What Are Schemas?

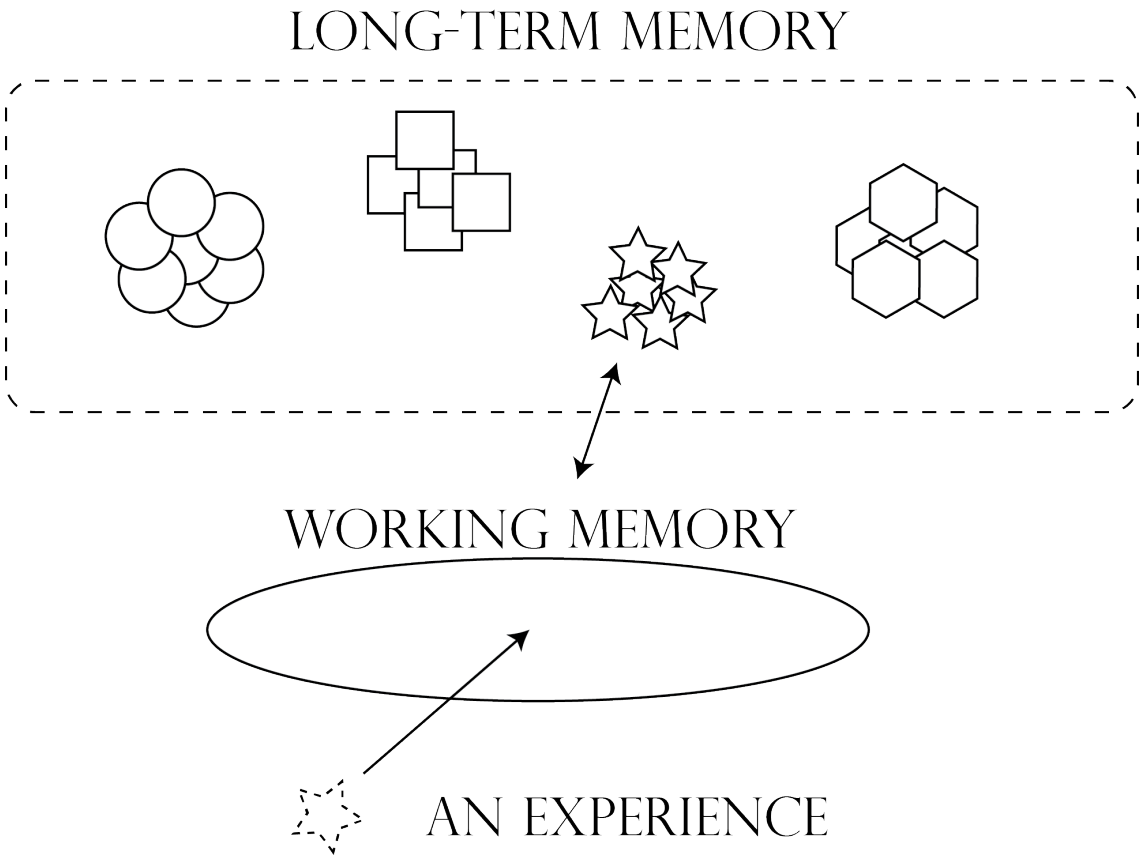
A *schema* (pl. *schemas* or *schemata*) is a pattern stored in the human mind, especially a pattern that is built up over time from exposure to similar experiences. We call the place when we store such patterns "memory," but in truth we have different kinds of memory suited for different tasks. For patterns of sound and music, human memory is built to deal with roughly three very different time-spans.

(1) For the briefest sounds—things that last fractions of a second—we may retain an almost perfect copy of them (even if we do not understand them—think of brief sounds in a foreign language). That perfect copy (a "sensory memory"), however, fades very rapidly, especially if new sounds intrude upon our attention.

(2) For things that take a few seconds to unfold—think of a person's full name, a verbal clause, a phone number, or a musical phrase—we can hold onto the gist of those sounds and try to understand them in "working memory" (also called "short-term memory").

(3) For things that we might want to recall days or even years later we have "long-term memory." All of our knowledge of language, of music, and of people is stored in long-term memory. It is not an exaggeration to say that long-term memory defines who we are.

The diagram shown below may help us to visualize how these three time-spans interact:



At the bottom of the diagram we see a star. It is tilted slightly and made of dotted lines, but we can still recognize it as a star. How do we do that? Our brains take the experience of those graphic elements and begin processing them in working memory. Cues detected in that processing seem to match up with long-term memories of stars, which have been stored together based on their similarity to each other. Clearly the best match of this experience to the memories shown is "star." The term used here for a memory of a class of patterns is "schema." Over the centuries other terms have been "category," "mental representation," "idea," "Gestalt," "family resemblance," "type," and so forth.

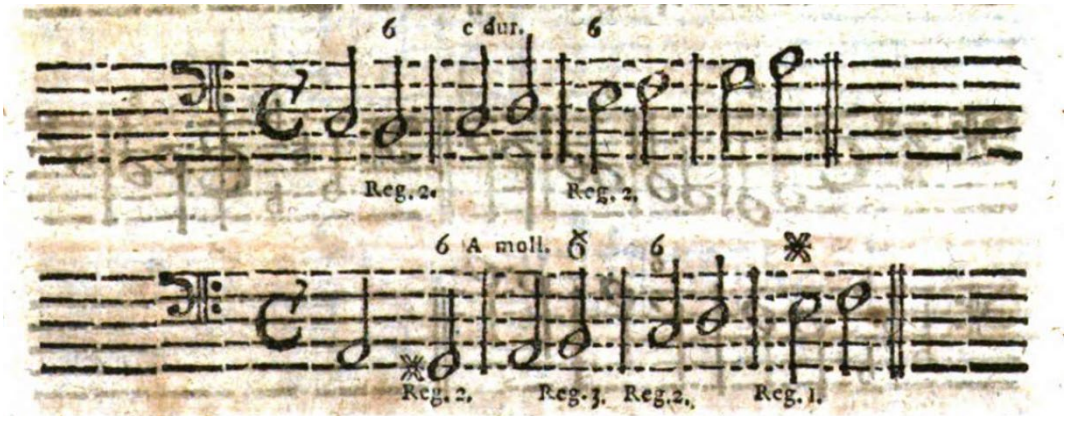
These three time scales depicted in the diagram correspond roughly to differences in the electrochemical workings of the neurons that make up the brain. Sensory memory, the briefest type of memory, corresponds to a kind of reverberation of the neural circuitry, something that is unrelated to meaning and that fades in fractions of a second. Working memory depends on semi-stable ensembles of neurons that remain active for a few seconds as a complex sonic experience is evaluated and categorized. These activations cannot, however, last for very long. As soon as your attention moves to something new, the previous state of working memory collapses and is replaced by the new focus of attention. Finally, long-term memories are stored by changing the physical structure of the points where neurons connect (i.e., "synapses"). Because these physical changes often become permanent, many of our memories can last a lifetime.

The kinds of things we recognize depend on our prior experiences. If a little boy grew up as an apprentice in the orchestra of the Imperial Japanese court during the 1700s, his many experiences of the sounds of court music would help his mind develop schemas for that repertory. Were this boy to then hear Mozart played on a visiting European ship in Tokyo bay, it is likely that he would find it confusing and "just noise." Europeans who visited other continents in the 1700s had similarly experiences with foreign musics, labelling them unmusical and "primitive." Today we can recognize this same effect when people raised on one type of popular music encounter the popular music of a very different group of people.

For boys in the old conservatories of Naples, many patterns could be learned through years of experience in listening, playing, and singing. We can call these patterns "implicit" because although they are learned, they may not have names and no one may have pointed them out as something special. Over the course of the 1600s, the music masters who taught the boys realized that progress could be accelerated if the boys were given "explicit" schemas. That is, by naming, pointing out, and having boys practice particular patterns, the masters were able to seed the boy's brains with schemas that would later be useful in the boys' improvisations and compositions. In Naples, the explicit schemas were (1) cadences, (2) the Rule of the Octave, and (3) bass motions termed *movimenti* ("moves") or *moti del basso* ("bass movements"). In Paris, one learned the cadences, the Rule of the Octave, and bass motions termed *marches harmoniques* (harmonic sequences or progressions). In Moscow, a student was given brief models to memorize and extend through sequences. In all these cases, students gained an accelerated facility in managing multi-voice music by having their brains "pre-loaded" with schemas. They could have learned the same patterns through long experience, but their ability to create music in the current style would have been greatly retarded by having only an imperfect and still developing understanding of the core patterns.

"Schema" is and has been an academic term. Jazz musicians, for instance, could say "We should use the schema of chord successions associated with George Gershwin's 'I've Got Rhythm,'" but they usually just say "Let's play Rhythm changes." A great deal of musical knowledge is completely nonverbal, being difficult to put into words even if one wanted to. Nevertheless the word "schema" has occassionaly been used to describe musical patterns, especially by writers who had formal educations and were comfortable with an academic vocabulary. A case in point is Johann David Heinichen, a German

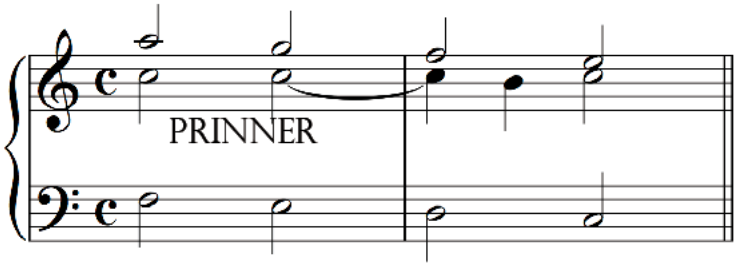
musician from the Bach and Handel generation who became the head musician in Dresden during the 1720s. He had been trained as a lawyer, went to Venice to study music, and then published two books that detailed his studies and conclusions about figured bass and many related topics. In his first book (1711) he discusses unfigured basses. For a lawyer, this seemed like a lawless area, where just from clues in the bass one was supposed to infer the correct chords and counterpoint. He realized that knowing which key one was in at the moment was crucial to interpreting a bass, so he deduced two patterns very similar to the Rule of the Octave for the major and minor modes. He termed the first one "the schema of C major" and the second one "the schema of A minor":



Heinichen went on to show how you could transpose these schemas to different pitches, thus modulating to different keys. In modern terms, he was demonstrating that a mental pattern could be instantiated at different frequencies without changing its essence. That is, we could recognize the schema of "major" or "minor" at any pitch so long as the interrelationships of the schema were preserved.

In 1865 the German physicist Ernst Mach contemplated a similar problem. In the vague idea of the brain's circuitry common in his day it was thought that each frequency of a sound excited a particular nerve whose signal would be registered in the brain at a kind of telephone switchboard. When a given set of circuits would "light up," one could recognize a given tune. But Mach, being a sophisticated thinker, realized that a given tune, when transposed a certain distance up or down, might excite a completely different set of nerves. None of the original circuits would light up. If this were true, then how could we recognize that the transposition was the same tune. Mach's answer was that we must be able to remember and recognize the shape and interrelationships of the tones, what he called their "Gestalt." Like Heinichen, Mach was pointing out that a musical pattern can be identified even when subjected to changes and slight variations.

Shown below is an instance of a Prinner schema, what psychologists term an "exemplar." It is not the schema itself. Schemas exist in our memories and contain all manner of detail and associations. For instance, in the Mozart style of music, a Prinner tends to be the second utterance in a work. In untold numbers of such compositions there will be a first statement that presents one of dozens of schemas,



and then there will follow a Prinner riposte, which is to say a kind of "comeback" that responds to and complements the opening statement. That sense of being a riposte is part of the Prinner schema, as is

the associated counterpoint, the locations of typical ornaments, the ways it can be extended, and so forth. Each exemplar only gives a snapshot of what the full schema entails. This combination of form and meaning is something that music schemas share with what modern linguists term "constructions."

So in the training of young musicians in conservatories, it was not enough for a master simply to show an exemplar of a schema and then to expect a boy to learn it. Instead, a schema would be introduced in the context of a longer exercise. In a partimento, for instance, a schema might be presented as a bass pattern at the opening to be played in the left hand. The boy would need to learn how to improvise a right-hand part that fulfilled or "realized" the implications of that schema. In the course of the next thirty to sixty measures of the partimento the same schema would recur in different keys or with small variations. As the boy worked through the lesson he gained a more complete and richer understanding of what that schema entailed. The same schema might also occur in solfeggi that the boy learned to sing. In solfeggi he would become acquainted with the types of melodic figurations that were associated with a given bass motion. When a boy had learned a small repertory of schemas and could play them at will at the keyboard, he could begin to improvise by stringing them together along with various cadences.

As a concrete example, consider the schema known in Naples as "rises a fourth, falls a third." As a bass in a partimento or solfeggio, one might see the sequence C – F – D – G – E – A, with every rise of a fourth (e.g., C – F) followed by a fall of a third (e.g., F – D). But that is not the schema. The boy still had to learn common counterpoints, which is to say melodies that were collocated ("co-located") with that bass. One of those melodies "falls a third and rises a fourth," which happens to move opposite to the bass. That collocation works very well if the counterpointing voice begins on a C an octave or two higher than the bass. If you know the Christmas carol "We Wish You a Merry Christmas" then you know this collocation and this schema. The fact that both the bass and counterpoint alternate moving by fourths and thirds means that a boy could construct a canon (think "Row, Row, Row Your Boat") between the bass and the counterpoint. The bass could begin on C, and where it rises a fourth to F, that is where the counterpoint could begin by rising a fourth from A to D (at which point the bass will fall a third to play its D, and so forth). So in the old conservatories, naming a schema by its bass motion was just a shorthand for the web of harmonies and counterpoints that it enabled.