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The seven sins of memory: an update

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ABSTRACT

Memory serves critical functions in everyday life, but it is also vulnerable to error and illusion. Two decades ago, I proposed that memory errors could be classified into seven basic categories or “sins”: *transience*, *absent-mindedness*, *blocking*, *misattribution*, *suggestibility*, *bias*, and *persistence*. I argued that each of the seven sins provides important insights concerning the fundamentally constructive nature of human memory, while at the same time reflecting its adaptive features. In this article I briefly summarise some key developments during the past two decades that have increased our understanding of the nature, consequences, and adaptive functions of the memory sins.

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Psychologists have long known that memory is subject to various forms of error and illusion. These observations played a key role in the emergence of the view that memory is fundamentally constructive rather than reproductive (Bartlett, 1932; Neisser, 1967). But even by the end of the twentieth century, there were few systematic attempts to organise or classify the ways in which memory can go awry. To fill the gap, I argued (Schacter, 1999, 2001) that memory’s misdeeds could be classified into seven basic categories or “sins”. Three “sins of omission” refer to different kinds of forgetting: *transience* (decreasing accessibility of information over time), *absent-mindedness* (breakdown at the interface of attention and memory), and *blocking* (temporary inaccessibility of information that is stored in memory). Three “sins of commission” refer to different kinds of distortion: *misattribution* (attributing a memory or idea to the wrong source), *suggestibility* (implanted memories that result from suggestion or misinformation), and *bias* (retrospective distortions produced by current knowledge, beliefs, and feelings). The seventh sin, also one of commission, is *persistence* (intrusive or pathological remembering of events). Although each of the sins can wreak havoc in everyday life, a key idea in the seven sins framework is that rather than reflecting fatal flaws in the architecture of memory, the sins are more usefully conceived as consequences of processes that contribute importantly to the adaptive functioning of memory in everyday life (Schacter, 2001, Chapter 8).

Two decades have now passed since the original proposal of the seven sins of memory, and during that time there has been much progress in documenting their causes and consequences. I recently completed a revision of the 2001

edition of *The Seven Sins of Memory* that discusses noteworthy new developments related to each sin (Schacter, *in press*). In this article, I will briefly summarise a few of these developments regarding the six forgetting and distortion-related sins that speak most directly to the reliability of human memory, and also consider the current status of an adaptive perspective on the memory sins.

The seven sins of memory: some new and noteworthy developments

Transience

The observation that memory performance typically declines over time famously dates to the beginning of the experimental investigation of memory pioneered by Ebbinghaus (1885/1964). It is therefore perhaps ironic that one of the more intriguing observations concerning transience during the past two decades concerns evidence for “anti-transience”: individual differences and experimental manipulations that selectively mitigate forgetting over time. The individual differences evidence comes from observations of individuals identified in studies by McGaugh and colleagues who have come to be known by the term Highly Superior Autobiographical Memory (HSAM; LePort et al., 2012). Beginning with a case study of a woman with a remarkable ability to recall her specific past personal experiences (Parker et al., 2006), and extending to larger groups of similar individuals (e.g., Patihis et al., 2013; Santangelo et al., 2018), research concerning HSAM has begun to unravel some of the cognitive and neural features that characterise these

individuals' exceptional abilities to recall personal experiences.

Most relevant to the present discussion, LePort et al. (2016) studied 30 HSAM individuals and found that they did not recall any more details than non-HSAM controls about personal events that had occurred a day or a week earlier. By contrast, the HSAM group did recall significantly more details about personal events that had occurred a month, a year, and 10 years earlier, thus indicating reduced forgetting over time. In a separate line of research, studies on the benefits of retrieval practice (also known as *the testing effect*) have shown a similar kind of anti-transience: In research on story recall, Roediger and Karpicke (2006) showed that compared with restudying, retrieval practice/testing did not benefit recall after a 5-minute delay, but did significantly boost recall relative to re-study after delays of 2 days and 1 week. These observations concerning HSAM and retrieval practice are probably not unrelated: HSAM individuals are known to repeatedly retrieve their past personal experiences, and this self-initiated form of retrieval practice is likely part of the explanation for their reduced transience at long delays. At the same time, these findings highlight the pervasiveness of transience in normal forgetting that is not mitigated by an unusual condition such as HSAM or a specific technique such as retrieval practice.

Absent-mindedness

A characteristic of absent-minded forgetting I emphasised in the first edition of *The Seven Sins of Memory* (Schacter, 2001) emerged from everyday examples and experimental research showing that when a person's task is to remember to carry out a specific action at a specific time in the future, if retrieval cues are not available at the moment the action needs to be carried out, and attention is not focused on the task goal, absent-minded forgetting can be severe (e.g., Vortac et al., 1995).

However, neither the prospective memory research nor everyday examples I cited presaged a phenomenon that was little known prior to 2001 but has become all too familiar since: parents who forget that their infant is in a car seat in the back of a hot car, often resulting in the death of the child. Such cases regularly appear each summer, and typically involve a "perfect storm" of circumstances that support catastrophic absent-minded forgetting: a change in routine, absorption with pressing concerns unrelated to the child, reliance on automatic behaviour, and an absence of retrieval cues at the moment they are needed. As Weingarten (2009) pointed out in his compelling discussion of these cases, they began to increase after experts recommended moving infant car seats to the rear of the car in order to avoid dangers posed to young children by front seat airbags: "If few foresaw the tragic consequence of the lessened visibility of the child ... well, who can blame them? What kind of person forgets a baby?".

We now know that almost anyone can exhibit such forgetting, including many highly functional and responsible parents. Fortunately, in recent years a variety of external cuing systems have been developed that provide the missing retrieval cue that is crucial to avoiding such tragedies (e.g., Baldwin, 2019; for further discussion of hot car cases and cuing systems, see Schacter, *in press*). These horrific cases of cue-dependent absent-minded forgetting represent a costly vulnerability of human memory, and yet they reflect the same principles previously demonstrated in the laboratory and in less consequential everyday examples.

Another important post-2001 development related to absent-minded forgetting concerns the phenomenon of *mind wandering*: when attention drifts away from the task at hand, and focuses instead on task-unrelated thoughts (for conceptual discussion of varieties of mind wandering, see Seli et al., 2018). Mind wandering, which emerged as a major topic of research in cognitive psychology and neuroscience during the first decade of the twenty-first century (e.g., Smallwood & Schooler, 2006), can operate as a source of divided attention that results in absent-minded forgetting of task-related information. This consequence of mind wandering has been examined in relation to educational settings, where studies of classroom and video-recorded lectures have demonstrated that mind wandering occurs frequently, and that more frequent mind wandering is associated with poorer retention of lecture material (e.g., Lindquist & McLean, 2011; Risko et al., 2012; Szpunar, Khan, & Schacter, 2013; for review, see Schacter & Szpunar, 2015). Interpolating brief quizzes regarding lecture content in video-recorded lectures can reduce the frequency of mind wandering and enhance retention of lecture content (Szpunar et al., 2013; see Pan et al., 2020, for similar benefits from pretesting lecture content).

Despite the negative educational consequences of mind wandering during lectures, and the tragic costs of forgetting young children in hot cars, it is encouraging that simple interventions can reduce both forms of absent-minded memory lapses.

Blocking

By 2001, much research had been published on various forms of retrieval blocking, including tip-of-the tongue states (e.g., Burke et al., 1991) and retrieval-induced forgetting (e.g., Anderson et al., 1994). But it was only during 2001 that a new kind of retrieval inhibition was introduced by Anderson and Greene's (2001) seminal paper using the now well-known think/no-think paradigm to show that trying to suppress retrieval of the target word from a paired-associate ("no think" condition) produced a small but significant reduction in later recall of the target compared with both "think" words (i.e., target items recalled in response to the paired cue) and, critically, baseline items that were studied but not presented during the

think/no think phase. The phenomenon engendered controversy because of some failures to replicate (e.g., Bulevich et al., 2006), but subsequent meta-analyses have revealed evidence for a modest but significant impairment of recall of “suppress” items in the think-no think paradigm (Anderson & Huddleston, 2012; Stramaccia et al., 2020).

Importantly, the effect has proven robust enough to study with neuroimaging procedures that have provided new insights into its neural basis. For example, Anderson et al. (2004) found that when people are trying to suppress a target item during the “no think” phase, (a) prefrontal regions associated with cognitive control showed increased activity, (b) the hippocampus, a brain region often linked to successful recollection, showed some evidence for decreased activity; and (c) these brain changes predicted the extent to which a specific item suffered from impaired recall that is attributable to retrieval inhibition. A more recent study (Schmitz et al., 2017) revealed a possible role for GABA, an inhibitory neurotransmitter, in modulating retrieval inhibition in the think-no think paradigm: there was a positive association between a higher resting concentration of GABA in the hippocampus and a greater ability to suppress “no think” items, and stronger coupling between the hippocampus and prefrontal cortex during attempted suppression. These and related findings provide new insights into the brain mechanisms that produce the kind of retrieval blocking elicited by the think/no think paradigm.

Misattribution

Misattribution can take various forms, including source memory confusion, false recall, and false recognition, which had all been studied extensively by 2001. By contrast, one of the most dramatic forms of misattribution, *déjà vu*, was still largely a clinical curiosity. That is no longer the case, however, as experimental studies have developed systematic methods to elicit and analyse *déjà vu*. For example, Cleary and colleagues developed novel virtual reality paradigms to show that *déjà vu* can result from structural similarity between a new, current visual configuration and a previously experienced one (Cleary et al., 2012), which in turn can provide a basis for an illusory conviction that one knows what will happen next when navigating a virtual environment (Cleary & Claxton, 2018). The development of systematic methods for eliciting *déjà vu* has even made it possible to study it using fMRI (Urquhart et al., 2018). These kinds of studies are adding to our theoretical understanding of *déjà vu* and its implications for constructive views of memory (Aitken & O'Connor, 2020).

More generally, fMRI studies of misattribution, especially false recognition, have increased dramatically during the past two decades. Early evidence discussed in Schacter (2001) suggested that true recognition could be distinguished from false recognition based on increased activation in brain regions associated with sensory-

perceptual processing, and numerous recent studies have delineated the conditions under which such sensory reactivation effects are and are not observed (Schacter et al., *in press*). Importantly, such studies have also begun to identify brain regions consistently associated with false retrieval (for a meta-analysis, see Kurkela & Dennis, 2016), thereby clarifying the basis of certain kinds of subjectively compelling but illusory memories.

Suggestibility

During the 1990s, psychologists developed experimental paradigms for inducing through suggestion what Loftus (2003) later called “rich false memories” – detailed but inaccurate recollections of everyday experiences. By the end of the 1990s, studies using procedures based on Loftus and Pickrell’s (1995) “lost-in-the-mall” paradigm showed that suggestive procedures (e.g., visualisation, social influence) resulted in false memories of various kinds of everyday events for 20-30% of participants (e.g., Hyman & Pentland, 1996; Porter et al., 1999).

More recently, Shaw and Porter (2015) reported that a potent suggestive procedure drawing on visualisation and social pressure induced 70% of their college student sample to develop a false memory of committing a crime as an adolescent, which greatly exceeded the proportion of false memories previously produced in similar paradigms. However, the interpretation of this striking result was questioned by Wade et al. (2018), who identified problems with the criteria that Shaw and Porter used to classify a participant’s report as a “false memory.” Citing earlier work that distinguished between false memories and false beliefs, Wade et al. argued that most of the reports that Shaw and Porter classified as “false memories” are more appropriately characterised as “false beliefs”, i.e., people accepted a suggestion as true and speculated about specifics of what might have happened, but did not report a subjective experience of remembering the event (for empirical and conceptual considerations regarding the relation between belief and recollection, see Scorbria et al., 2014). After re-scoring Shaw and Porter’s results using criteria from previous studies that distinguish between false memories and false beliefs, they found that only about 25-30% of Shaw and Porter’s participants falsely *remembered* committing a crime, in line with earlier results.

Despite this important qualification, Shaw and Porter’s (2015) findings nonetheless provide a notable extension of previous work on suggestibility by showing that a combination of social coercion and imagination can lead a surprisingly high proportion of young adults to develop a false belief that they committed a crime. Wade et al.’s (2018) observation that only a much smaller proportion develop full-blown false memories is important theoretically, but the high proportion of false beliefs in this study nonetheless highlights the vulnerability of memory reports to corruption from suggestive influence.

Bias

A common form of retrospective bias is known as *consistency bias*, where people rewrite the past to make it consistent with their current knowledge, beliefs, and feelings (e.g., Ross & Wilson, 1999). During the past decade, evidence has emerged linking consistency bias with false recollections in the domain of political cognition. For example, Frenda et al. (2013) used an online survey to examine memory for three actual political events and five fabricated ones. They found that 27% claimed to remember seeing the fabricated events on the news (and about 50% claimed some type of memory for the fabricated event). Consistency biases influenced these false memories, with conservative participants especially likely to report false memories for fabricated events that depicted President Obama in a negative light, and liberal participants especially likely to report false memories for fabricated events that depicted President Bush in a negative light.

More recently, Murphy et al. (2019) reported related data in a study conducted just prior to the May 2018 referendum in Ireland concerning abortion rights. The eighth amendment to the constitution of Ireland guaranteed the unborn a right to life, resulting in extremely restrictive abortion laws. The “yes” side voted to repeal the eighth amendment and won a landslide victory over the “no” side that voted to preserve it. The week before the election, Murphy and colleagues administered an online survey to over 3000 adults, most of whom indicated that they would be voting in the referendum. The survey included photos and headlines of four true and two fake news stories pertaining to both the “yes” and “no” campaigns. Critically, there were two versions of each of the fake news stories, one that reflected negatively on the “yes” side and another that reflected negatively on the “no” side.

Participants were asked to choose among five options regarding their memory for the news stories: (1) I remember seeing/hear this; (2) I don’t remember seeing/hearing this but I remember it happening; (3) I don’t remember this but I believe it happened; (4) I remember this differently; (5) I don’t remember this. False memories occurred frequently for the fake news stories: 48% of participants choose either option 1 or 2, and the percentage increased to 63% when option 3 (i.e., false belief) was included. There was also some evidence that consistency bias played a role: “yes” supporters were more likely than “no” supporters to falsely “remember” fake news involving a fabricated scandal about the “no” side, whereas “no” supporters showed the opposite pattern. These findings are not only relevant to current political divisions in the United States, where the nature and even existence of “truth” has become a partisan issue, but also highlight a novel role for consistency bias in shaping the emergence of false memories.

An adaptive perspective

As noted earlier, a key concept in the seven sins framework is that rather than reflecting fatal flaws in the architecture of memory, the sins can be viewed as consequences of adaptive features of memory that contribute to its usefulness in everyday life. In the initial articulation of this perspective (Schacter, 1999, 2001), I relied on functional and evolutionary analyses of memory, some developed in previous work on adaptive aspects of forgetting (e.g., Anderson & Milson, 1989; Anderson & Schooler, 1991; Bjork & Bjork, 1988), to make the case for this approach to conceptualising the seven sins.

However, whereas there was little experimental evidence to support this adaptive perspective in 2001, during the past two decades an increasingly impressive body of such evidence has emerged. Much of this evidence has been reviewed elsewhere and I refer the interested reader to those sources for in-depth discussion (Ditta & Storm, 2018; Fawcett & Hulbert, 2020; Howe, 2011; Nørby, 2015; Schacter, *in press*; Schacter et al., 2011; Schacter et al., *in press*). Recent evidence is particularly strong for misattribution errors, including findings that (a) false memories in the Deese-Roediger-McDermott false recognition paradigm (Roediger & McDermott, 1995) can boost performance on subsequent tests of creative problem solving (Howe & Garner, 2018) and analogical reasoning (Howe et al., 2015); (b) source misattributions are increased when people make correct (vs. incorrect) associative inferences regarding overlapping features of related episodes (AB, BC) by retrieving and recombining elements of those episodes, including contextual features that are mistakenly combined (Carpenter & Schacter, 2017, 2018); and (c) episodic simulation and retrieval processes that support the adaptive function of future thinking can also increase memory errors and biases (Devitt & Schacter, 2018, 2019; Dewhurst et al., 2016; Dewhurst et al., 2019; Thakral et al., 2019; for a theoretical analysis, see Schacter & Addis, 2007, 2020).

Conclusion

Overall, the picture of the memory sins painted during the past twenty years supports a constructive perspective on memory by providing new examples of the manifestations and consequences of each of the sins, as well as novel insights into the mechanisms that produce them. The emerging evidence on the benefits of the memory sins supports the view that they reflect the operation of *adaptive constructive processes* (Schacter, 2012), which play a functional role in memory but produce errors and distortions as a consequence of doing their adaptive jobs. A constructive memory is not always a reliable one, but it need not be a dysfunctional one either: the same processes that can undermine memory’s reliability sometimes do so while contributing to the effective operation of a variety of mental functions.

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