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COMMENTARY

Reforming the Seven Sins of Memory to Emphasize Interactions and Adaptiveness

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Memory errors can take many forms: forgetting an ice cream container in the back of a hot car, recalling an accident in a way that absolves one of culpability, or believing that election misinformation is true, among many others. Much research seeks to understand such errors. They provide the basic scientist with windows into understanding how memory works and have implications in a myriad of real-world domains including but not limited to eyewitness testimony, advertising, education, and the proliferation of political misinformation (Schacter, 2022b; see also Baddeley et al., 2002; Dunlosky et al., 2013; Loftus, 1979). In an effort to gain traction on such errors, the review by Schacter (2022a) builds on prior work (Schacter, 1999, 2022a, 2022b) that classifies memory errors into the seven sins of memory: the sins of commission include misattribution (incorrectly remembering the source of a memory), bias (knowledge or beliefs shaping memory of the past), suggestibility (misleading suggestions leading to memory errors or false memories), and persistence (the retrieval of aversive memories), as well as the sins of omission such as transience (forgetting information over time), absentmindedness (lack of attention leading to forgetting), and blocking (failure to retrieve information stored in memory). This taxonomy serves several important functions: it emphasizes that there is more than one kind of memory error and highlights errors' similarities and differences; it offers a convenient way of talking about memory errors (for both scientists and the general public); it also coins catchy labels that attract attention to the science of memory errors. While taxonomies are powerful because they simplify, this should not be at the cost of understanding the complex cognitive processes that underlie these memory sins. Therefore, 2 decades after the original publication of the "Seven Sins of Memory" (Schacter, 1999), we believe this taxonomy should more explicitly reflect two things, neither of which we think is particularly controversial: first, that many memory errors reflect a confluence of sins, and second, that it is time to more enthusiastically embrace a "cup half-full" approach, emphasizing the adaptive nature of memory.

Like a plane crash, rarely is a memory error the result of a single sin. Airline disasters often result from a confluence of errors: human, mechanical, and weather (Dismukes & Nowinski, 2006). For example, United Express Flight 4933 crashed on a snowy runway under foggy conditions with blowing snow impairing vision; the Federal Aviation Administration report notes that fatigue led the pilots to ignore instrument readings and other visual signals important in such snowy contexts. The same thing happens with many major memory errors, such as when a parent forgets a child in a hot car: it often occurs during a break in routine (deviation from a schema), while absentminded (perhaps worrying about work), and without retrieval cues (no view of a backward-facing baby in one's rearview mirror). This confluence of processes can also be protective—such as when a distracted parent automatically drives to day care and unloads the child without fail (schema reliance). This is why experts recommend placing retrieval cues in the car—for example, stowing one's purse in the back seat when buckling the child or keeping an object in the car seat that is moved to the front seat when the child is buckled. Doing so creates retrieval cues that can counteract the negative outcomes of absentmindedness, requiring a driver to see the baby when searching for their bag or providing a physical cue associated with the infant passenger in the view of the driver, respectively.

To illustrate the multifactorial nature of memory errors with data, we use a seemingly simple memory error: the illusory truth effect. This simple effect is the finding that a statement is rated truer if it was read earlier as compared to new statements (Brashier & Marsh, 2020; Dechêne et al., 2010; Hasher et al., 1977). This finding is not limited to obscure trivia statements; it also occurs with news headlines, both real and those containing falsehoods or misinformation. Studies have shown that when assessing people's willingness to share news headlines, the perceived accuracy of that news is highly influenced by the number of times people had seen the same headline before—the more times a news headline is seen, the more believable the news headline is (Pennycook et al., 2018; see also Calvillo & Harris, 2022). The illusory truth effect can be interpreted as a sin of misattribution: incorrectly remembering a fake news headline as true and misattributing fluent processing to an accurate source. However, it can also be explained as a problem of blocking, with recently exposed (incorrect) information blocking access to the correct information stored in memory (Fazio et al., 2015). That

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is, even when people hold the correct information, knowledge, or skills to identify a false statement, the recent repetition of false claims can block access to stored knowledge, resulting in an illusory truth effect even when participants knew better. Further, the illusory truth effect can also be linked to bias—because the default assumption is that information is true (Gilbert, 1991); based on past experience, we expect the information we encounter to be true, unless warned otherwise (Jalbert et al., 2020; Newman et al., 2020).

Recent work from our own lab also shows a role for absentmindedness in the illusory truth effect. Here, we probed participants' self-reported mind-wandering as they were initially exposed to and rated the truth of each of a long series of true and false scientific claims (Stanley et al., 2022). Periodically during this stream of true and false claims, participants were interrupted and asked to rate whether they were focused on the task at hand or thinking about things unrelated to the truth-rating task. Then, at test, as each scientific claim was again rated for truthfulness, we examined whether scientific claims encountered while mind-wandering elicited the illusory truth effect. That is, we asked how participants rated the truth of statements encountered during a time when they reported being off-task and absentminded. Quite interestingly, mind-wandering during initial presentation had no impact on the illusory truth effect: previously seen statements were rated as truer on the final test, as compared to new statements, even if that initial exposure occurred during a period of absentmindedness. While mind-wandering did not overall affect the presence of an illusory truth effect, the depth of mind-wandering mattered—when participants were asked to rate the severity of their mind-wandering, we found that the more intense or severe an episode of mind-wandering was the smaller the illusory truth effect was (though still present).

In short, the illusory truth effect can be linked to four of the seven sins: misattribution, blocking, bias, and absentmindedness—with implications for interventions in the world. This analysis gives us a better understanding of the mechanisms driving the effect, but important for our current thesis, this more fine-grained analysis also highlights a problem with the taxonomy's strength (of simplifying memory). While it is intuitive to illustrate particular mechanisms with specific examples, stopping there runs the risk of implying a direct causal link between specific examples and specific sins instead of understanding the full picture of the complex, and sometime adaptive, memory processes involved.

In addition to highlighting individual errors over interactions between processes, the taxonomy emphasizes problems over the adaptiveness of the processes driving these errors. While Schacter has repeatedly stressed the adaptiveness of memory (see Schacter, 2022b; see also Carpenter & Schacter, 2017, 2018; Carpenter et al., 2021; Schacter, 2012; Schacter & Addis, 2007, 2020; Schacter & Guerin, 2011; Thakral et al., 2021), labeling the errors as sins puts the focus on the shortcomings of these processes—even though they likely evolved because they normally help the learner. For example, most of the time the absentminded bike rider still ends up at home, even if they are thinking about the events of the day. The rider does not need to explicitly remember each step-by-step direction, because the familiar commute provides strong contextual cues that prevent the rider from turning down the wrong streets, allowing multitasking. Like the classic saying "one person's trash is another's treasure," whether these processes yield trash—a memory error—or treasure—contributing to an adaptive process—depends upon the task at hand.

To illustrate this problem with data, consider two parallel studies that are often cited for very different reasons. One is the classic Bransford and Franks's (1971) study where individuals heard sentences like "The ants in the kitchen ate the jelly," "The jelly was on the table," and "The ants ate the sweet jelly." At test, subjects were told to classify each of a series of related sentences as heard earlier versus new. The famous finding is that subjects claimed to have heard "The ants in the kitchen ate the sweet jelly on the table" even though that sentence was never actually presented during study. Now, consider a more recent study by Bauer and San Souci (2010), in which young children listened to several stories, one of which contained the fact "dolphins live in groups called pods" and another of which contained the fact that "dolphins communicate by clicking and squeaking." Of interest was whether children would later be able to answer the question "how does a pod talk?" The important finding is that young children were able to "productively extend their knowledge" by linking these two episodes together and inferring that pods communicate by clicking and squeaking. At their essence, the two studies are the same: a never-stated statement is extracted. But in one case, the memory is considered an error and in the other an impressive inference.

A similar example comes from aging research, when thinking about how prior experience supports aging memories (see Umanath & Marsh, 2014, for review). Older adults' vast knowledge about the world can both help and bias memory. For example, Koutstaal et al. (2003) examined people's abilities to recognize whether abstract shapes had been previously studied or not; at study, some shapes were labeled (i.e., lamp) in a way that provided an interpretation for the shape. Without labels, older adults were no more likely than younger adults to false alarm to novel figures at test. However, when shapes could be interpreted as familiar objects, older adults were more likely to falsely recognize an item as being previously studied, in comparison to their younger counterparts (see also Koutstaal, 2006). We see similar findings from Castel (2005), who also showed how reliance on prior knowledge and schemas affects memory—except in this case, the focus was on supporting memory rather than on memory error. Older and younger adults studied prices of groceries and later recalled cost information; critically, some grocery items were priced realistically, at market levels, whereas others were priced arbitrarily. Schema-consistent (market prices) information was accurately remembered regardless of age, whereas older adults showed the standard age deficit in remembering arbitrary prices. Again, both studies show the effects of schemas, but one focuses on the cost (false memory), whereas the other focuses on the benefit (supporting older adults' memories).

To complement Schacter's (2022a) analysis and to address the two issues outlined here, we suggest the following way forward: a stronger focus on the memory processes involved rather than on a taxonomy of errors. For example, rather than focusing on the sin of misattribution, it is helpful to think about how people interpret fluent processing. Sometimes, fluency provides a shortcut to correct inferences because we base our interpretation of that fluency on our past experiences in the world. Other times, when something is fluent for the wrong reasons, fluency leads us astray. Naming the sin but not the adaptive use of fluency puts too much emphasis on the cost of an adaptive process. Focusing on the processes involved would also remove another problem with the taxonomy; as currently written, some sins refer to processes (e.g., misattribution), but others

describe the products of processes (e.g., transience). For example, suggestibility is defined as misleading suggestions yielding memory errors (or even false memories), which is an end state that could come about in many different ways. Being clearer about the processes would also help with overlapping sins; for example, blocking and misattribution often occur together (such as when a misleading suggestion is attributed to a prior event). Choosing to study these memory sins as processes opens the door to applying theoretical nuance when investigating real-world memory errors, focusing not on simple classification but a mechanistic understanding of how memory operates—its failures, successes, and interactions between processes. Ultimately, this can lead to a deeper understanding of not only the shortcomings of memory but also the adaptiveness of these systems when operating in a complex, error-prone environment.

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