# A Systemic Lens on the Multi-store Model/Modal Model

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Abstract: The Modal Model (MM) is part of every Intro to Psychology or Cognition course and textbook because it provides a generalized, simple, and clear structure of how memory works. Because of its intuitive structure and simplicity, the model has been used for more than 50 years and the original paper upon which it is based has been cited over 11,000 times. The MM has received both wide support and some valid criticism but remains, generally speaking, a useful model for some applications of mind. This paper elucidates some of the more specific processes at play, specifically in the attentional, rehearsal, and encoding processes that act as gates to sensory, short, and long term memory and retrieval. It further points to the important role metacognition (i.e., DSRP awareness) plays in a subject's agency regarding the modal mind process.

Keywords: Modal Model | memory | systems thinking | DSRP | attention | encoding

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1. Modal Model of Memory	9
n 1968, Richard Atkinson and Richard Shiffirin introduced a general theoretical framework that explains human memory, this model is called the Multi-store Model/Modal Model (1). This model divides memory into three components:	, 10 11
1. Sensory register,	12
2. A short term store, and	13
3. Long term store,	14
The Information that reaches sensory memory where information that has been processed in short-term memory has been	L 15
drilled and can be stored in the long term. This is a useful model to understand how the mind works and how memory works.	. 16
Sensory Register: This is the place when the information enters the five senses. Each sense has a sensory memory system.	. 17
The sensory register holds the information for short-term memory.	18
Short Term Store (STS): The STS is also called the auditory-verbal-linguistic. The short term store is a working memory	′ 19
where the information from the sensory register and long-term store is processed. It receives selected information from the	; 20
sensory register and long term store. In the short term store, the information decays completely and can be lost within 30	21
seconds (1). The rehearsal process (control process) can maintain a limited input in this store according to the attention of the	22
subject.	23
Long Term Store (LTS): All information can be lost from sensory registers and short term stores, but the information is relatively permanent in the long term store (1).	, 24 25

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Fig. 1. Structure of The Memory System

Figure 1 illustrates that as information arrives at the sensory register, any attention in the sensory register will lead to a short term store. Attention and encoding on that short term store will cause the memory to enter the long term memory. The flow of information among the three components is under control of the subject, mostly through the application of attention, reheared and (or encoding (1))

rehearsal, and/or encoding (1).

## **2.** Pros and Cons of the Multi-store Model/Modal Model.

The Modal Model (MM) provides a generalized, simple, and clear structure of how memory works. Because of its intuitive structure and simplicity, the model has been used for more than 50 years and the original paper upon which it is based has been cited over 11,000 times (source: Google Scholar). Evidence of MM predominantly comes from two studies (2, 3) on what is now called the serial effect—the tendency for people to remember the first and last items in a list and forget the middle items. There are however a criticizence of the MM model according its uplidity and the need for its three compute memory stores

There are, however, criticisms of the MM model regarding its validity and the need for its three separate memory stores (4). First, MM proposes the idea of a single STS system responsible for maintaining memory items and processing other cognitive tasks (5). Second, MM explains that rehearsal is the sole mechanism for transferring the information to LTS. Other research shows that long-term memory depends on the level of processing of the to-be-remembered material and that keeping information does not affect memory performance (5). Third, MM studied memory tasks, mostly on the short-term retention of acoustic/linguistic material, hence visio-spatial information is ignored (6).

Healy and Mcnamara (1996) analysed MM, including the search for an associative memory model. They provide alternative structures to the MM model such as: working memory, conceptual short-term memory, long-term working memory, short-term activation and attention, processing streams, the feature model, distinctiveness, and procedural reinstatement. In summary, they propose that MM needs further development and specificity to be generalized, but it can be used to study verbal learning

45 and memory (4).

# **3.** Applying a Systems Lens to the Modal Model

47 There are four structural patterns, acting as simple rules, that lead to the emergent property of cognition. These structural

patterns are explained by Cabrera and Cabrera (7–9). The Cabrera's explain that these four structural patterns act as simple
rules in a Complex Adaptive System (CAS) and are therefore compounding, nonlinear, fractal, and dynamic in their collective

50 dynamics, which yield systemic forms of thought. They are:

Patterns	E	Elements		
Distinctions (D)	identity (i)	$\leftrightarrow$	other (o)	
Systems (S)	part (p)	$\leftrightarrow$	whole (w)	
Relationships $(R)$	action (a)	$\leftrightarrow$	reaction $(r)$	
Perspectives (P)	point (p)	$\leftrightarrow$	view (v)	

### Table 1. Universal DSRP Structural patterns and their Elements

In order to see how Systems Thinking (DSRP) applies to MM, let's explicate some of the critically important relationships in 51 the MM that were not highlighted in Figure 1. Figure 2 illustrates that when attention is paid to Environmental Information it 52 is registered by our senses (i.e., Hearing, Sight, Smell, Touch, Taste). This simply means that information that is not attended 53 to is not sensed or specifically, if one doesn't look at something it won't be seen, or if one doesn't eat an apple it can't be 54 tasted, etc. From this point additional attention ensures that these sensory signals are stored in Sensory Memory. Here we 55 recognize that if the eyes look but do not register some aspect of what they are looking at, or if they are drawn to another 56 aspect of the scene, sensory memory will be affected. Here again, additional attention is required for these [fleeting] sensory 57 memories to be converted into Short-term or working memory. From here further attention is needed but this time in the form 58 of rehearsal or encoding (also known as cognition, thinking, structuring, or organizing information in order to make meaning of 59 it) to ensure that these memories are converted into Long-term, retrievable memories. 60



Fig. 2. Expanded MM with Relational Detail

If we now apply a Systems Thinking (DSRP) lens to this MM model (in Figure 3) we can see that the dynamic and actionable places in the model are its relationships (composed of attention, rehearsal and structuring (encoding)). But when we apply the DSRP lens we see that structuring with DSRP plays a critical role at each and every conversion step.



Fig. 3. MM + DSRP

We see for example (first green box from left in Figure 3) that because DSRP is embedded in the physical world, not merely the cognitive, the information we receive is information about structural properties that must be reconstituted as cognitive structure.

We see (second green box from left in Figure 3) in the attentional relationship between Senses and Sensory Memory that, "what you sensory-DSRP gets attention." That is, for example, the distinctions your tongue or eyes or ears make (or are perspectivally capable or prone to making) will be where attention occurs.

A similar conversion event occurs (third green box from left in Figure 3) between Sensory Memory and Short-term memory. That is, "what you DSRP gets attention." Here the transition is from the sensory (perception) to the cognitive (cognition) and therefore requires more complex DSRP structures.

Between Short-term memory and Long-term memory, the conversion is based not only on attention but on rehearsal and/or encoding for both of which increased structure increases retention. For encoding (structuring), increased structuring via DSRP increases retention, because DSRP structuring provides the very definition of encoding. For rehearsal, it is important to

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recognize that rehearsal itself, includes structural and informational rehearsal for better retention. And, that increased DSRP 76

structuring increases retrieval. 77

Perhaps most important of all is not that these processes are occurring, but that being more aware of them (i.e., being 78 metacognitive about DSRP attention and structuring) is likely the most effective way to alter their course purposefully toward 79 80 better, improved, less biased, more effective ends.

In the song Frozen by Madonna, a line reads, "You only see what your eyes want to see." What we attend to gets attention 81 82

and therefore persists and moves on to the next conversion in the MM model (e.g., it moves right). What we encode or structure is the epitome of attentional acquisition. At each and every one of the transition/conversion zones (i.e., the green zones in 83

Figure ??), DSRP is at play through attention and structuring/encoding. This means that bias is at play at each of these 84

conversion zones as well. And, it means that bias begins long before your eves have seen it. It also means that metacognition 85

(i.e., awareness of DSRP) at each of these steps can dramatically improve a subject's agency in the perception and cognition 86

process. 87

#### References 88

- 1. RC Atkinson, RM Shiffrin, Human memory: A proposed system and its control processes. Psychol. Learn. Motiv. 2, 89–195 (1968). 89
- 90 2. M Glanzer, AR Cunitz, Two storage mechanisms in free recall. J. Verbal Learn. Verbal Behav. 5, 351-360 (1966).
- 3. BB Murdock, Jr., The serial position effect of free recall. J. Exp. Psychol. 64, 482-488 (1962). 91
- 92 4 AF Healy, DS McNamara, Verbal learning and memory: does the modal model still work? Annu. Rev. Psychol. 47, 143–172 (1996).
- 5. G Plancher, P Barrouillet, On some of the main criticisms of the modal model: Reappraisal from a TBRS perspective. Mem. Cogn., 1–14 (2019). 93
- 94 6. AD Baddeley, GJ Hitch, RJ Allen, From short-term store to multicomponent working memory: The role of the modal model. Mem. Cogn. 47, 575–588 (2019).
- 95 7. Cabrera, D., Cabrera, L., Cabrera, E., A literature review of the universal patterns and atomic elements of complex cognition. cabrera research lab. ithaca, NY. accessed on may 3, 2020 at (help.cabreraresearch.org/long-review-evidence) (2020).
- 97 8. DA Cabrera, Ph.D. thesis (Cornell University) (2006).
- 9. L Cabrera, D Cabrera, Systems Thinking Made Simple: New Hope for Solving Wicked Problems. (Odyssean Press, Ithaca, NY), (2015). 98