy mood, and task enjoyment. For example, scores on the BDI-II correlated positively with sad mood ratings—$r(20) = .66$, $p < .001$, following both negative and positive SenseCam review—and negatively with happy mood ratings; $r(20) = -.59$, $p < .01$, following negative review, and $r(20) = -.60$, $p < .01$, following positive review. This association with BDI was in the same direction but did not achieve significance for enjoyment ratings at 24 hour follow-up; $r(20) = -.41$, $p = .07$. A very similar pattern of associations was found for STAI-T scores.

SUIS trait imagery scores also correlated positively with ratings of happy mood, $r(20) = .48$, $p < .05$, and task enjoyment, $r(20) = .44$, $p = .05$, following SenseCam review with positive captions, and importantly this association between SUIS scores and task enjoyment ratings following positive SenseCam review remained significant at 24-hour follow-up, $r(20) = .48$, $p < .05$. Associations between SUIS scores and mood ratings following negative review, on the other hand, did not approach significance ($p > .24$ in both cases).

Following SenseCam review with positive captions, sad mood also correlated positively with bystander imagery ratings, $r(20) = .50$, $p < .05$, whereas happy mood and task enjoyment correlated positively with field imagery ratings, $r(20) = .81$, $p < .001$ in both cases. Following review with negative captions, no correlations achieved significance (all *p*s $> .3$).

DISCUSSION

The present study sought to determine first whether SenseCam review with captions expressing positive and negative meanings could be used to bias mood and interpretation of ambiguous tasks performed by healthy volunteers; and second, to assess the contribution of individual differences. The results indicate that SenseCam review with captions does have significant potential to bias participants' mood and enjoyment experience of a set of ambiguous laboratory-based tasks—immediately afterwards *and* 24 hours later. These immediate and delayed effects are not simply related to memory, but are potentiated by an individual's mental imagery ability. The results are also asymmetric with respect to valence. Whereas negative captions gave rise to the larger component of mood effects immediately following SenseCam review, the valence effect on enjoyment at 24-hour follow-up was due to a shift to a generally positive assessment of experience of carrying out our 12 tasks.

With respect to the initial asymmetry evident in mood ratings following SenseCam review, several points must be considered. First, in contrast to clinically depressed samples, healthy participants generally show an overall positivity bias (Mezulis, Abramson, Hyde, & Hankin, 2004; Taylor & Brown, 1988). This is certainly true for the current sample, who reported higher baseline happy and enjoyable ratings than sad ratings in the initial performance phase of the study. Our positive captions could well have been consistent with that bias, leading at best to a modest additional mood shift. Negative captions, on the other hand, which are inherently "inconsistent" with that bias, may have been more noteworthy; this could have led to negative captions having larger effects on sad, happy, and enjoyable ratings. At 24-hour follow-up the demand characteristics of a less-formal assessment via telephone interview, that had greater distance between experience of our 12 tasks, meant that demand characteristics should have played a less-prominent role. Here, when participants were asked to recollect the extent to which they had enjoyed each of the tasks, enjoyment ratings for those tasks that had been paired with positive captions at review were found to be significantly higher than baseline, while those for negative captions were, at this point, no different from baseline and far less negative overall than immediately following SenseCam review. The data from the 24-hour follow-up are consistent with an interpretation that the shift in bias is primarily on the positive rather than negative pole of the valence dimension. It is not entirely clear why the positive captions produced more lasting changes at follow-up, though the results of an experiment by Ganzach and Mazursky (1995) are consistent with this observation. They demonstrated that immediately following information acquisition, when positive and negative information are vivid in memory, participants' judgements tend to be biased in a negative direction, whereas in the delayed stage, judgements become positively biased. Previous work has also shown that relative to negative CBM, positive CBM can be used to successfully manipulate appraisal bias in control participants, with fewer negative intrusions reported one week later (Lang, Moulds, & Holmes, 2009).

A second constraint on the interpretation of results following SenseCam review arises out of the patterning of effects in relation to individual differences. While the mood shift effects remained after covarying out Beck Depression Inventory scores, they were no longer significant when trait imagery scores were covaried out. Our sample size is modest for firm conclusions to follow; however, the results underline the importance of considering not just memory traces but also differences in the mental processing activity that is associated with laying down those traces and their recovery. During SenseCam review, participants were trained and encouraged to produce a mental image that incorporated the SenseCam footage together with the associated negative or positive captions. This aspect of the experimental design was based on previous evidence of a special role for imagery-based processing in the generation of emotional responses to ambiguous stimuli (Holmes & Mathews, 2005). In the present study participants' levels of trait imagery correlated positively with ratings of happy mood and task enjoyment following SenseCam review with positive captions, and importantly this latter association held at 24-hour follow-up. Associations between trait imagery and mood ratings following negative review, on the other hand, did not approach significance. In addition, following SenseCam review with positive (but not negative) captions, sad mood correlated positively with bystander imagery ratings, whereas happy mood and task enjoyment correlated positively with field imagery ratings. Previous investigations have manipulated whether participants use mental imagery or verbal elaboration to produce a combined percept of the verbal or pictorial stimulus and associated caption, whereas such strategies were not manipulated in the current study. Nevertheless, our data indicate that mental imagery processes, rather than mood, may be involved in the extent to which SenseCam review with positive captions influences ratings of task enjoyment. This latter finding reinforces our view that future research should target the relationship between imagery and more enduring effects on the positive pole rather than the larger short-term effect on the negative pole (Holmes, Lang, & Deeprose, 2009).

Overall our preliminary results offer some encouragement for further explorations on the value of integrating SenseCam technology into an emotional bias modification protocol by adding valenced captions. Of course, it could be argued that the current study demonstrates that SenseCam offers ''just'' another empirical means of inducing mood and that we already have a range of powerful enough mood induction techniques: Velten statements, emotional films, pictures, or music, and autobiographical memories (Coan & Allen, 2007). We would argue that SenseCam technology brings with it important new attributes. The present approach has the advantage not only of providing similar and standardised dynamic stimulus events, but also the content of the images generated are open to self-related, more systematic, and refined design than, say, the content of film clips or pictures. This element of the experimental design should enable future studies to eliminate potential confounds in the affective qualities of life experiences and the level of detail or differentiation in the recollection of an individual's experience.

While CBM paradigms started out using simple ambiguous words and pictures, as reviewed in our introduction, captioning self-experienced event types with richer content is now enabled by SenseCam recordings. Captioning offers the potential to re-model not just valence, but perhaps richer qualitative attributes linked to maladaptive self-models across a range of clinical conditions as well, such as imagery strategies (Holmes, Lang et al., 2008) and modes of attending to meanings (Teasdale et al., 1999). Both attributes are now established to be of clinical value. Further relevant to this idea is research by Ylvisaker and colleagues demonstrating that metaphors, rather than simple negative and positive assertions, are effective in helping to remodel self-identity in the context of disabilities that follow traumatic brain injury (Ylvisaker & Feeney, 2000). Their intervention procedures use metaphors to help individuals with traumatic brain injury reconstruct an organised and positive sense of personal identity. For example, one brain-injured patient, Jason, constructed a new model of self by using the metaphor of Jason-as-Clint-Eastwood. This was grounded in the insight that, like Clint Eastwood, he would have to take seriously his roles as actor *and* director with his success dependent on a blend of positive emotions (like strength and power over others) and restraint (by making effective use of support personnel).

Our preliminary results are naturally subject to a number of limitations and constraints on interpretation, including the possible role of demand characteristics. Our procedure invites replication with appropriate manipulation checks and implicit measures of change in cognitive bias after a delay (e.g., homograph interpretation task) (Hertel, Mathews, Peterson, & Kintner, 2003). Also of note, participants were encouraged to use mental imagery to inter-relate captions with SenseCam footage and trait levels of mental imagery were found to potentiate the observed mood effects. Whether training participants to use mental imagery to inter-relate SenseCam footage and captions is *necessary* cannot be determined in the present study as the use of SenseCam and mental imagery were confounded. Future research could refine the experimental methodology to include independent and combined comparisons of each factor. Furthermore, the present study did not profit fully from the valuable capabilities that SenseCam offers in terms of acquiring personalised and naturalistic footage. As the purpose of this preliminary study was to determine the feasibility of using SenseCam to modify cognitive bias, it was considered important to use well-controlled, standardised stimuli. A clear and important next step is for participants to collect their own SenseCam footage that can be used to generate corresponding and meaningful personalised positive and negative captions—an approach that can ultimately be applied to populations with subclinical and clinical variation in depressed mood. The extent to which mood and meaningful captions are integrated is also open to validation using fMRI. A paradigm developed by Teasdale and colleagues offers one route forward. They demonstrated that picture–caption combinations that cohered to create a meaningful ''schematic model'' (Teasdale & Barnard, 1993) gave rise to greater activation in frontal regions associated with cognitive-affective synthesis than did the same material when presented in non-coherent combinations (Teasdale et al., 1999).

While our conclusions must remain tentative at this stage, the evidence indicates that SenseCam technology, when combined with valenced meanings using mental imagery, has the potential to induce mood change in a community sample of healthy participants. The changes induced by combining SenseCam traces with captions persist on a 24-hour timescale, are asymmetric with respect to valence, and are modulated by trait differences in imagery. It will be the task of future empirical research to clarify with greater precision how SenseCam can best be integrated into a bias modification paradigm in clinical samples, and how imagery processing can be used to maximise the specific effects on emotional wellbeing, to promote a rose-tinted view of one's recently experienced past.

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