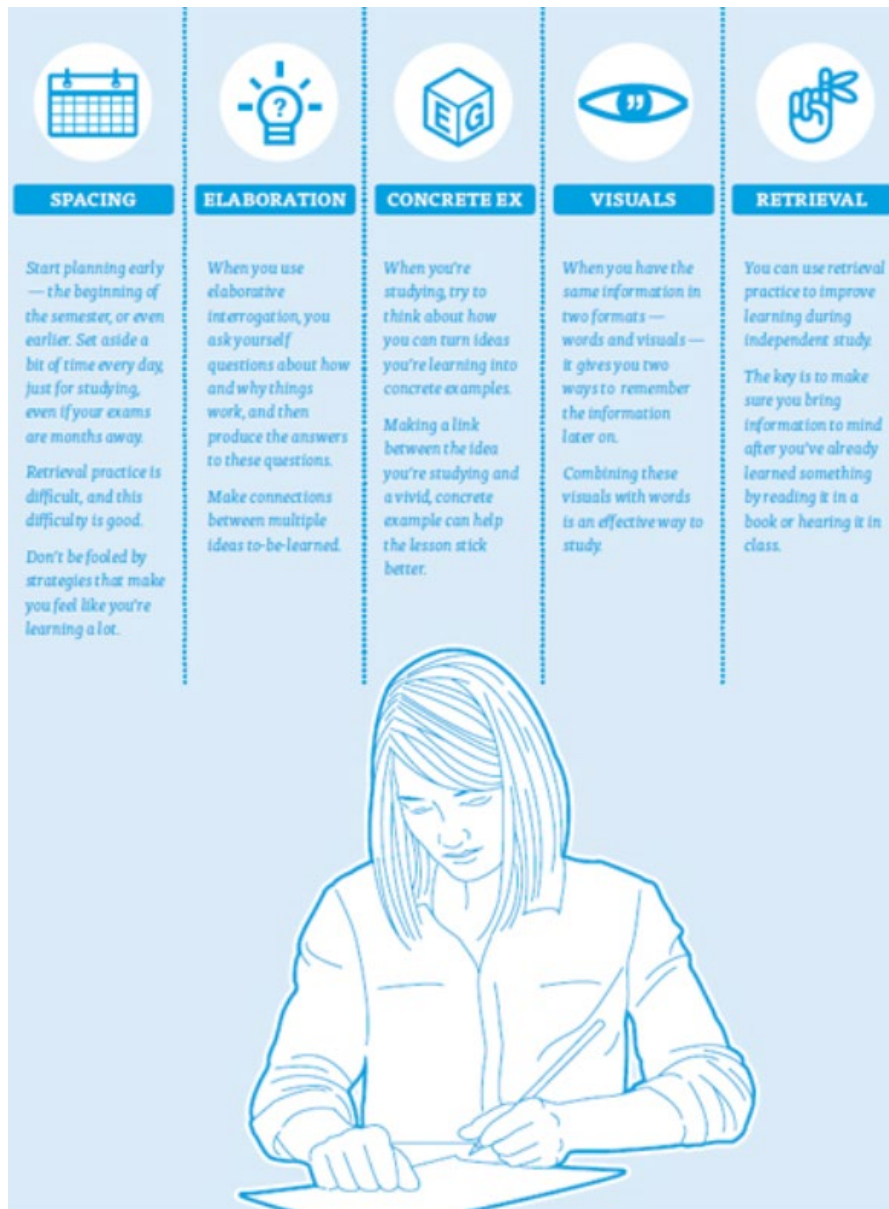



Tips for Students

<https://www.learningscientists.org/blog/tag/how+to+study>



SPACING	ELABORATION	CONCRETE EX	VISUALS	RETRIEVAL
<p>Start planning early — the beginning of the semester, or even earlier. Set aside a bit of time every day just for studying, even if your exams are months away.</p> <p>Retrieval practice is difficult, and this difficulty is good.</p> <p>Don't be fooled by strategies that make you feel like you're learning a lot.</p>	<p>When you use elaborative interrogation, you ask yourself questions about how and why things work, and then produce the answers to these questions.</p> <p>Make connections between multiple ideas to-be-learned.</p>	<p>When you're studying, try to think about how you can turn ideas you're learning into concrete examples.</p> <p>Making a link between the idea you're studying and a vivid, concrete example can help the lesson stick better.</p>	<p>When you have the same information in two formats — words and visuals — it gives you two ways to remember the information later on.</p> <p>Combining these visuals with words is an effective way to study.</p>	<p>You can use retrieval practice to improve learning during independent study.</p> <p>The key is to make sure you bring information to mind after you've already learned something by reading it in a book or hearing it in class.</p>



Students who are studying on their own can utilize planning, development, and reinforcement strategies to make their independent learning more effective. Here, we provide practical tips to help students apply effective learning strategies during their independent learning.

Planning (spacing)

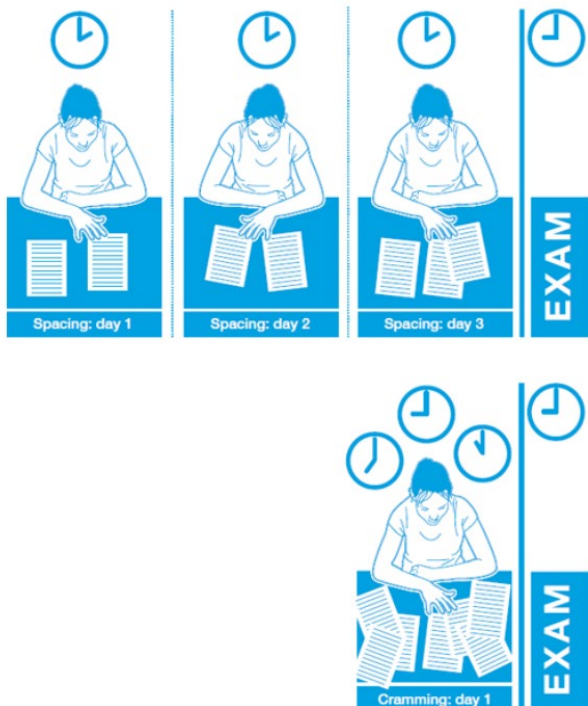
Spaced practice is the exact opposite of cramming. When you cram, you study for a long, intense period of time close to an exam. When you space your learning, you take that same amount of study time and spread it out across a much longer period of time. Doing it this way, that same amount of study time will produce more long-lasting learning. For example, five hours spread out over two weeks is better than the same five hours right before the exam. But spacing your learning requires advance planning; you can't just decide to space out your studying at the last minute.

How to study with spaced practice

- Start planning early – the beginning of the semester, or even earlier. Set aside a bit of time every day, just for studying, even if your exams are months away. This may seem strange at first if you are used to cramming right before an exam; but it's just a new habit that you will get used to if you persevere.
- Review information from each class, but not immediately after class. A good way to do this is to reserve some time one day after each of your classes meet. For example, if you have classes Monday, Wednesday, and Friday, you might review the information on Tuesday, Thursday, and Saturday respectively for each of those classes.
- Spacing your learning doesn't mean you won't be studying at all right before the exam. You can still study up until the exam – but instead of only studying then, spread it out so that you're studying days and weeks before the exam as well. You'll spend less time and learn more both in the short term and in the long term.

When you sit down to study, it's important that you don't just sit down and re-read your notes. Instead, you should use effective learning strategies such as those we describe in the rest of this chapter. After you study information from the most recent class, make sure to go back and study important older information to keep it fresh. This may seem difficult and you may forget some information from day to day, but this is actually a good thing! You need to forget a little bit in order to benefit from spaced practice. Create small spaces (e.g., a few days) between your study sessions, and do a little bit at a time so that it adds up!

“But, but ... cramming works!”



If you're reading this and you're skeptical because cramming has worked just fine for you in the past, here's why. Cramming can, indeed, do exactly what it suggests – cram some of the information into your mind right before an exam. But, this isn't a good idea. It may not seem this way, but as students you do need to worry about long-term learning. You will need to remember information that you are learning now later on in your schooling. If you only worry about passing the one test now, you will have to work double as hard for the next test – even if it is just a few weeks later in the semester. The problem will continue to get worse and worse as you continue to advance through each semester. In other words, the cramming strategy that may work in the very short term, right now, will make things even more difficult for you later on, and “later” is closer than you may think.

There are at least three really big problems with cramming:

1. **First, cramming actually takes more time.** Think about it: if you learn more in the same amount of time spaced out (e.g., five hours in one-hour increments compared to one five-hour cram session), then you have to spend more time during the cramming session to get to the same level of learning.
2. **Second, as quickly as you learned that information, you will then also forget it.** You may do fine on the test, but all that extra time you spent during cramming? It will all have been wasted. If you had spaced your learning, you would forget much less after the test. No matter what you are learning –

science, math, a foreign language – future learning will depend on previous learning. It is therefore very inefficient to forget everything you learned for one test, only to have to re-learn it again later along with new, more complicated information! This also applies to future classes, where it might be helpful to retain knowledge from a previous class.

3. **Another reason why cramming is a bad idea is that it inevitably replaces sleep**, which is very important for learning (Mazza et al., 2016) and also for your mental and physical health more generally (Smith, Robinson, & Segal, 2016). So, resolve to form a healthy habit today and plan to space your learning!

Note: You need to get enough sleep

Sleep is extremely important for learning. Sleep deprivation can produce a number of physical health problems such as increasing weight gain and increasing chances for illness. Sleep deprivation can also cause impairments to attention, problem solving, and decision making (Smith, Robinson, & Segal, 2016). What is particularly important to realize is that even mild sleep deprivation can cause these effects. Some studies show that risk to health and cognitive impairments increases if you lose 1–2 hours of sleep each night! (In other words, if you're only getting about six hours of sleep per night, your cognitive functioning, including learning, is likely to suffer.) Further, research shows that getting sleep after learning improves performance later, especially for understanding information and problem solving (De Vivo et al., 2017; Mazza et al., 2016). This is another reason that cramming (as opposed to spacing) can be so bad for your learning. When you cram, you often lose sleep the night before the exam.

Developing understanding Elaboration

Ask yourself questions about how and why things work, and then produce the answers to these questions. The specific questions that you ask yourself will depend, in part, on the topics you are studying (e.g., How does x work? Why does x happen? When did x happen? What caused x? What is the result of x? and so on). Here's how to do it:

- Start by **making a list** of all of the ideas you need to learn from your class materials. Then, go down the list and **ask yourself questions about how these ideas work and why**. As you ask yourself questions, go through your class materials (e.g., your textbook, class notes, any materials your teacher has provided, etc.) and look for the answers to your questions.
- As you continue to elaborate on the ideas you are learning, **make connections** between multiple ideas to be learned, and **explain how they work together**. A good way to do this is to take two ideas and think **about ways they are similar and ways they are different**.
- Describe how the ideas you are studying **apply to your own life experiences or memories**. In addition, as you go through your day, take notice of the things happening around you and **make connections** to the ideas you are learning in class. Doing this will engage an additional process that is highly effective: **spacing learning over time**.
- So far, we have suggested using elaborative interrogation as you study your class materials. At the start, you can definitely use your class materials to help you and fill in gaps as you elaborate. However, ideally, you should work your way up to describing and explaining the ideas you are learning on your own, without your class materials in front of you. In other words, you should **practice retrieval** of the information!

Concrete examples

- When you're studying, try to think about how you can turn ideas you're learning into concrete examples.
- Making a link between the idea you're studying and a vivid, concrete example can help the lesson stick better.
- Creating your own relevant examples will be the most helpful for learning; but before you get to that stage, if possible, always verify your examples with an expert.

Dual coding

When you have the same information in two formats – words and visuals – it gives you two ways of remembering the information later on. Combining these visuals with words is an effective way to study.

- When you are looking over your class materials, find visuals that go along with the information and compare the visuals directly to the words.
- Cover up the text, and try to describe the visuals with words.
- Another time, you can do the opposite: read the text, and try to create your own visuals.
- This technique will be helpful regardless of whether you generally prefer pictures or words.
- Work your way up to practicing retrieval by drawing what you know from memory.

Reinforcement (retrieval practice)

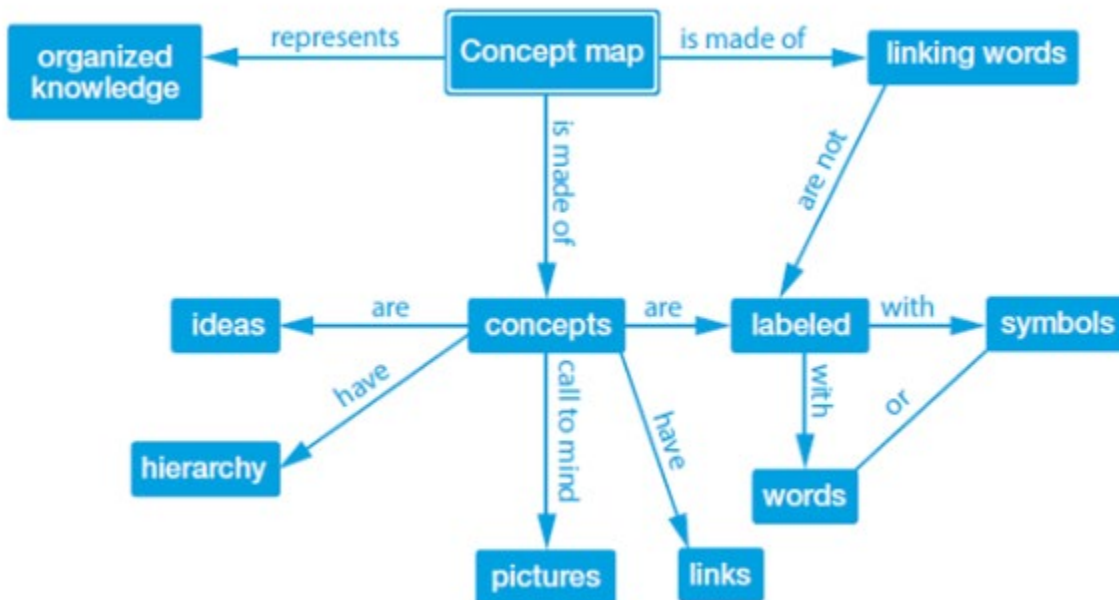
You can use retrieval practice to improve learning during independent study. The key is to make sure you bring information to mind after you've already learned something by reading it in a book or hearing it in class. There are a lot of different ways to practice retrieval at home on your own. Here are some ideas:

- If your teacher provides **practice tests**, or there are **practice questions in your textbook**, make sure to attempt them – but without looking at your book or notes! Once you are done answering the questions, make sure to check your answers for accuracy. If there are questions that you got wrong, go back to those sections in the book or your class notes and review the material. If you're struggling to understand some of the ideas, go back to Chapter 10 and try using some of those strategies to strengthen your understanding.
- If you don't have practice questions (or you've already answered all of your practice questions a few times), **you can make your own questions**. This process takes a lot of time, but if you create a study group you can each create a few questions and trade. Just make sure that the questions are about the content you are supposed to learn, and they aren't too easy. You want the questions to help you think back to the material you have learned and guide you to reconstruct the information. You also want to make sure to go beyond just remembering definitions of key terms. Definitions are important, but they are likely not the only thing you need to learn. Try creating broader questions, describing and explaining various topics, and even coming up with your own examples of the ideas.
- If you're having trouble coming up with specific questions, then you can **try just writing out everything you can remember on a blank sheet of paper**. If you have a lot of information to remember, try breaking it up into sections. You can use the headers in your textbook or general ideas provided by your teacher as prompts to help you recall as much as you can. When you are done, make sure to go back and review your class materials so that you can see what you missed and what you might need to work on more.
- You can also **create flashcards** to practice retrieval. The easiest way to create flashcards is to put a question or a prompt on one side of the card, and then put the answer on the other side. To use the flashcards to practice retrieval, look at the question side of the card and try to come up with the answer. Make sure that you are really retrieving the answer. Sometimes our students say they look at the question side and have a general idea that they know the answer, but this is not the same thing as really bringing the full answer to mind. You might even consider writing the answer down on a separate sheet of paper to really make sure you're bringing it to mind. Then, after you've retrieved the answer yourself (or given it a good try) flip the card and take a look at the correct answer. There are also many apps for this if you prefer to use technology.
- Do make sure to practice retrieving more than just the simple concept definitions you write on your flashcards, though – try linking concepts, or trying to remember how two concepts are similar/different. A student of Yana's created her own method for using flashcards to get at more complex learning. She creates two stacks of cards – one with concepts, and the other with instructions for how to use the concepts to practice retrieval. For example, one instruction

card could say “Pick two concept cards and describe how the two concepts are similar”, whereas another might say “Pick one concept card and think of a real-life example related to it” (Adragna, 2016).

- If you like sketching, you can try to **draw everything you know about a topic from memory!** It doesn't have to be pretty – it just needs to make sense to you. As long as you're drawing what you know from memory, then you're practicing retrieval!
- While sketching, you can also try to **organize your ideas into a concept map.** A concept map is a way of showing how various concepts relate to one another. You create circles with ideas, and then create links between them that describe the relationship between the various ideas. The example opposite is a concept map about concept maps! Just make sure to always try to make the concept map from memory first!

Remember, retrieval practice can be difficult, whereas the alternative – reading and re-reading your notes and textbook – might feel easier. I (Megan) often tell my students: if your exam is going to be reading your textbook or notes as fast as you can without making any mistakes, then by all means repeatedly read to prepare for this exam. However, if the exam requires you to remember the information and apply it in new situations, then make sure you can actually do this during preparation! Practice retrieval, and you will learn the information in a more flexible and durable way.



Don't be fooled by strategies that make you feel like you're learning a lot. This is not necessarily the case! When you begin practicing retrieval, you probably will not be able to remember everything, and that's okay. It does not mean that you aren't learning anything from retrieval practice, or that retrieval practice is not “working for you.” Retrieval practice is difficult, and this difficulty is good. Keep at it, and you can work your way up to being able to recall more.

Frequently asked questions

How can I integrate the six study strategies into a study routine or regimen?

Spaced practice helps you figure out when you should study. Retrieval practice is the most important study strategy, and you should engage in this activity every time you study; it answers the overall question of how you should study. And finally: elaboration, concrete examples, and dual coding provide additional techniques that can be used in conjunction with retrieval practice. Good luck!

It sounds like there is a lot of overlap among the strategies. How do I know which is which? Should I try to use just one at a time?

Yes, there is definitely a lot of overlap among the strategies. This is not necessarily a bad thing! They are not meant to stand alone and can (and should) be used together. For example, spacing needs to be used with other strategies, because spacing is only about when to cover material, and not how to cover material. Retrieval practice can and should be integrated with all of the strategies. With elaboration, you can work your way up to being able to describe and explain how and why things work from memory. With dual coding, you can work your way up to being able to sketch out what you know from memory, and then describe those sketches in words from memory. By using dual coding with retrieval practice, you are encouraging multiple contexts and representations of the information AND retrieval of those representations, which both help learning! With concrete examples, you can work your way up to creating examples on your own from memory. If you have a fair amount of background knowledge about the topic you are studying, you may even be able to create your own concrete examples and trade them with your friends. Your friends could then describe and explain how the example fits the concept. Now we're combining retrieval, concrete examples, and elaborative interrogation into one group activity.

So, while the strategies can be used in isolation (aside from spacing, of course), they really can and should be used together. One thing to note, though, is that there is not a lot of literature directly testing the effectiveness of the combination of strategies compared to using them in isolation. There is a lot of evidence supporting the combination of spacing and retrieval practice, but not much with the combination of other strategies. But for the others, not as much research has been conducted ... yet. Based on what we know, combining the strategies ought to be one of the best ways to maximize effective learning, and to keep students interested and engaged.

Does caffeine hurt or help learning?

There are lots of misunderstandings out there about nutrition and the brain, but the positive effects of caffeine you may have heard about aren't one of them. A recent meta-analysis suggests that coffee – in moderation, and particularly when you are fatigued – can increase the speed with which you react and your ability to persevere on a boring, repetitive task (McLellan, Caldwell, & Lieberman, 2016). In general, moderate levels of caffeine appear to help with attention. However, the research on caffeine's effects on memory is more mixed; there doesn't seem to be a consistent direct benefit of caffeine for memory. But to the extent that caffeine helps you stay on task while studying, it could be beneficial.

How can I take more effective notes in class?

Our answer to this question comes not from cognitive psychology, but from an adjacent field: applied behavior analysis. Research from this field recommends the use of "guided notes" to improve students' note-taking and learning from lectures (Barbetta & Skaruppa, 1995). The guided notes technique involves taking notes on a worksheet with cues and blank spaces so that you are prompted to take notes about specific concepts covered in the class. This method of note-taking has been shown to produce greater learning than other learning conditions such as presenting students with key points on PowerPoint slides, and/or having them take their own unstructured notes (Konrad, Joseph, & Eveleigh, 2009). If your teacher gives you guided notes, then you're in luck. If not, then make sure you are taking notes by hand instead of your computer, if at all possible. Writing out your notes by hand has been shown to improve later memory compared to taking notes on an electronic device (Mueller & Oppenheimer, 2014).

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