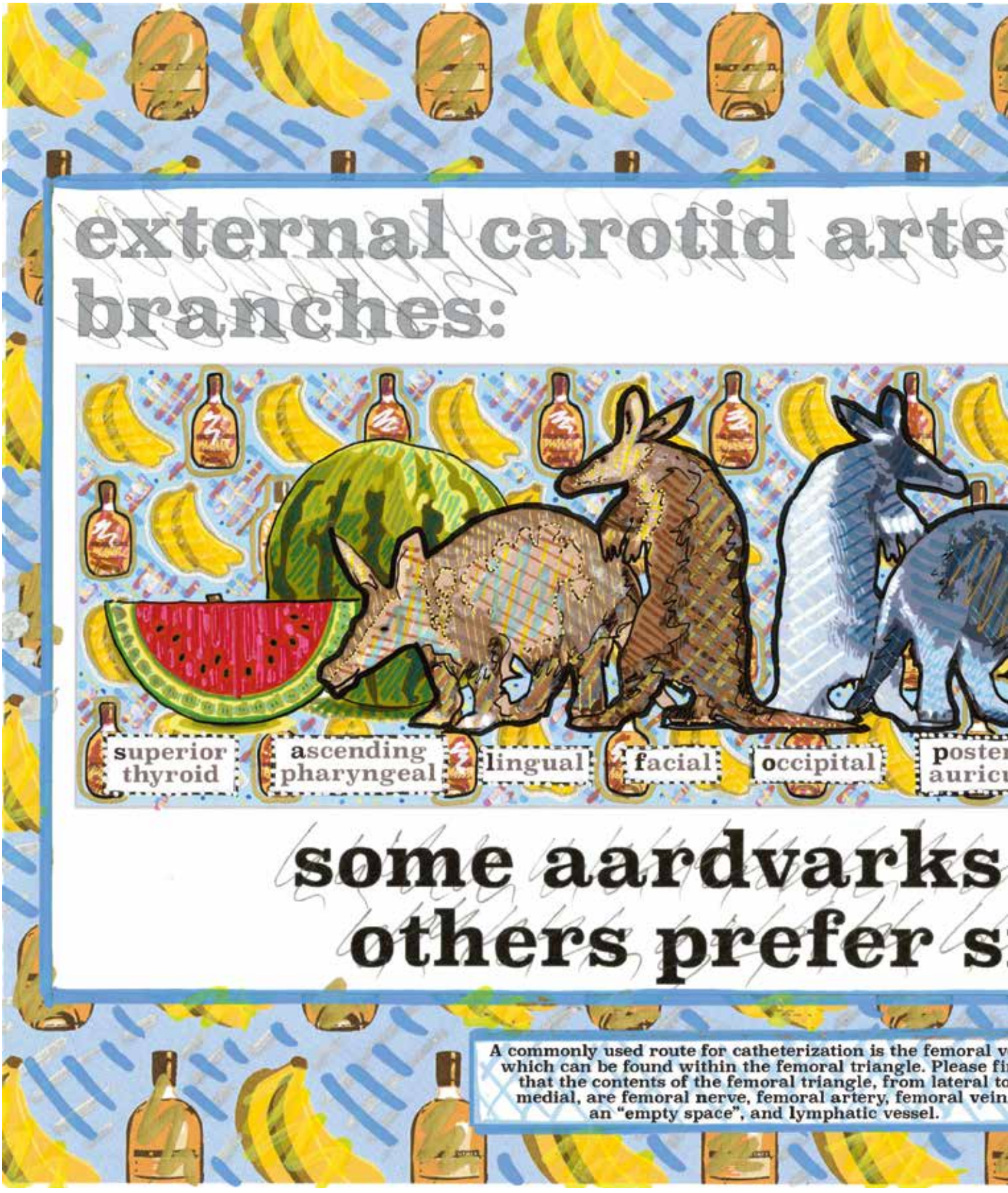

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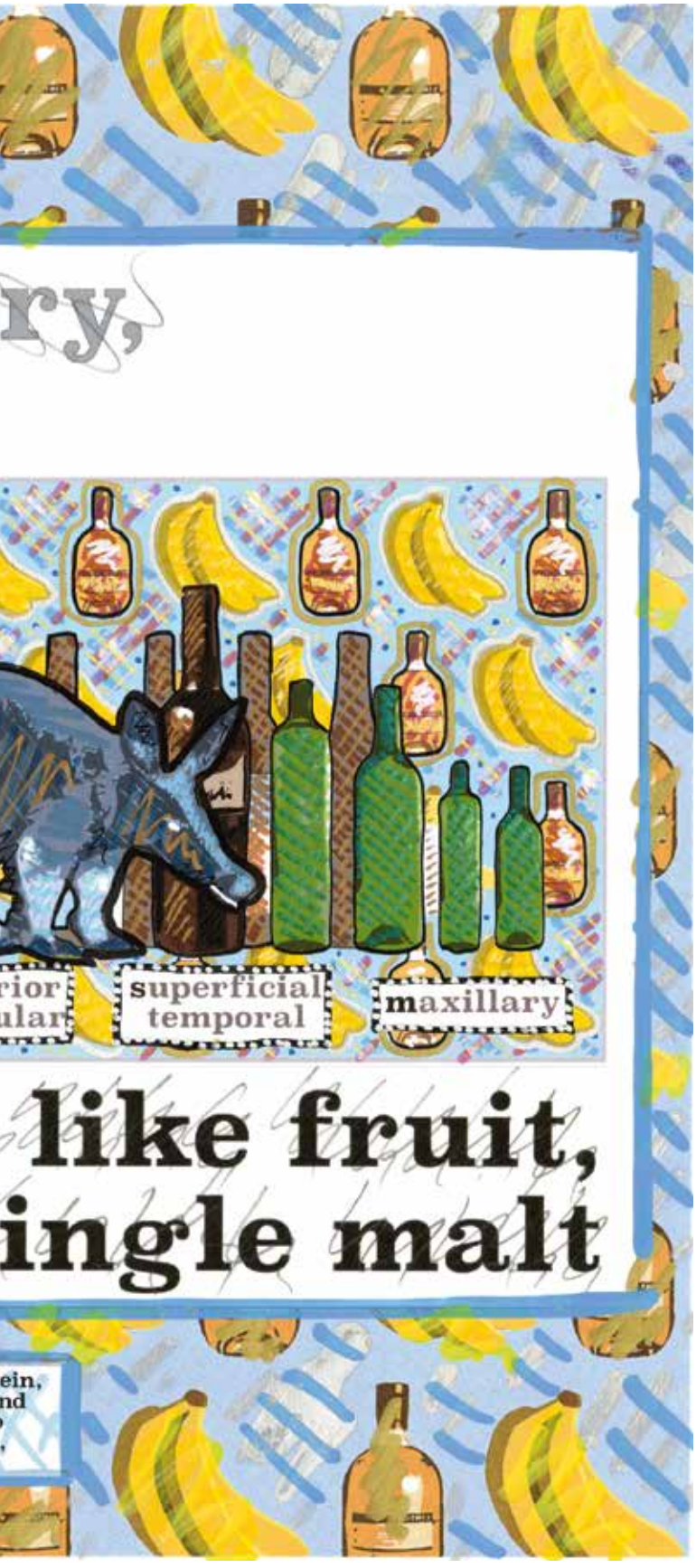

The importance of medical mnemonics in medicine

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The copious amount of information medical students and residents must learn is often compared to drinking water from a fire hydrant. A creative device to memorize information in medical school and residency is the medical mnemonic, which comes in a variety of forms.

Acronyms, acrostics, and visual and kinesthetic mnemonics are key to learning. Other proven mnemonic devices that can enhance memory include memory palaces, visual imagery, peg word technique, blogs and diaries, flashcards, simulations, mind maps, and algorithms.

Acronyms

Acronyms are the most commonly used device, exemplified by SLUDGE as the symptoms of cholinergic poisoning (Table 1). Another time-tested and occasionally revised acronym is MUDPILES (Table 2) providing an

instant differential diagnosis of anion-gap metabolic acidosis (paraldehyde is not included since this acrid-smelling medication is no longer used to treat alcohol withdrawal).

TABLE 1

S	Salivation
L	Lacrimation
U	Urination
D	Defecation
G	GI Upset

TABLE 2

Acronym for differential diagnosis of Anion-Gap Metabolic Acidosis	
M	Methanol
U	Uremia
D	Diabetic Ketoacidosis, D-Lactic acidosis
P	Prolyne glycol, Pyroglutamic acid
I	Iron toxicity
L	Lactic acidosis
E	Ethanol
S	Salicylates, Starvation

Too often, acronyms are overused to save time and typing—the "alphabet soup" in government, business, and medicine. A more constructive use of acronyms is to enhance memory by providing a framework on which to hang facts so that they can be recalled without omissions.

Acrostics

An acrostic takes the first letter, syllable, or word of each line, paragraph or other recurring feature in the text and spells out another message. An example from a century or more ago is "On Old Olympus' Towering Top, A Finn And German Viewed Some Hops," wherein the first letter of each word corresponds to the first letter of each of the 12 cranial nerves (Table 3). The rhyming, poetic quality of this mnemonic also facilitates memory.

TABLE 3

Acrostic for 12 cranial nerves	
On **O**ld **O**lympus' **T**owering **T**op, **A** **F**inn **A**nd **G**erman **V**iewed **S**ome **H**ops	Olfactory, Optic, Oculomotor, Troclear, Trigeminal, Abducens, Facial, Auditory, Glossopharyngeal, Vagus, Spinal accessory, Hypoglossal

Culinary imagery is employed in an acrostic that uses condiments for a hamburger to recall the list of tumors that metastasize to bone—bacon, lettuce, tomato, ketchup, pickles, mayonnaise, and mustard, translates to breast, lung and lymphoma, thyroid, kidney, prostate, multiple myeloma, and melanoma.

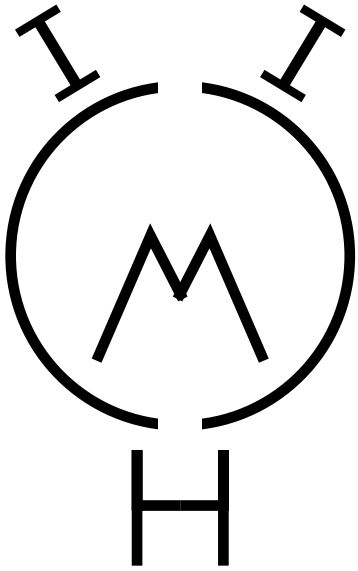
Visual mnemonics

Joshua Foer, author of *Moonwalking with Einstein: The Art and Science of Remembering Everything*, wrote:

> …our brains don't remember all types of information equally well…we are [exceptional] at remembering visual imagery, [but] terrible at remembering other kinds of information, like lists of words and numbers."[1]

The vast majority of what must be learned in medical school and residency consists of words and numbers. Visual mnemonics allow the brain to associate disparate diagnoses with powerful, easily recalled images. The visual mnemonic for the differential diagnosis of splenomegaly is one example (Figure 1). Causes of splenomegaly are the acronym-proof congestion (cirrhosis and congestive heart failure), collagen vascular disease (lupus), infiltrative diseases, infectious diseases (mononucleosis), hemolytic anemia, and malignancy—C, C, I, I, H, and M. Using a quirky device such as a reversed C in the illustration that looks like a Martian may actually enhance memorability.

FIGURE 1. Visual mnemonic for the differential diagnosis of splenomegaly



Kinesthetic mnemonics

Kinesthetic mnemonics rely on muscle memory (technically procedural memory) to depict the radiological stages of pancreatitis[2] (Table 4). Another is use of the hand to depict a normal serum protein electrophoresis[3] (Figure 2).

FIGURE 2

TABLE 4

	Normal pancreas
	Enlarged pancreas
	Peripancreatic inflammation
	One pancreatic fluid collection
	Two or more pancreatic fluid collections

History of mnemonics

Mnemonic devices originated with the ancient Greeks. The Iliad and Odyssey are thought to contain memory devices that facilitated recitation—literary epithets "rosy-fingered dawn" and "swift-footed Achilles."[4]

Simonides of Ceos, a Greek poet who lived around 500 BC, used a mnemonic system to identify the crushed

bodies of more than 50 friends killed by the collapse of a banquet hall. Simonides, who had addressed the group moments earlier, retained a vivid mental picture of where each person sat within the hall. His memory device, later called the method of loci or the memory palace, was the first of numerous memory techniques developed by the ancients.[5] A recent example of memory palaces is illustrated in season two of the BBC television series, *Sherlock*. Holmes (played by Benedict Cumberbatch) uses a variation of the memory palace to save himself from a point blank gunshot wound.

The first major known book on memory, *Rhetorica Ad Herennium,* by Cicero, was published in 80 BC. He advised the association of a passage with a highly memorable, graphic image.[6]

The early Christians used the Greek word for fish (ιχθύς) as an acronym for Jesus Christ.[7] Soon, the visual image of the fish, without the word itself, was a sufficient mnemonic.

Use of mnemonic devices reached a peak during the late Middle Ages and early Renaissance with Thomas Aquinas, Peter of Ravenna, and Giulio Camiollo, all publishing memory systems, often with religious themes. There is speculation that Dante's *Inferno* was actually a type of memory system (memory palace) for learning about Hell and its tortures.[8]

The golden age of memory began to fade with the advent of Gutenberg's printing press. In his dialogue with Phaedrus, Socrates disparaged writing because he thought men would devalue their memories and learn less.[9] Ultimately, he was correct. However, it was printing, and not writing, that devalued the art of memory. Memory has been even further devalued with the advent of the Internet, and the smart phone, which have made memorization the refuge of Luddites.

George Miller, a Harvard psychologist, published an article in 1956 on the limited ability of the mind to focus on more than seven things at one time—one possible explanation for the seven digit telephone number.[10] Mnemonics employ a form of chunking, decreasing the number of items to remember by grouping them together. An example of chunking is the string of digits 1207194109112001, more easily remembered as the two dates on which the United States was attacked.

Phone numbers and Social Security numbers are remembered by chunking into two or three groups of numbers. Songs can also be a useful way to chunk large amounts of material. Small children know this instinctively by singing the ABC song.

By grouping together the most common symptoms of cholinergic poisoning into a single word—SLUDGE—the learner can recall the answer more efficiently.

The neuropsychology of memory

One of the main arguments against using mnemonics is that they are a "form of decontextualized knowledge. They are superficial, the epitome of learning without understanding."[1] The counter-argument for this encourages mnemonics as building memories and avoiding information simply going in one ear and out the other. Mnemonics enhance retention, and can also serve as a bridge to a more comprehensive knowledge base. This is more than just logic; this is compatible with neuropsychological theory.

Memory is complex neuroanatomically, and is well-described in Bennett Schwartz's book *Memory: Foundations and Applications*.[11] The right hemisphere of the brain encodes pictures, while the left hemisphere encodes words. The primary lobes involved are the frontal and temporal. The occipital lobe is involved in visual memory. The hippocampus in the temporal area is also involved with memory, and injury to it can cause an inability to form new memories.

Encoding is the first step in the memory process. It is the initial encounter with new information, and the transfer of that information into memory. It is how we learn. Encoding is enhanced through writing the desired information—note-taking, avoiding competing stimuli (e.g., contrary to popular belief, listening to music reduces encoding), use of case-based learning, and use of mnemonics.

Retrieval is the process by which information is recovered from long-term memory. Retrieval can be enhanced through flashcards and test questions, as opposed to simply rereading the desired information. If the information is carefully encoded with multiple retrieval cues, there is a much better chance of recovering it.

Rehearsal is preservation of short-term memory through repetition. Mnemonics work by providing a highly memorable, rapid cue to retrieval. Rehearsal reinforces remembering the mnemonic device.

Creation of medical mnemonics

Mnemonics are applied to medical education to assist with the broad base of knowledge one must know. However, a goal in education is to empower learners to make their own mnemonics. Self-created mnemonics appear to work better than acquired ones because of the encoding that occurs during their creation. Acronyms are

some of the most straight-forward mnemonics that can be created.

The first step in making medical mnemonics is to find a group of topics or common diagnoses and/or treatments that are difficult to remember, but have a similar theme. When working with such a list, and searching for an acronym, think of synonyms to provide a larger choice of letters to use. For example, cancer, neoplasia, or malignancy are interchangeable synonyms, and furnish the letters C, N, or M.

A key to building a successful mnemonic is attempting to use words that can be linked intuitively to the condition and/or diagnosis, and are easy to remember such as CLUBBING (Table 5), which uses the condition's own name to list its causes. Another common acronymic mnemonic with an obvious link is I GET SMASHED (infections, gallstones, ethanol, trauma, surgery, malignancy, autoimmune, scorpion sting, hyperlipidemia/hypercalcemia, ERCP, drugs) to determine the causes of acute pancreatitis. Foer explains that the use of off-color, inappropriate images tend to linger longer in memory.[1] However, this would not be appropriate in a professional teaching setting.

TABLE 5

C	Congenital, Cystic fibrosis, Cirrhosis, Congestive heart filaure, Cyanotic congenital heart disease
L	Lung abscess
U	Ulcerative colitis
B	Brachail AV fistula
B	Bronchiectasis
I	Infectious endocarditis, Interstitial lung disease
N	Neoplasia
G	Graves' disease

To remember the 2013 American Heart Association Guidelines for statin use—LDL>190, known atherosclerotic disease, risk factor profile, 10-year risk>7.5%, and diabetes with LDL>70[12]– the first letter of each of the conditions spells out LARD. The use of the word lard is a trenchant encoding device since excess lard, i.e., fat, either in a patient's diet or within his/her body, carries a logical link to statins. This mnemonic is easy to remember because of its brevity, uniqueness, and memorable word choice.

Successful mnemonics must be updated intermittently for accuracy. They should also be used every few months to retain memory.

The role of mnemonics in medical education and practice

The importance of mnemonics in medical education is apparent in the thousands of books and websites dedicated to the topic. An informal survey on Google yields more than 450,000 websites dealing with medical mnemonics, and Amazon lists 423 books on medical mnemonics.

Mnemonics can be applied as checklists to ensure proper care of the patient. Runciman showed retrospectively that the use of the acronym mnemonic COVERABCD could have prevented or mitigated 60 percent of 2,000 anesthetic incidents.[13] COVERABCD includes circulation/capnograph/color, oxygen, ventilation, endotrachial tube, review of monitors and equipment, airway, breathing, circulation, and drugs.

Another acronym used for decades by medical trainees, NAVEL (nerve, artery, vein, empty, lymphatic), helps avoid the femoral artery during central line placement.

The verbal mnemonic FAST alerts a lay person to early indications of stroke: face, arm, speech, and time (to call 911). Use of this mnemonic through a television campaign in England reduced median hospital arrival times by more than one hour.[14]

The rapid availability of the desired information on the Internet has called into question the use of mnemonics, and memorization. Is it an asset to instantly know stuff, or is it more important to be able to find stuff? Intuitively, the argument could be made that "knowing stuff" is critical.

Medical practice consists of interviewing and examining patients, constructing differential diagnoses, ordering appropriate tests, performing appropriate procedures, and maintaining a positive physician-patient relationship. All of these actions require in-depth medical knowledge, and the more quickly the knowledge can be retrieved, recalled, and applied the better for the patient. While information retrieval from web-based resources is an important skill for physicians to acquire, it cannot replace a physician with an extensive knowledge base.

The anatomic space behind the peritoneum is known as the retroperitoneum. It houses the suprarenal (adrenal) glands, aorta/IVC, duodenum (second and third segments), pancreas (except the tail), ureters, colon (the ascending and descending parts), kidneys, esophagus and rectum.

Illustration by Nick Love

There are concerns that physicians may become overly dependent on web-based knowledge. In 2010, Jerome Kassirer sounded the alarm with an editorial in *Lancet*:

> To develop expertise in problem-solving and decision-making, it is not enough to learn how to find information. We also need to remember the information and know how to use it.[15]

Mnemonics are tools to allow compilation of medical knowledge in long-term memory.

In the education of future physicians, continuing medical education and maintenance of one's medical knowledge are of upmost importance. Foer describes memory as "a spiderweb that catches new information. The more it catches, the bigger it grows. And the bigger it grows, the more it catches."[1]

If as educators we can provide learners with the tools to continue to learn and remember beyond the classroom, then we have accomplished the goal of medical education—to create lifelong learners.

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