Introduction

The Atkinson-Shiffrin (1968) model is often referred to as the “modal model” because it masterfully synthesized many of the prevailing ideas of that era into a compelling—and above all, useful—information processing theory of human memory. As a result, it is one of the most well-known and highly cited theories in the field. Even today, according to Google Scholar, this singular chapter is cited more than 700 times a year. Virtually every introductory psychology textbook, and certainly every Google Scholar, this singular chapter is cited more than 700 times a year. In its simplest form, the Atkinson-Shiffrin (1968) model holds that if you attend to information registered in a sensory store (e.g., the auditory information associated with several just-spoken words), some of that information will be transferred to short-term store (STS), where it can be rehearsed and ultimately transferred to long-term store (LTS). In essence, STS is what you are consciously thinking about right now, and nothing is transferred to LTS without first passing through STS. Later, any information successfully transferred to LTS can be retrieved back into STS (i.e., back into conscious awareness).

And that’s pretty much it, or so I thought for a long time. Like me until relatively late in my career, you may not have read the original Atkinson and Shiffrin (1968) chapter. Instead, your understanding of it likely consists of the simplified textbook version that you use when teaching a class that covers the topic of human memory (i.e., the version briefly summarized above). Yet it is worth reading the chapter itself because, though largely missing from the historical record, these authors were a lot more forward-thinking than the basic version of their model implies. For example, you might not know that the Atkinson-Shiffrin model was offered as “…a general framework within which specific models can be formulated” (p. 91),” not as a finished theory. Yet the simplest version of that modeling framework is what appears in textbooks, which sometimes go on to claim that the model was later proven...
wrong. However, the first three sections of the chapter (pages 90 to 122) present not only the general framework described above but also a broader theoretical perspective about how human memory works. These pages should be required reading for any student of memory because, aside from describing their famous modeling framework, Atkinson and Shiffrin anticipated some of the most influential developments in the field of memory that would occur in the ensuing years (developments that could be easily implemented in the framework they proposed).

The pdf of the original chapter does not make for easy reading because it looks as old as it is. Therefore, in hopes of encouraging you to read it, and to also put Atkinson and Shiffrin’s theoretical perspective into the archival literature, the Journal of Memory and Language agreed to have the initial pages of the original chapter (pages 90–122) re-typeset and published anew. These pages are where Atkinson and Shiffrin present their overall conceptualization of memory, including both the modeling framework and their more encompassing theory of memory. The remaining 72 pages (pages 123–195) describe a particular instantiation of the proposed framework involving a singular verbal STS and a rehearsal process that transfers information into LTS at a constant rate. They also present the results of various experiments testing that version of the model, and those pages are very much worth your time as well. However, my main focus is on how Atkinson and Shiffrin conceptualized human memory, as described in the first three sections of their chapter that are reproduced here. I next provide a brief overview of several post-1968 theoretical developments that are sometimes thought to contradict the Atkinson-Shiffrin model even though one can find those same theoretical ideas clearly spelled out in their chapter. In considering these issues, my goal is to ensure that, going forward, this seminal and still highly influential chapter is more accurately characterized than it has been in the past.

Working memory

One of the major developments that would follow the original publication of the Atkinson-Shiffrin model was Alan Baddeley’s recasting of the short-term store into a multistore system consisting of a verbal buffer and a separate visual buffer, plus a central executive (Baddeley, 1992). Baddeley’s original view has evolved even further over the years, but the basic idea of separate stores remains viable to this day. I used to teach students that this advance in our understanding of short-term store overturned one of the central assumptions of the Atkinson-Shiffrin model. However, when I finally read their 1968 chapter, I was surprised to learn that Baddeley’s influential model is an elaboration of ideas proposed by Atkinson and Shiffrin, not a rejection of how they viewed the short-term store. In fact, Atkinson and Shiffrin even explicitly used the phrase “working memory,” emphasizing not only storage capacity but also the role of STS as a mental workspace. In addition, they drew a distinction between a verbal short-term store and a separate visual short-term store. For example, on page 92 of their chapter, they write: “The second basic component of our system is the short-term store. This store may be regarded as the subject’s ‘working memory’” (emphasis added). And on page 111, they write: “If the word ‘cow’ is presented, for example, the sound of the word cow will enter STS; in addition, associates of cow, like milk, may be retrieved from LTS and also entered in STS; furthermore, an image of a cow may be entered into a short-term visual store” (again, emphasis added). And consider this:

“As each element in the register is scanned, a matching program of some sort is carried out against information in long-term store and the verbal ‘name’ of the element is recovered from long-term memory and fed into the short-term store. Other information might also be recovered in the long-term search; for example, if the scanned element was a pineapple, the word, its associates, the taste, smell, and feel of a pineapple might all be recovered and transferred to various short-term stores” (p. 96).

Various short-term stores? I never realized they conceptualized memory in that way until I read the chapter, at which point I stopped teaching that the later discovery of a multimodal short-term memory system proved the Atkinson-Shiffrin model wrong. Evidently, the various multimodal short-term stores they envisioned could be implemented in the Atkinson-Shiffrin modeling framework even though, in their experiments, they pursued the simplest version of that modeling framework involving a single verbal STS.

The distinction between STS and LTS

Another way in which the model is sometimes said to be wrong is its foundational assumption that the brain’s short-term store is distinct from its long-term store. Some argue that no such distinction exists, but something made Atkinson and Shiffrin assume otherwise. What was it? Essentially the same thing that makes many researchers assume otherwise to this day. When the Atkinson-Shiffrin model was proposed in 1968, Brenda Milner had recently reported that amnesic Patient HM’s digit span appeared to be largely intact despite his dense anterograde amnesia. The theoretical implications of HM’s memory profile were compelling, and Atkinson and Shiffrin (1968) summarized those implications as follows: “For this reason, we turn to what is perhaps the single most convincing demonstration of a dichotomy in the memory system: the effects of hippocampal lesions reported by Milner (1959, 1966, 1968).” Apparently, a short-term store remains to the patients, but the lesions have produced a breakdown either in the ability to store new information in long-term store or to retrieve new information from it. These patients appear to be incapable of retaining new material on a long-term basis” (p. 97).

This same point was later underscored even more convincingly when Larry Squire described both the preserved abilities and profound impairments of Patient EP (e.g., Insassiti et al., 2013). EP’s bilateral MTL lesions were larger than HM’s and his anterograde amnesia was complete. This is unlike HM, who retained a sliver of his premorbid ability to form new memories. Theoretically, at least, that slightly preserved ability might be able to explain his well-functioning verbal short-term memory. However, this argument does not work with Patient EP because his ability to transfer information to LTS (i.e., his ability to form conscious declarative memories) was nonexistent.

Some have argued that amnesic patients like these have a working memory impairment as well, and that may or may not be true. However, any such impairment is trivial relative to the impairment in forming new
long-term memories. To see why, watch Patient EP effortlessly repeat back from verbal STS a list of 4 words at the 1:27 mark of this video. In contrast to his ability to hold words in his verbal short-term store, elsewhere in the video, it illustrates just how complete his anterograde amnesia is. For example, EP has met Squire’s lab manager, Jen, ~200 times but still does not know her name or remember ever having seen her before. In other words, nothing gets into his long-term store. To me, and to this day, there is no more convincing evidence that the distinction between verbal STS and LTS is prima facie valid. Whether the same holds true of visual short-term memory and LTS is a separate question, but verbal STS appears to be a distinct capacity subserved by brain regions that are distinct from the medial temporal lobe (the structures that support the transfer of information to LTS).

Depth of processing

Finally, more than any other misconception I once had about the Atkinson-Shiffrin model, none was more wrong than the idea that the model contained no provisions for what we now call “depth of processing.” Upon reading their chapter for the first time, I was caught by surprise upon reading these words:

“This transfer from STS to LTS may be considered a permanent feature of memory; any information in STS is transferred to LTS to some degree throughout its stay in the short-term store. The important aspect of this transfer, however, is the wide variance in the amount and form of the transferred information that may be induced by control processes. When the subject is concentrating upon rehearsal, the information transferred would be in a relatively weak state and easily subject to interference. On the other hand, the subject may divert his effort from rehearsal to various coding operations which will increase the strength of the stored information. In answer to the question of what is a coding process, we can most generally state that a coding process is a select alteration and/or addition to the information in the short-term store as the result of a search of the long-term store. This change may take a number of forms, often using strong preexisting associations already in long-term store” (emphasis added, p. 115).

This is a modern perspective in that the coding processes Atkinson and Shiffrin had in mind (“...select alteration and/or addition to the information in the short-term store as the result of a search of the long-term store”) are not unlike what Fergus Craik would later call “deep semantic processing” (Craik & Lockhart, 1972).

Again, the fact that Atkinson and Shiffrin foreshadowed how we would later come to think about human memory does not mean that they should be credited with this discovery. Craik and his colleagues performed the decisive experiments that moved the field to where it remains even today. My point instead is that it is a mistake to believe that these later developments contradicted the Atkinson-Shiffrin model, as if their main argument was that rote/maintenance rehearsal is what transfers information to LTS.

How did the Atkinson-Shiffrin (1968) model come to be viewed as a theory of maintenance rehearsal, per se? It is not entirely clear, but consider what they say here:

“A second purpose of rehearsal is illustrated by the fact that even if one wishes to remember a telephone number permanently, one will often rehearse the number several times. This rehearsal serves the purpose of increasing the strength built up in a long-term store, both by increasing the length of stay in STS (during which time a trace is built up in LTS) and by giving coding and other storage processes time to operate. Indeed, almost any kind of operation on an array of information (such as coding) can be viewed as a form of rehearsal, but this paper reserves the term only for the duration-lengthening repetition process” (emphasis added, p. 111).

The length of stay might very well build up a trace even without coding processes (i.e., despite the use of maintenance rehearsal), but as noted earlier, they suggested that it would be a weak trace. In agreement with this idea, there is evidence that maintenance rehearsal does in fact have this effect, detectable mainly when recognition is used (Greene, 1987) but also under certain circumstances even when a recall test is used (Hartshorne & Makovski, 2019; Lehman & Malmberg, 2013; Wixted, 1991).

But the key point is that Atkinson-Shiffrin (1968) made it clear that coding processes akin to elaborative rehearsal would be more effective than what we now call maintenance rehearsal. For example, on page 171 of the chapter (in the experimental section that is not reproduced here), they say “Certainly if the subject is engaged in coding or other active transfer strategies, the time spent in attending to an item should be directly related to the amount of transfer to LTS.” It stands to reason that the more effective a coding process is, the less time would be required to effectively transfer information into LTS. Indeed, using strong preexisting associations already represented in LTS, information could presumably be transferred with minimal rehearsal. This might explain why patients with limited STS capacity and limited ability to rehearse can nevertheless transfer auditory verbal information into LTS when the to-be-remembered material consists of meaningful paired associates (Baddeley et al., 1988). Yet, in their experiments, Atkinson and Shiffrin (1968) chose to mainly focus on the “duration-lengthening repetition process” of verbal information instead of manipulating coding processes. A “repetition process” sounds like the veritable definition of maintenance rehearsal, so perhaps this is why their model is often incorrectly viewed as a model of the effects of maintenance rehearsal, per se.

Conclusion

Few people appreciate that Atkinson and Shiffrin, in addition to proposing an influential and enduring modeling framework, were in many ways ahead of their time. This is why the model they described is often mischaracterized as having been disconfirmed by subsequent research. I was guilty as charged until I finally read their highly cited chapter, for reasons I cannot even recall. I suggest that you consider reading their chapter earlier in your career than I did. Like me, you might be surprised by what you find.

CRediT authorship contribution statement

John T. Wixted: Conceptualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

References


