

Episode 11: O Memory, Memory, Wherefore Art Thou Memory?

Show Notes

Cognitive psychologists make a lot of distinctions with different types of memory. In this episode I provide an overview of the various ways that scientists have divvied up memory, and how each relates to how we play games.

Game References

Assassin's Creed: Origins, Call of Duty, Clank!, Dominion, Kingdomino, Scrabble, Uno

Research References

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Transcript

Hello! Welcome to Episode 11 of the Cognitive Gamer podcast. I am your host, Steve Blessing. I have already done a couple of episodes related to memory, but it occurs to me now that I should probably give a general overview of memory and how it relates to games. Indeed, there will be several more episodes in which we'll talk about memory. Having a bit of a roadmap to talk about as we go along seems like a good idea. As we've noted, we couldn't do much of anything without a memory, playing games included. Imagine trying to play a game, even a simple one like Uno, if you couldn't remember the rules. Or, if you couldn't remember what each of the cards do in Dominion. Or, if you couldn't remember what buttons to press as you play Super Mario Odyssey on your Switch. Using our different types of memories allows us to play all the games we like to play.

As you probably already knew, or at least gathered if you listened to the previous episodes, we have more than one type of memory. Depending on which researcher you talk to, you may get a slightly different list of memory types. What I would like to do in this podcast is to give you a sense of those different types, giving you a relatively complete picture of the different types of memory that are out there. We'll concentrate on where there is consensus between researchers, but I'll also point out some of the differences as we go along as well.

To begin, there are three main types of memory. We've already mentioned two of them on previous podcasts, a shorter term memory and a longer term memory. The shorter term memory, which some researchers call short term memory and some call working memory, holds a limited number of items, like 4 or 5, on the order of seconds to minutes. Long term memory, on the other hand, can hold essentially a lifetime's worth of memory for as long as we need it. Working memory is what is in our conscious awareness, whereas long term memory hold items that we can access in order to bring them into our consciousness. There are different types of working and long term memories, and we'll touch on those as we move through.

First though, I'll like to talk a little bit about the third type of memory that I haven't mentioned yet on a podcast. We need a way to get information from our environment into our conscious awareness, our working memory. There is a type of memory that works as a buffer that allows us to do just that. This is called sensory memory, and it operates as a very brief waystation or temporary warehouse for all the information that comes in through our senses. We touched on this a little bit back in episode 3 when we talked about Attention. A lot of information comes in through our senses, but we can only attend to a little bit of it. Conceptually, it's our sensory memory that takes in all of this information from our senses, and only a little slice of it ultimately winds up in our working memory. That's the role of attention, selecting what we take from our sensory memory to end up in our conscious awareness.

Okay, so this type of memory is called sensory memory, and in theory, we would have a sensory memory for each of our five senses, seeing, hearing, touch, taste, and smell. In practice, researchers have only really studied the first two in any real detail, seeing and hearing. Our sensory memory for sight is sometimes called iconic memory. This is the one we know the most about. I think about it a lot when playing video games in particular. Maybe I'm playing the new Call of Duty, I'm concentrating on one part of the screen, but I see something out of the corner of my eye and I switch my attention. It's my sensory memory that allows me to do this. All the information that comes in visually stays here for a short bit, and unless it's attended to, will fade away extremely quickly, in a fraction of a second. The same holds true for hearing, which uses what is called echoic sensory memory. All of the noise we pick up through our ears lands in echoic memory for maybe a couple of seconds at most, and unless we attend to it, will be lost forever. One important thing to note about sensory memory is that there is no meaning associated with the items here; they are just an icon or an echo, and those require attention to process, and it's only when those items end up in our shorter term memory that we attach meaning to them. Put another way, maybe we see Mario on the screen, that comes in through our iconic memory, but just like the screen has no understanding of the pixels it's showing that account for Mario, our sensory memory also has no understanding of the image or icon it registers, until our attention places that information into our shorter term store.

Okay, so the information initially lands in our sensory memory, and through attentional processes comes into our shorter term store. Here is where we are consciously aware of things. You look at your starting hand in Dominion, that information lands in iconic memory, and by attending to the features on the cards, you realize you have 4 coppers and an estate, and that is what is stored in working memory. At this point, you don't need to keep looking at them, because you have stored that information in your working memory. This shorter term store has been studied extensively, and we'll talk much more about it on future podcasts. We've already

talked about chunking in episode 7, a way that helps us to overcome working memory constraints. Because, as we mentioned in that episode, we can only have precious few items in this shorter term store, probably only like 3-4, unless we start to chunk items together. So, I might be able to remember all the cards in my current Dominion hand, but probably not the cards in my discard or draw pile late in the game, unless I'm a Dominion expert.

In a later podcast I'll talk much more about a particular theory about this shorter term store, Alan Baddeley's theory of working memory. This is a very well developed theory about what happens in this shorter term store, and how information comes in and out of it, and the different parts that compose this memory itself. Baddeley's theory is so influential it's why many researchers just call this shorter term memory "working memory" to begin with. Again, I'll get into some of this theory's particulars in a later podcast, but I'll give you a thumbnail sketch of it now. Under working memory, this shorter term memory is itself composed of three main parts, a central executive, and then two subordinate systems called the phonological loop and the visuospatial sketchpad. Later versions of the theory propose more parts, but I'll just concentrate on these three. As its name implies, the central executive runs the show making sure it has the information it needs to properly operate, and then it uses the phonological loop to handle verbal information and then the visuospatial sketchpad to do the more visual stuff. This is a dichotomy we have touched on before, as early as the first couple of episodes. We have different stores for visual stuff and for verbal stuff. We obviously see this in terms of how this information first gets processed by our senses, and that differentiation of duty, particularly between visual and verbal, gets kept not only here in working memory, but also as we have seen, in long term memory as well. And, as I believe I've also mentioned, if we can use this differentiation to complement our memories, then our ability to remember information increases. In particular, we can generally remember visual stuff much more easily than verbal stuff. So, if it's a list of items that you would like to remember, like maybe which cards you have already drawn into our hands in Dominion, so you know what you are likely to get on the next draw, if you could devise a visual picture to store to complement the verbal names, then you stand a better chance at remembering that information.

Okay, so, the information has come in through sensory information, and then, if attended to, goes into working memory where it is processed in a more meaningful way. If it is processed sufficiently, then it will go into a what's referred to simply as long term memory, where it could stay indefinitely. There's a lot of provisos to that, which we'll get into in a later podcast. Obviously things do get forgotten from long term memory and we don't remember things perfectly. The contents of our long term memories can change across time in very interesting ways. But again, that's a topic for another podcast. For many of you, your first memory is probably from when you were about 3 years old. That's just sort of how memory works, where we don't have any recallable memories from the first couple years of our lives. But, from age 3 on, you have at least some memories. Depending on your age now, those memories are now decades old. That's long term!

Long term memory then seems pretty straight-forward on the surface, these memories from way back that you are currently not consciously aware of, but you can, perhaps easily or perhaps with some effort, recall into your consciousness. These would include things like the rules for your favorite game, your ability to navigate through a video game you haven't played in years, or the events of your last game night. However, long term memory is a bit more complicated than that.

Most researchers will agree that there are different types of long term memories, just like there are different types of working memory. However, there is disagreement as to how exactly to divvy up long term memories, in terms of not only simply which labels to use, but also, more fundamentally, what the different types of long term memories are. I'll go through all the issues as we talk about things here.

Most researchers agree there are two main types of long term memories, what I will call declarative and non-declarative. Declarative memories are called that because you can easily declare them, or in other words, talk about them. If you find it easy to put into words, then it's probably a declarative memory. I can easily name all the games that I like to play. I can open the box for Clank! and describe what I see. I can tell you the story I've been through so far in Assassins Creed: Origins. Those are all declarative memories.

It gets a little complicated after that. Many if not most researchers will sub-divide declarative memories into two types, episodic and semantic. The issue becomes whether these two types, episodic and semantic, are truly qualitatively different from one another, or if they are really the same type of memory, but just differ in some type of quantity. I'll get a bit into that once I explain what each type is.

Episodic memories are memories that you know when and where they took place. That is, they have time and date information stored with them. Put simply, they are memories of episodes from your life, hence the name episodic. You can probably pretty easily bring to mind the last game that you played, either board game or video game. You can picture it in your mind's eye, and tell me where you were and what time it happened, and who you were with. That's an episodic memory. Maybe you have been to a convention recently, and you could tell your best friend everything that you did there. Again, that would be an episodic memory. The last Spiel des Jahres winner was Kingdomino. If you can recall when and where you were when you heard that news, that would be an episodic memory for you as well.

A semantic memory does not have that time and date information associated with it. It's essentially just a cold, hard fact that you picked up someplace but at this point you have no idea where. Some of you might be able to rattle off all the Spiel des Jahres winners for the last decade, but you couldn't necessarily say where or when you heard that information. That's semantic information. You can tell me the point values for the tiles in Scrabble, but again you have no idea when or where you first learned them. Most would say that's also semantic information.

We have these two types of declarative information, episodic and semantic. They are both declarative because you can easily talk about them, like the last game night you had or the components to your favorite game. As I said, there is some disagreement as to whether you need to postulate two different types of memories to account for these seeming differences, or can you account for everything with just one category. They do seem different, with episodic memories usually being associated with being able to picture things in your mind's eye, and semantic memories not so much. There are neurological studies that show different parts of the brain are active when you access these two memory types. That does definitely suggest differences. However, most if not all semantic memories probably started out as episodic memories. You

may not remember learning the point values of Scrabble tiles, but at some point someone did tell you, or you saw them, and right after that happened, you would have had an episodic memory of that event. But, that's faded over time and over all the times you might have played Scrabble, to where now it's more of a semantic type of memory.

Okay, we've talked about declarative memories, one of the two main types of long term memories. If you remember, I mysteriously called the second type of long term memory "non-declarative." In other words, researchers haven't necessarily come to agreement as to what best to call this second type, or perhaps even if there is just one type, so we'll call everything that isn't a declarative memory, a non-declarative memory. My bias is to just call it all procedural memory. This is your knowledge of how to do things like ride a bicycle, do multiple column addition, and use a twin stick controller. In class I'll tell students that your declarative knowledge is your "what" knowledge, your knowledge of what things are, and your procedural knowledge is your "how" knowledge, knowledge of how to do things. Some researchers will subdivide non-declarative knowledge into not only into procedural knowledge, but also include priming and conditioned learning. I won't take the time to disentangle all of those, but they all have this flavor that this is knowledge that you are not fully conscious of. Indeed, non-declarative knowledge usually works best when you don't try to be consciously aware of your actions. Have you ever tried to do an action that you are very familiar doing, like riding a bicycle, while trying to describe it to someone who doesn't know how? One of three things happens: 1) either it just slows you tremendously down, as you translate this procedural knowledge into something more declarative, or 2) not only does it slow you down but you also make mistakes, because you can't perform the action as fluently as you'd like; or 3) you're just left saying, "Well, you just do it like this" and you don't provide any useful commentary as you perform the action as quickly and assuredly as you usually do.

To most people this division of memory makes good sense, the division between declarative and non-declarative memories. There is actually another division that a fair number of researchers also make, and that's between implicit and explicit memories. Explicit memories are those that you can consciously recall, whereas implicit memories are those that you cannot consciously recall. That does sound a lot like the distinction between declarative and non-declarative that I made, but there are subtle differences that a cognitive scientist will argue with you about. Some will argue that you can have implicit and explicit declarative memories, along with implicit and explicit non-declarative memories. But, that's a distinction I don't think we need to make. And, I've seen some people argue for a third type of long term memory, conditional memory, containing your knowledge of why, as opposed to either what or how. For our purposes moving forward, I'll stick with just talking about declarative long term memories and procedural long term memories. That's the distinction that's made in the ACT theory of cognition of John Anderson, my mentor, thesis advisor, and big name in cognitive science. If it works for him, it works for me.

You may be curious to hear about one piece of evidence to support this distinction between two different types of long term memory. One classic example is from a patient who had brain trauma. In the literature he goes by the initials HM, but upon his death in 2008, his name was revealed to be Henry Molaison. When he was young, Henry got into a really bad accident involving his bicycle. After the accident, he was prone to suffering seizures. The seizures got so

bad that when he was 27, he underwent a radical surgery. To relieve the seizures, a surgeon removed Henry's hippocampus, along with some related parts of the brain. The hippocampus is key in working memory and forming new long term memories. The surgery relieved Henry of his seizures, but he now had a new problem; he had anterograde amnesia, meaning he could not remember new events that happened to him. His past was still intact, but no new memories could be formed. Psychologists used Henry's misfortune to learn a lot more about how memory works. One key insight was this distinction between declarative and non-declarative memories. I told you that Henry couldn't form new long term memories, but that's not entirely correct. As the psychologists worked with Henry, they discovered he could learn some new material. One classic example had Henry learn a new game of sorts, mirror tracing. In mirror tracing you simply trace a figure, like a star, with a pencil while looking at it in a mirror. It's a little challenging, because movement of course reverses in the mirror. As you would imagine, like with any skill, people get better at doing the task as they practice it. The psychologists were curious about Henry's ability to learn this game of mirror tracing. They brought him in on the first day, and asked if he ever did the task before. He correctly answered he hadn't, so they told him what to do. As long as Henry's concentration wasn't broken, he could remember what was happening to him. He practiced mirror tracing, and they saw improvement in terms of time and errors across that session. The next day they brought him in for another round of mirror tracing. When asked if he had ever done the task, he replied that he hadn't. That declarative memory wasn't able to be formed due to his missing hippocampus. So, they told him how to do the task again, and he commenced doing it. To their surprise, he showed improvement in doing the task over how he performed the task on the first day. That is, he didn't consciously remember having done the task before, he lacked the declarative "what" knowledge, but he still had laid down some procedural "how" memories that allowed him to show improvement at doing the task. This, along with similar evidence from other brain trauma patients, suggests two different types of long term memory, regardless of how you refer to them. If you are clever, you can also show dissociations between these two memory types with people with intact brains. But, that will have to wait for another podcast.

Just like some researchers posit that all semantic knowledge starts off as episodic, some researchers, like John Anderson, posit that most procedural knowledge has declarative origins. Again, that makes sense. We acquire most knowledge declaratively, by being told or reading it, and then that knowledge becomes proceduralized as we use it. Consider learning how to play a game. You maybe saw a Watch it Played video, or had someone explain the game to you live, or maybe you just read the rules. Those are all declarative, and, at the time, episodic, experiences. But, over time, those rules become second nature to you; you've proceduralized them. In order to describe the rules to someone else, you need to stop, slow down a bit, and your explanation isn't so much the rules as you've internalized them but rather you narrating what it is that you are doing. That's at least partly why people find rules explanations hard to do, because you are verbalizing stuff that has already transitioned from this more conscious declarative storage, to a more non-conscious procedural storage.

I hope you enjoyed this trip down memory lane, looking at the various types of memory and how they can be divvied up. We'll use this as a roadmap on future episodes of Cognitive Gamer. When you play your next game, be it a video game or a board game, think about the different types of memory you are using as you play. The next episode will be our second Cognitive

Gamer Cognalysis, where we take a deep dive into one particular game. As always, I welcome any comments or questions you may have, so please email me, steve@cognitivegamer.com and also visit my website, cognitivegamer.com. Also, you can like me on Facebook, Cognitive Gamer, or follow me on Twitter, [@cognitive_gamer](https://twitter.com/cognitive_gamer). If you haven't done so already, I'd appreciate it if you took the time to give this podcast a rating and a few kind remarks on iTunes or wherever you listen to Cognitive Gamer. Like for most dice rolls, higher numbers are better when it comes to reviews, so I appreciate those 5-star ones. Until next time, remember to think about what you play, and have fun doing it.