Exploring the basis and boundary conditions of SenseCam-facilitated recollection

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SenseCam review has been shown to promote and sustain subsequent access to memories that might otherwise remain inaccessible. While SenseCam review facilitates recollection for personally experienced events, we know little about the boundary conditions under which this operates and about how underlying processing mechanisms can be optimally recruited to offset memory impairments of the sort that occur in dementia. This paper considers some of these issues with a view to targeting future research that not only clarifies our evolving body of theory about how memory works, but also informs about how memory-assistive technologies for patients might be employed to maximal effect. We begin by outlining key factors that are known to influence recollection. We then examine variability in the decline of memory function both in normal ageing and in dementia, and we suggest that this may reflect shared underlying mechanisms. We conclude by discussing how one particular theoretical rationale can be intersected with key SenseCam capabilities to define priorities for ongoing and future SenseCam research.

Keywords: SenseCam; Recollection; Dementia; Depression.

Healthy individuals who have had the opportunity to use SenseCam typically report similar intuitions when viewing a replay of a personally experienced event. As a sequence of discrete visual images sampled from the original event follow one another at a moderately rapid rate, memories of that event come flooding back. What is particularly striking about these memories is that they are not restricted to the actual content of these images. What comes to mind includes many hallmark elements of autonoetic consciousness and recollection of the episode (Tulving, 1983): thoughts, feelings, and impressions experienced at the time of encoding as well as other information not present in the replay, such as conversations that occurred at the time. Photograph albums or home videos can, of course, give rise to similar experiences but SenseCam-facilitated recollection seems to bring with it qualitative differences that include, among other things, reflecting on aspects of self-experience in new ways (Harper et al., 2007). Unlike video recordings, *the full event* is not re-experienced in real time, and unlike the often deliberately staged, framed, or otherwise contrived and *momentary* snapshots of photograph albums, SenseCam imagery captures sequential and relational aspects of how the real event unfolds in time from a first person or "field" perspective.

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This informal testimony is now supported by behavioural and neuroscientific evidence. SenseCam review can facilitate recollection in normal healthy individuals (Sellen et al., 2007) and in patients with significant or mild memory impairments, with secondary benefits for confidence and well-being (Berry et al., 2007; Browne et al., 2011). An fMRI study of a patient with limbic encephalitis showed that successful recognition following SenseCam rehearsal, compared to unrehearsed and control conditions, activated cortical regions known to be involved in normal episodic memory (Berry et al., 2009). Healthy students also show increased activity in key brain regions supporting memory when viewing Sense-Cam traces (St. Jacques, Conway, Lowder, & Cabeza, 2011). Such evidence invites two relatively straightforward conclusions. First, Sense-Cam review promotes and sustains subsequent access to memories that might otherwise remain inaccessible. Second, at least some memory deficits may be partially counteracted by the informationally rich cues that life-logging devices such as SenseCam offer to support recollection (Lee & Dey, 2008).

While SenseCam review facilitates recollection for personally experienced events, we know little about the boundary conditions under which this operates and about how the underlying processing mechanisms can be optimally recruited to offset memory impairments of the sort that occur in dementia. Does SenseCam review promote recollection for only some types of material, such as special events, like trips out? Or does it also promote recollection for more ordinary events, like washing-up or shopping? An obvious attribute of SenseCam is that the pictures are taken automatically and without intention, enabling the wearer to document much more routine or ordinary activities than would typically be the case when still photography or video is used more selectively to capture perhaps rather more noteworthy material. We know little about how and when the content of SenseCam images promotes access to otherwise inaccessible material. Whether the kinds of mental activity that occur during the original experience and at the point of remembering contribute to the effectiveness of SenseCam review also remains unclear. There is also an acute lack of evidence directly comparing Sense-Cam to other memory-assistive technologies. This paper considers some of these issues with a view to targeting future research that not only clarifies our evolving body of theory about how memory works, but also informs how memory-assistive technologies for patients might be employed to maximal effect. Our strategy is straightforward. We first identify key factors from the literature that are known to influence recollection. Second, we examine variability in the decline of memory function in normal ageing and dementia. By drawing attention to similarities in the recollection deficits associated with depression and dementia, we then propose that these similarities could possibly reflect shared theoretical underpinnings. Finally, we discuss how these ideas might shape novel SenseCam interventions and assessments of their efficacy.

INFLUENCES ON RECOLLECTION

The literature on human recollection is extensive. It encompasses research conducted using tightly controlled but largely non-personally significant material such as pictures, words, and narratives (Baddeley, 1990) through to considerations of how autobiographical memory works on a lifelong scale (Conway, 1990; Conway & Pleydell-Pearce, 2000). This literature emphasises a number of core themes. Since the seminal work of Bartlett (1932) it has been recognised that memory for complex events is reconstructive rather than literal, depending on wider schemata for knowledge relevant to the topic in focus, as well as the detail of the experienced event. What happens at the time of the experienced event is equally important. Greater elaboration of meaning at the time of encoding leads to heightened recall of presented information (Craik & Lockhart, 1972). The cues used to frame access to information represented in memory are also important (Long, Prat, Johns, Morris, & Jonathan, 2008). In their classic study, Pichert and Anderson (1977) asked participants to recall a visit to an apartment, first from the perspective of someone wanting to buy the house and then from the perspective of a burglar. The body of material recollected from the second perspective differed with new information, not previously reported, being accessed.

Both generic and specific attributes of the experienced event and how these relate to the individual constitute other core themes. On a lifetime scale, recollection is not equally distributed. Reminiscence bumps of enhanced recollection have been reported for "public events" between the ages of 10 and 19 years and for more private events between 20 and 29 years (Conway & Holmes, 2004). Events coupled to emotional experience, whether extreme or mild, are typically better recollected than those not associated with affect (Anderson, Wais, & Gabrieli, 2006; Ochsner, 2000). For example, mildly emotional pictures, words, and narratives are better recollected than well-matched neutral ones (for a review, see Kensinger, 2009b). Recollections of events associated with extreme emotional experiences can be subject to distortions, such as in life-threatening situations that lead to post-traumatic stress disorder (Sotgiu & Mormont, 2008) and in scenes where emotionally arousing features are better recollected than peripheral details, termed the weapon focus effect (see Pickel, 2007).

Specific emotional attributes of stimuli modulate recollection. For example, whether a stimulus invokes a specific emotion (e.g., fear or disgust) or has positive or negative valence (Talarico, Bernsten, & Rubin, 2009) or is more or less arousing (Ochsner, 2000) can have powerful effects on recollection. Imageability is also a highly relevant attribute. Conway and Pleydell-Pearce (2000) noted that autobiographical recollection is often accompanied by visual or other forms of imagery. This is consistent with the finding that cue words of higher imageability give rise to greater specificity in autobiographical recollection (Williams, Healy, & Ellis, 1999). Much research has also emphasised the role of distinctiveness and related concepts (familiarity, incongruence, surprise) in modulating recollection (Hunt & Worthen, 2006; Schmidt, 2006). A key problem in unravelling the contribution of specific stimulus attributes to recollection is that the different attributes tend to intercorrelate. This has been shown in a large sample of pictures rated on 14 attributes, in which rated memorability correlated significantly with every other examined variable except valence (Libkuman, Otani, Kern, Viger, & Novak, 2007). An individual reviewing the recollection literature would thus find evidence to support many specific influences on recollection but little in the way of deeper theoretical consensus about underlying mechanisms.

Very similar considerations are relevant to the properties of individuals and tasks. It is well known that depressed individuals show characteristic memory impairments, and their recall patterns for positive and negative material exhibit systematic biases (Lloyd & Lishman, 1975). Recollection of a specific autobiographical episode in response to a cue is also compromised in depressed individuals, relative to normal healthy controls (Williams et al., 2007). Here evidence is accumulating that the mood state is not in itself causal, but rather that impaired recollection arises out of some intricate combination of properties of the underlying schemata relating to the self, world, and others, and how mental resources are deployed to process them in real time (Dalgleish et al., 2007; Ramponi, Barnard, & Nimmo-Smith, 2004; Williams et al., 2007). Likewise, in the context of recollecting everyday experiences in normal healthy individuals, generic properties of self-related schemata, other than valence, may play a key role in promoting access to memory. For example, Eldridge, Barnard, and Bekerian (1994) reported that people with more differentiated schemata for the activities that they undertake in their work report more information about what they were doing at work 1 week earlier than do those whose schemata are less differentiated. More widely, with complex materials like narratives, people recall the overall gist while disregarding minor detail (Kintsch & van Dijk, 1978); they also recall information relevant to the task at the focus of attention while omitting to report lesscentral detail (Frase, 1969; Gerrig & O'Brien, 2005). It is clear that recollection helps resolve specific "cognitive" tasks or problems, but it also serves wider communicative and social functions by allowing individuals to share experiences and explicitly or implicitly inform others about "who" they are (Conway, 2003; Horton & Gerrig, 2005; Nelson, 2003; Wilson & Ross, 2003; Woike, 2008).

As with the wider literature on recollection and autobiographical memory, the effects on memory of normal ageing and dementia are subject to a similar pattern of multiple determination. A substantial literature on memory functioning in normal ageing addresses such issues (Hess, 2005), and it is frequently emphasised that there is considerable variability in the pattern of decline (Luo & Craik, 2008). Some aspects of recollective capability are also better preserved than others. Of particular relevance are those that concern effort, context, and the offsetting role of specific attributes such as emotional content, categorical organisation, and the use of imagery. In a meta-analysis of 46 studies, Spencer and Raz (1995) concluded that age differences were reliably greater in memory for context than for content, but tasks requiring greater retrieval effort gave rise to larger age differences in memory for content relative to context. May, Rahhal, Berry, and Leighton (2005) showed that younger adults outperformed older adults in the recall of contextual information. However, when participants recalled emotional information concerning the context, age differences disappeared, suggesting that emotional information could well differentially engage older individuals (for a recent review see Kensinger, 2009a). In evaluating possible influences on recollection at encoding, Salthouse (1980) noted that older adults use imagery strategies less often and less effectively than younger adults (see also Dirkx & Craik, 1992). There is also evidence that cognitive support in the form of categorical organisation can offset age-related decline in recollective capability (Bunce, 2003).

Variable rates of decline are equally characteristic of patients with dementia. A recent study tracked 686 Alzheimer's disease (AD) patients on multiple measures over 2 years and reported that 12% of the cohort exhibited a very rapid decline, 25% exhibited relatively stable performance, and the remainder showed moderate but significant evolution of the disease (Cortes et al., 2008). It is generally agreed that there are discrepancies between neuropathology and clinical manifestation. Katzman and colleagues (1988) described patients with extensive AD pathology but little manifestation of the disease, arguing that these patients may have had greater "reserve" capacity to mitigate the underlying pathology of dementia (Boyle, Wilson, Schneider, Bienias, & Bennett, 2008). Ideas linked to both reserve properties of neural hardware and more "software-like" cognitive reserve have been discussed extensively, particularly in relation to a role for intelligence, education, and occupational attainment in offsetting decline. While the idea of generic "reserve" is easy to grasp, the evidence relating this to variability in rates of decline is unlikely to be fully accommodated without further differentiation of the neural and cognitive capabilities implicated in recollection. Indeed, studies of neuropsychological rehabilitation in dementia tend to support a multifaceted and holistic approach that includes targeted use of external memory aids (Clare, 2007).

MECHANISMS COMMON TO DEPRESSION AND DEMENTIA AND THEIR THEORETICAL UNDERPINNINGS

If memory-assistive technologies are to prove effective, we will unquestionably need a deeper understanding of the origins of the variable decline of recollective functions in dementia. Diagnostic challenges remain and emotional variables are frequently neglected in memory clinics. Dementia, mild cognitive impairment (MCI), and depression all involve memory impairments. Furthermore, depression is often reported to be comorbid with dementia and the links may run deeper (Saczynski et al., 2010). MCI is often thought to be a precursor to AD, but it progresses to AD in only some cases. Modrego and Ferrández (2004) conducted a prospective study of 114 patients with amnestic MCI over a 3-year period. Depression was observed in 36% of all the patients at baseline, and 59% of all the patients recruited subsequently went on to exhibit AD. Of those who were depressed at baseline, 85% went on to develop AD, compared to only 32% of the nondepressed patients. A more recent study has established depression as a risk factor for dementia, on the basis of a monotonic increase in risk for dementia and AD as a function of the number of episodes of depressive symptoms (Dotson, Beydoun, & Zonderman, 2010). These, and more recent findings concerning this relationship, are consistent with the hypothesis that mechanisms underlying depression, AD, and compromised recollective capabilities may have something in common.

It is possible that the memory deficits common to MCI, AD, and depression, together with evidence that links comorbid MCI and depression to the subsequent development of AD (Modrego & Ferrández, 2004), reflect common biological determinants. However, an alternative possibility is that the patterns of cognitive processing that determine poor recollection in depression may also occur in MCI, accelerating decline into AD irrespective of any underlying physical pathology. We refer to the interacting cognitive subsystems (ICS, Barnard & Teasdale, 1991; ICS, Teasdale & Barnard, 1993) architecture to explain impoverished recollection in depression and how similar mechanisms may help to explain rapid decline from MCI to AD.

The ICS architecture postulates two meaning systems. One type of meaning, propositional meaning, represents referentially specific content that lacks emotional charge (e.g., concepts, properties, and relationships); it is the kind of meaning that we think of as being expressed in sentences. The other, schematic meaning, is more holistic and can optionally carry emotional charge; it represents the deeper regularities of our experience as "schematic models" of the self, world, and others. The schematic level of representation is directly influenced by visual, auditory, and bodily inputs (hence the link to emotion), and these are combined with the products of processing propositional content. In contrast, propositional material captures just those subsets of referentially specific meanings activated to control verbal thoughts and vocal articulation, spatial imagery, and spatial-praxic interactions with the physical world. Propositional meanings are inherently narrower and more focused than schematic ones.

Each level of meaning has its own stored representations and human ideation is seen as an ongoing dialogue between the two levels: schematic representations are used to derive specific propositions, and the products of propositional elaboration feed back and update current schematic representations. This same internal dialogue, when augmented by access to stored representations, functions to support reconstructive retrieval. In this approach, retrieval and report of specific facts require activation of schematic models and the construction of specific propositions, not only to express the material recovered, but also to "validate" the content that is expressed as a recollection. This core account of memory and the data it accounts for is treated at some length in Teasdale and Barnard (1993) and Barnard (1999). The following paragraphs explore in more detail the arguments and evidence for a potential link between attributes of depressive thinking and rapid decline in those otherwise prone to dementia.

Depressive thoughts and feelings about the self, the world, and others are predominantly negative (Beck, 1979). These thoughts are characterised by over-simple generalisations and repetitive verbal rumination around restricted themes. We have argued elsewhere (Teasdale & Barnard, 1993) that depressed states are maintained by a toxic combination of three influences. First, individuals vulnerable to depression have over-simple and undifferentiated schematic models of the self, others, and the world that are associated with a characteristic pattern of "black-and-white" thinking. Second, attention in the mind is predominantly focused on the narrower content of propositional meanings and verbal thoughts with a corresponding neglect of attention to the broader content of schematic models and visuo-spatial imagery. Third, depressive thinking is guided by significant discrepancies and incongruities that are irresolvable in the context of currently activated self-models.

Given that an individual's schematic models capture regularities in experience and ultimately support adaptive responding, discrepancies between input and those schemas signal the need for further mental processing. In a wider evolutionary context, such discrepancies are highly significant as they implicitly index material that may require modification or the development and elaboration of new, more adaptive schemata (Barnard, Duke, Byrne, & Davidson, 2007). Elaborative processing of new information at or around the time of encounter or, for example, at the time of SenseCam review, could well be more focused on distinctive or incongruent features that lead to schema-discrepant states than on features that more readily fit existing models. Similarly, emotional charge associated with particular experiences can be understood as a marker to guide discrepancy reduction in the adaptive selection of actions towards appetitive ends and away from aversive ones (Oatley & Johnsonlaird, 1987). These may be particularly salient in the context of SenseCam-facilitated recollection where incongruous or emotional images may act as triggers. To take an example, while looking through a set of images taken 8 months previously, a patient with memory impairment, Mrs W, had no recollection of the event until one particular image "jumped out" at her. The image was one of her dog jumping on a visitor. At this point, Mrs. W remarked "now I remember" and relayed the entire event to the researcher (Browne et al., 2011).

Recollection requires activation, reconstruction, elaboration, and evaluation of specific propositions about a target event in successive cycles of dialogue between the two levels of meaning, and verbal or visual imagery derived from those propositions. Depressive deficits in recollection are accounted for, partly because of low levels of differentiation in schematic model content which act to restrict access to the full range of information preserved in memory, and partly because attention in the mind is directed at propositional representations and their verbal realisations. There is evidence of a causal link between both low differentiation in schematic model content and a ruminative response style and compromised specificity of both autobiographical recollection and recollection of laboratory presentations of word lists (Barnard, Watkins, & Ramponi, 2006; Eldridge et al., 1994; Ramponi et al., 2004). This theoretical analysis suggests a number of ways in which more differentiated thinking should, in principle, bring about more differentiated thought patterns. It has been argued that increasing the attention paid to schematic model content allows richer connections to be made among domains of pre-existing knowledge of the self, others, and the world (Barnard, 2004; Teasdale & Barnard, 1993; Teasdale et al., 1999). This in turn facilitates the generation of more varied propositional content, greater elaborative processing, and more differentiated and richer cues, all of which should support access to information preserved in the memory substrates associated with both levels of meaning.

This theoretical reasoning provides a plausible basis for the observed links between depression and the rate of decline in AD. But in particular we suggest that this theoretical reasoning can provide a foundation from which future Sense-Cam research priorities and testable predictions can be drawn. While we await advances in drug interventions that will counteract the advance of neuropathology, much may be done to optimise the use of degrading neural capability. The conjectures derived from the ICS approach, though based on similarities between memory difficulties in depression and MCI and on evidence linking comorbid MCI and depression to the subsequent development of AD (Dotson et al., 2010; Modrego & Ferrández, 2004), give rise to testable predictions. Those patients who decline rapidly are predicted to be those with lessdifferentiated schematic models of the self, the world, and others and those who ruminate along negative lines of thought or who otherwise focus their thoughts around narrow themes less obviously coupled to negative ideation. Patients with these characteristics should be less likely to generate rich representations at the time of encoding or rich cues at a later point that promote reliable access to what is preserved in memory. While this reasoning maps onto the concepts of brain and cognitive reserve in dementia (Stern, 2009), it is more specific about the nature and inter-functioning of cognitive capabilities. This hypothesis has clearer implications for how SenseCam or similar technologies might best be deployed.

SenseCam differs from other forms of event recording such as videos or photos, as SenseCam imagery can usefully be thought of as providing a temporally scaled model of an event. Indeed, SenseCam can capture an 8-hour event structure in 960 images, many of which are effectively redundant. Although attempts to define the temporal extent of a "psychological moment" have remained controversial (Block, 1990), for the purposes of argument were we to assume that information is mentally "integrated" in 100-ms chunks, then a SenseCam trace of an event (with images captured every 30 s) would represent a 1/300 scale model of just the visual component of a far richer and multi-modal experience. It would be a temporal analogue of a hobbyist showing off a physical model of an Airbus A320 with a wingspan of just 5 inches.

Regularities underlying propositional and schematic representations act to support pattern completion in much the same way as occurs in visual and auditory perception (Kellman & Shipley, 1991; Warren, 1970; Warren, Wrightson & Puretz, 1988). Reconstructive retrieval involves a dialogue between the two proposed levels of meaning that involves pattern completion and testing whether any routine or eventspecific content that emerges "feels right" in the context of either an explicit retrieval demand or an implicit product of current processing activity. Importantly, schematic meanings arise out of a blend of the products of information derived directly from sensation and those derived from propositional processing. The kind of temporally scaled visual input provided in SenseCam review would, in theory, massively augment the more selective, focused, and abstract cues for memory access derived from propositional meanings or more static pictures. Our current working hypothesis is that SenseCam review offers a very direct and rapid means of activating deeper schematic models related to the target event. This in turn provides the grounding from which specific retrieval cues can be elaborated to facilitate recollection.

We have so far examined a range of influences on recollection, the variation in rate of decline in ageing and dementia, and observed links between MCI, AD, and depression. For simplicity, this examination has been highly selective and has neglected to address definitional issues concerning different forms of memory. It nonetheless supports several key observations. First, while review of SenseCam traces of personally experienced events may well facilitate recollection, there are unlikely to be simple "univariate" answers to questions about the boundary conditions under which this process works. Recollection instead arises out of an intricate interaction between specific properties of not only the actual event experienced (e.g., distinctiveness) and mental processing activity at the time of encoding (e.g., elaborative processing), but also mental processing at the point of access (e.g., reconstructive effort). Second, this is true for healthy individuals, and even more so for patients with pathology of the brain regions that support human memory, in whom variable rates of decline have been reported. Third, observed links between depression and dementia suggest that priorities for patient research can be informed by intersecting theory-derived hypotheses with the novel features that SenseCam review enables us to exploit. When it comes to the potential benefits of using SenseCam or similar devices with such patients, isolation of the active ingredients that promote recollection and intersecting them with classes of memory deficits is a unique challenge.

INTERSECTING PRIOR EVIDENCE WITH PROPERTIES OF SENSECAM CAPTURE AND REVIEW

Faced with a progressive condition, a key aim of SenseCam research should be to maximise the potential use of available neural and cognitive capabilities. While SenseCam may facilitate recollection in all memory-impaired patients, our view is that benefits may be greatest for the 75% of patients who are vulnerable to more rapid rates of decline in cognitive function. If those prone to rapid decline do so because their mental functioning shares properties with depressed ideation, where there is a strong evidence base for the efficacy of cognitive interventions, then cognitive interventions with the "right" properties should also work to slow decline in dementia. While current evidence suggests that SenseCam review can lead to long-lasting effects for some events, the next research priority should be to establish whether SenseCam review can promote differentiation of skills in accessing memory that will then generalise to assist recollection in daily life. We will conclude here by giving an example of an application of the theoretical position outlined above to an intervention protocol that we are currently evaluating in a series of case studies with patients in the early stages of AD.

It was noted earlier that a restricted focus of attention to a narrow range of propositional meanings can be counteracted by drawing greater attention to schematic model content. This creates conditions where richer connections can be made within and among domains of pre-existing knowledge concerning the self, others, and the world. This in turn should lead to the generation of more varied propositional content, greater elaborative processing and more differentiated and richer cues to support access to information preserved in the memory substrates associated with both levels of meaning. Given the objective of developing generalisable cognitive skills, the focus was not on the review of "whole days" of experience, but rather on the review of patientspecific "montages" created by editing together a representative sample of traces of different activities undertaken in the course of daily life. The montage included the environments, tasks, contexts, and people they interact with in their social world. SenseCam traces of these activities are best seen not as a *solution* to the access problem but as a *vehicle* for enriching the generation of conceptual cues to facilitate access.

Five specific principles, justified on the basis of the research described above, guide the research protocol. First, schematic models of activities or states are open to hierarchical decomposition via description. Descriptions of activities can be more or less *elaborated* either in terms of the number of levels of decomposition or the number of elements decomposed at a level. Second, the elements of a schematic model are open to re-composition in which new elements can be added enabling alternative "paths" not currently captured in a particular description of an activity. Third, schematic models are composed of multimodally derived sources of information. When engaged in an activity, that activity will have an essence (e.g., a sequence of actions) but also projections into visual, auditory, bodily, verbal, and conceptual dimensions. If we think about the basic "schema" as abstracting just the essence of a routine event, then multimodal aspects may be more or less under-represented with the consequence that such information may not be readily available to cue

memory access. Fourth, *conceptual links or associations* can bridge one idea to another in a variety of different ways. Many such associations are "latent" within conceptual networks and only a fraction of such associations are likely to be relevant in a particular context. Making these associations explicit has the potential to enrich the cues available for memory access. Fifth, *conceptual links can be processed in a range of different ways* – in most circumstances we can, for example highlight the similarities between two things or their differences. Awareness of alternative attributes of conceptual links relates to the role of perspective in memory access described earlier,

and may facilitate elaboration of cues for the

retrieval of schematic content. A strategy for hierarchical decomposition capitalises on a key feature of SenseCam imagery: the ability to systematically vary rates of presentation. Exploratory work in our laboratory found that movies for specific days and more highly differentiated montages can be presented at up to 12 frames per second (fps). At this rate, the content of some frames masks information in preceding frames. Nonetheless, with appropriate editing, both our impressions and those of the patients we have recruited are that this enables the essence of the event to be grasped. The fleeting nature of an image sequence containing approximately 24 different basic activities, each lasting 4 seconds, naturally restricts elaborative processing of detail. Theoretically, however, this should function to activate or prime a wide range of schematic content in close temporal proximity, thereby rendering their respective contents more accessible in the immediate term. When the same montage is slowed to 6 fps (8 s per activity), less material is masked and more specific details of the decomposition of the montage become explicit. We introduce each intervention session by showing the patient his or her own montage at 12 fps, immediately followed by a 6-fps exposure, to prime the full range of schematic models encapsulated in the montage. The therapist or carer then presents only one or two of the 24 basic activities and the sequence can be paused to allow discussion of the detailed content of the activity. In this final phase, the patient is guided and encouraged to use concrete strategies based on decomposition and recomposition of schematic content; multimodal imagery; associations to bridge from one content area to another to render implicit links explicit; and cognitive tactics to explore similarities, differences, and use of alternative perspectives.

SUMMARY AND CONCLUSION

The ideas presented in this paper must, of course, be read and assessed for what they are: theoretically derived conjectures based on prior evidence concerning recollection in normal ageing, dementia, and depression. Evidence from divergent sources indicates that there are unlikely to be simple answers to deep theoretical questions about the underlying mechanisms of impaired recollection. Instead, variability in the decline of memory function is likely to arise from multiple factors. In particular, attention was drawn to similarities in the recollection deficits associated with depression and dementia, suggesting the possibility of shared underlying mechanisms. It is our view that future SenseCam research must pay careful attention to emotional and cognitive processes that are common to these disorders. Schemata or schematic representations were considered not only to be a key determinant of recollection but also to form a direct bridge to a key property of SenseCam imagery-the possibility for simulating a complete event schema in temporally compressed, but nonetheless contextualised form. This paper outlines a number of specific principles or strategies that may be usefully applied to enrich the generation of conceptual cues that may facilitate mnemonic access.

At a more practical level, only a firm evidence base for the efficacy of SenseCam-based interventions will justify the scale of commitment and effort required of users, carers, and therapists. That evidence base should include well-charted boundary conditions for effectiveness across patient samples and detailed information about SenseCam's "active ingredients". It should also demonstrate effect sizes that are not just "statistically" but also clinically and socially significant. Even for such an inherently engaging technology as SenseCam, these are tough challenges.

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