

# Teaching It Twice:

The effects of spaced encoding and textbook type on student learning in a general education cognitive science course.

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## INTRODUCTION

- Effective learning in the post-secondary classroom requires students to complete a significant amount of reading outside of class (Simpson & Nist, 2002); professors often expect students to gather information from texts that will not be covered in class.
- Spaced encoding (learning information multiple times with significant amounts of time in between each exposure) tends to lead to stronger memories and increased likelihood of retrieval (Bahrick, Bahrick, Bahrick, & Bahrick, 1993; Dempster, 1987)
- The selection of textbooks and the schedule of readings devised by an instructor might be used to build spaced encoding into the course.

## RESEARCH QUESTIONS

- How will teaching the content of an interdisciplinary cognitive science course twice during a semester affect students' knowledge of key concepts?
- Will a traditional textbook be more effective than a popular paperback at increasing students' knowledge of key concepts?

## COURSE & AUDIENCE

This study took place in an interdisciplinary cognitive science course at Andrews University called 'Dealing with Your Mind'. This course...

- ...was developed as one of four interdisciplinary social science course options for the general education program and as part of an NSF-funded project to increase the number of students planning on a career in neuroscience research
- ...is taught at a freshman/sophomore level to students with no background in cognitive science; students of all levels enroll in the course
- ...is taught by a cognitive psychologist
- ...integrates psychology, biology, cognitive science, philosophy, and daily life.

## CURRENT STUDY

- 54 subjects over two semesters (38 Fall 2006, 16 Spring 2007) completed all coursework and all three normed assessments (see Technique).
- All students were given a syllabus at the beginning of the semester that outlined the schedule of readings.
- Selected textbooks were *The Student's Guide to Cognitive Neuroscience* (traditional textbook; Ward, 2007) and *Phantoms in the Brain* (popular paperback; Ramachandran & Blakeslee, 1998); the order of textbooks was reversed in the second semester relative to the first.
- Labs and lectures were matched to the readings and thus followed the order of readings each semester.

## TECHNIQUE

### SCHEDULE OF READINGS

- Students read the traditional textbook first, followed by the popular paperback during Fall semester; the order was reversed Spring semester.
- Because these textbooks had significant overlap in content, topics were covered twice during the semester, at approximately two month intervals (as described anecdotally by deWinstansley & Bjork, 2002 for an introductory psychology course), as opposed to covering related material on multiple consecutive days at one point during the semester.
- As a result, students were exposed to concepts at widely, rather than closely, spaced intervals.

### ASSESSMENT

- Student knowledge of course content was assessed using the Neuroscience Literacy Questionnaire (NLQ; Herculano-Houzel, 2002), which was developed for assessing the knowledge of the general public during a museum exhibition on neuroscience (similar to the goals of general education).
- A measurement of neuroscientist consensus exists for the NLQ, yielding a subset of 58 questions; answers for the full set of 83 questions were derived from the textbooks themselves.
- Subjects gave either agree, disagree, or "don't know" responses to 95 psychological and neuroscientific statements (83 factual, 12 opinion).
- Control group: students enrolled in an upper division physiological psychology course prior to starting the course and immediately following the course; intended to control for interest and prior exposure and to identify an upper limit on student correct response rates.

## RESULTS

- At the beginning of the semester, scores for both textbook order groups were substantially lower than the control group on both the full set and the neuroscientist-normed subset sets of NLQ questions.
- At mid-semester (after completing the first textbook), both groups' average scores had reached the initial level of the upper-division controls, regardless of the textbook used first. This was a significant change in knowledge level. (58 Q:  $t_{(55)} = 7.71, p < 0.01$ ; 83 Q:  $t_{(55)} = 7.96, p < 0.01$ )
- The relatively high level of understanding (higher than that of the general public in Herculano-Houzel's 2002 study) was maintained to the end of the semester; no further change in knowledge level occurred (58 Q:  $t_{(55)} = 1.47, p > 0.1$ ; 83 Q:  $t_{(55)} = 0.87, p > 0.1$ )
- The interaction between textbook type and assessment time was not significant ( $F_{(51, 2)} = 1.289, p > 0.1$ )
- Despite the option of dropping a test in this class, students' test scores showed a consistent increase over the course of the semester.

## IMPLICATIONS

- Given that the majority of increases in knowledge occur prior to mid-semester, it appears that students can cope with the pace of the two-textbook course.
- Only a main effect of time was present during the first half of the semester and there was no main effect of textbook order nor any interaction between time and textbook order; thus, it appears that a popular paperback can be as effective in this setting as a traditional textbook.
- Consistent increases in test scores despite the option to drop a test suggest that the teaching twice technique may be a means of utilizing spaced encoding effects in the classroom to aid the consolidation of curriculum into robust long-term memories.

## LIMITATIONS

- This technique requires students to purchase a second textbook for the course; with larger texts, students may feel rushed to complete the reading in half a semester. However, the textbook could be combined with a set of journal articles or teacher-created materials in an upper-division class.
- Because of a last minute change in the time the course was offered during the Spring semester, enrollment was lower during that semester; second semester students may have had higher overall motivation – however, no interaction was present.
- The increase in learning may reflect an effect of the instructor rather than, or to a greater degree than any effect of textbook type; nevertheless, these results suggest that students can acquire content quite rapidly, allowing for application and synthesis activities during the latter half of the semester.

## RESULTS

Control subjects (20 subjects): 56.1% correct responses for all 83 Qs; 69.6% correct responses for 58 neuroscientist consensus Qs prior to course.  
62.6% correct responses for all 83 Qs; 73.4% correct responses for 58 neuroscientist Qs at the end of the course.

