Learning - Theory and practice
On students and the algorithmic approach to effective studying

Remco Pronk

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1 Spaced repetition learning

Students are not trained on how to study; when they are told it's general advice not always useful on studying for tests. There is a conflict between choosing to cram for a test a few nights before, or to study for the long haul where the information is retained for a much longer time. The issue for the student here is that studying not just for the exam but for the long term, seems more time consuming. Students also need to be taught on how to study, showing that spaced repetition learning[1] is not only the way to remember the material longer, but also less time consuming when done correctly.

The first hurdle to take in changing the study behaviour of students is convincing that spacing out studying is the better method, and that repeating study material is essential [1]. This is proven by the combination of the testing effect and the spacing effect [2]. The testing effect is the increase of probability in recalling it at a later point when successfully remembering it at the current point in time. The connections between the information is strengthened in the brain, and so the reactivation of this information now is more likely in the future. The spacing effect, which was first described by Ebbinghaus [3], is the increase in correctly recalling facts when study trials are separated. This increases the recallability in the future versus when it had not been accessed [4].

These effects are in conflict and require a balance. The testing effect wants as many study trials as possible, whenever possible. Whereas the spacing effect requires the biggest amount of time possible between study trials [2]. This balance can be struck by finding the moment where the fact is almost forgotten, and is just able to be recalled. Here the maximum amount of time between trials is passed. And when this method is repeated, the testing effect is also satisfied.

For the second and final hurdle, students needs to be show a way to incorporate these methods.

[1] Spacing out study sessions and also repeating study material at later times

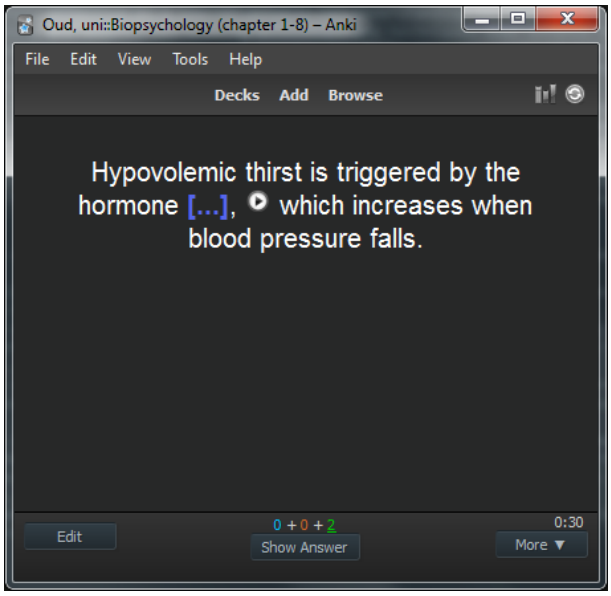

Figure 1: Front of a flashcard in Anki

2 Introducing Anki - powerful and intelligent flashcards

Personally, I've been using the free open-source software Anki[2] since my final year of high school to study using the above method. It has been my go-to method of studying ever since.

It allows the creation of flashcards, which then gets added to a deck. Anki then determines when a card has to be asked to the user. The user is shown the front of the flashcards containing some form of question. When the user remembered the answer, or gives up on remembering the answer, he can press a button to show the answer. The software then asks whether recalling the answer was done correctly, and if so, if that was an easy or hard task. Dependent on this evaluation and some parameters, the next time the card will be asked is calculated. This calculation is responsible for determining the moment the answer of the question will be almost out of the user's memory, taking care of both the testing and spacing effect.

In figure 1 and 2 you can see an example flashcard. In figure 1 the front of the flashcard can be seen, asking the question. In figure 2 the answer is shown. Note the bar in the bottom asking how easy remembering the answer was. The moment the next review will be scheduled is noted above the button, corresponding to the expected moment the answer will be almost forgotten.

Anki supports multiple types of flashcards, and gives the user to create their

[2] http://ankisrs.net/

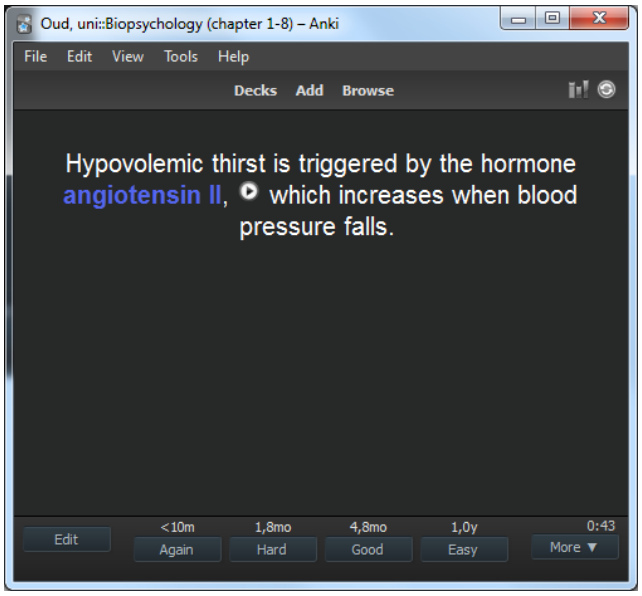

Figure 2: Back of a flashcard in Anki, note the bottom bar

own templates for them. The three most popular flashcards are called *Basic*, *Cloze* and *Image Occlusion*.

Basic is the most basic type of card. It has a question with at the front, and an answer at the back. *Cloze* uses cloze-deletion, based on the work of Taylor [5]. This is basically a fill-in-the-blanks question. This is shown is figures 1 and 2. *Image Occlusion* is a card where a part of an image is hidden. Much as a *cloze*-card, this requires the user to fill in a blank. These cards are perfect when studying anatomy. An example can be seen in figure 3.

Another powerful feature of Anki is the ability to include all sorts of media on a flashcard. Audio clips, like text-to-speech for difficult words (seen in figure 1 or your own voice recordings, can really make studying easier. And the same goes for the usage of images, like in figure 3. It also supports LaTeX-markup for scientific formulae.

3 The forgotten issue

The literature is convinced of the effect of spaced repetition learning. However, in the majority of research towards learning techniques, the hypothesis is tested by letting subjects learn word-pairs (such as translations of words), or recognising images (i.e. learning the species of bird by looking at pictures) [1] [2] [6].

However, students aren't constantly learning definitions. Especially in the hard sciences, concepts are way more important than learning the definition

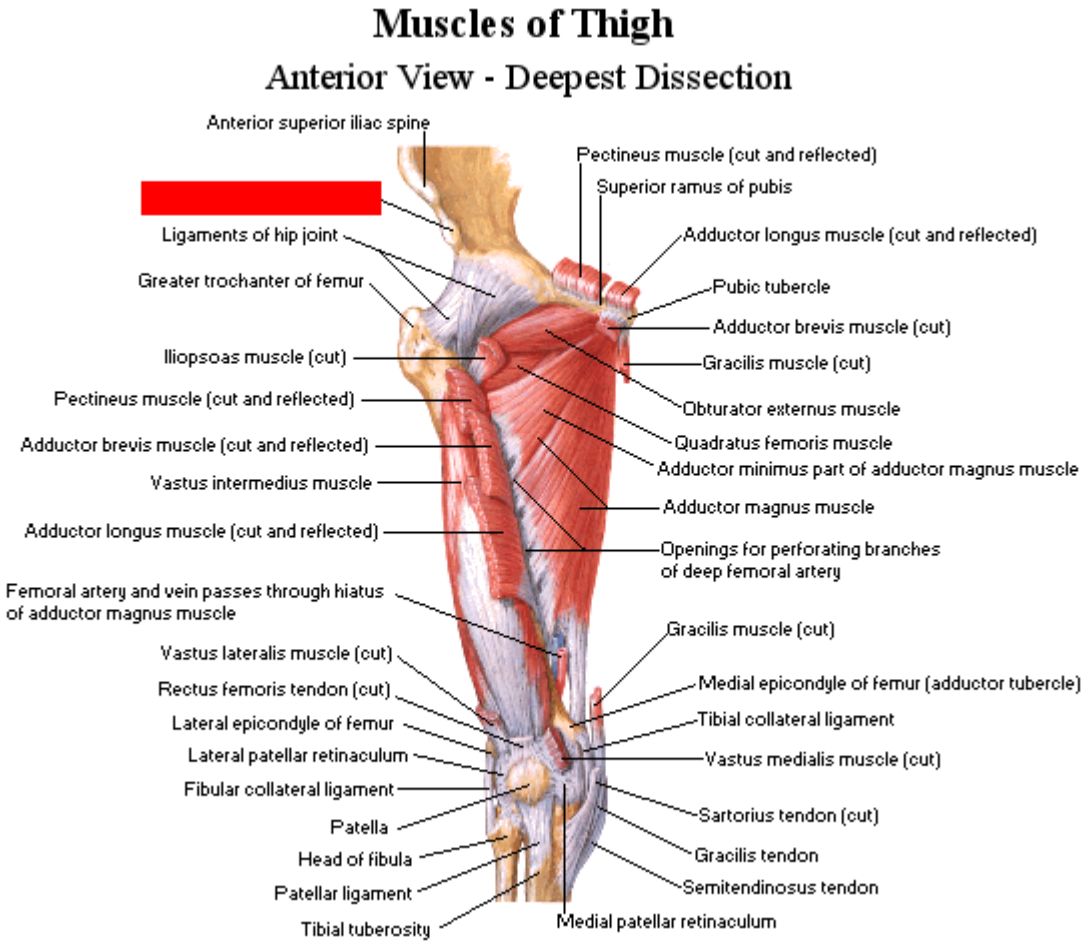

Figure 3: Example of image occlusion. Taken from http://tmbb.bitbucket.org/image-occlusion-2/index.html

of some phenomenon. How, for example, does one create effective flashcards teaching how something complex as the general problem solver [7] works?

Cognitive scientists should focus more on how one should encode such abstract things, for students benefit more from this in a realistic situation.

4 In conclusion

Students should be taught the benefits of spaced repetition learning, showing that doing it well can lead in a decrease in study time and an increase in long-term retention. This can be easily be done these days using computer software doing most of the busywork. However, spaced repetition learning is only as effective as the clarity the questions and answers are formulated during studying the material.

References

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