Learning and Individual Differences 63 (2018) 70–77

Contents lists available at ScienceDirect

Learning and Individual Differences

journal homepage: www.elsevier.com/locate/lindif

Incentives and test anxiety may moderate the effect of retrieval on learning

Daniel A. Clark[a,*], Jason R. Crandall[b], Daniel H. Robinson[c]

[a] Texas A&M University, Central Texas, United States
[b] Washington University in St. Louis, United States
[c] The University of Texas at Arlington, United States

ARTICLE INFO

Keywords:
Learning
Motivation
Testing effect
Retrieval
Test anxiety

ABSTRACT

Many studies have shown that retrieval practice improves learning in various settings. Similarly, other studies have shown that offering incentives improves learning, whereas test anxiety inhibits learning. Few studies have examined the possible combined effects of incentives and test anxiety when examining retrieval practice. The current study manipulated incentives between subjects and test anxiety within subjects. Interestingly, combining incentives with retrieval practice was not optimal. Establishing such boundary effects may help to identify best practices when using retrieval practice.

1. Introduction

The cognitive strategy of retrieving encoded information from memory has received extensive empirical support as an effective learning intervention across many different types of stimulus materials, individuals, and learning contexts (Roediger & Karpicke, 2006a; Rohrer & Pashler, 2010). The robustness of this effect has even led many researchers to suggest that retrieval practice should be widely implemented in educational settings (McDaniel, Agarwal, Huelser, McDermott, & Roediger, 2011; Pashler et al., 2007; Phelps, 2012). Before implementing such an intervention in the classroom, an instructor would be wise to inquire about effectiveness of retrieval practice as a learning intervention for learners with differing levels of extrinsic reinforcement, such as grades or other incentives. Although studies have shown that testing circumstances have an effect on testing performance (O'Neil, Brenda, & Baker, 1995; Wolf & Smith, 1995), the current study addressed the effect of such extrinsic conditions on using retrieval practice for learning.

1.1. Retrieval-enhanced learning

Many of the more recent studies of retrieval practice and learning are surprisingly similar to the first one that was published over 100 years ago. Abott (1909) had her participants memorize nonsense word lists either by simply re-reading the words for 16 min or by re-reading the words for 8 min and then attempting to retrieve them from memory for 8 min. Retrieval practice resulted in better memory than re-reading.

A more recent study involved teaching fifth grade students key scientific concepts through word definitions (Lipko-Speed, Dunlosky, & Rawson, 2014). In this study, these students were initially shown 20 definitions to learn. Next, the students were allowed to re-read some definitions for as long as they desired, and were prompted to attempt to type the remaining definitions from memory (retrieval practice). The students then studied the same definitions in the same manner in two subsequent sessions. Two days after the last study session, the fifth graders were given a final test concerning all 20 definitions. The authors concluded that although overall memory performance was low, retrieval practice was superior to self-directed restudying of difficult scientific concepts. Other classroom-based studies have found similar effects of retrieval practice with middle schoolers (McDaniel et al., 2011), college students (Wickline & Spektor, 2011), and more mature adults (Maddox & Balota, 2015). Studies also have also found that retrieval practice is helpful when using different types of content, such as visuospatial memory (Carpenter & Pashler, 2007), prose (Roediger & Karpicke, 2006b), and lecture (Butler & Roediger, 2007).

Several theories exist about the reason why retrieval practice appears to improve learning. Spreading activation theory suggests that the act of retrieval creates additional connections between different types of knowledge, therefore increasing the probability of long-term retrieval because of the existence of more memory traces (Anderson, 1983). Transfer appropriate processing theory posits that retrieval practice has a positive effect on learning because the act of retrieval during the learning phase approximates the same retrieval process during the criterion learning task (Morris, Bransford, & Franks, 1977). Disuse theory suggests that humans have a limited retrieval capacity and that unretrieved memories are crowded out by retrieved memories (Bjork & Bjork, 1992). Recent fMRI research suggests that the retrieval

* Corresponding author.
E-mail address: daniel-clark@tamuct.edu (D.A. Clark).

https://doi.org/10.1016/j.lindif.2018.03.001
Received 23 February 2017; Received in revised form 27 February 2018; Accepted 14 March 2018

practice may stabilize memory activation patterns in numerous brain areas that are often associated with long-term memory (Keresztes, Kaiser, Kovács, & Racsmány, 2014).

Finally, new research is beginning to examine how retrieval practice may have different effects depending on individual differences (Brewer & Unsworth, 2012; Tse & Pu, 2012). Both of these articles suggest not surprisingly that individual differences in memory may moderate the effect of using retrieval practice. Brewer and Unsworth (2012) reported that an individual's episodic memory and fluid intelligence were both negatively correlated with learning from using retrieval practice. Tse and Pu (2012) reported no significant prediction from working memory alone, but found that for individuals with lower working memory scores, test anxiety was negatively correlated with the effect of retrieval practice. Therefore, it appears that test anxiety may be an important factor in whether an individual can benefit from using retrieval practice.

1.2. Test anxiety and performance

The Diagnostic and Statistical Manual of Mental Disorders (5th ed.) suggests that anxiety involves "muscle tension and vigilance in preparation for future danger and cautious or avoidant behaviors" (American Psychiatric Association, 2013). Test anxiety involves the experience of heightened rates of tension, worry, task-irrelevant thoughts, and focus on uncomfortable bodily reactions while taking a test (Sarason, 1984). It is often separated into two main components: a cognitive worry component and an emotionality component that is more aligned with physiological symptoms (Schwarzer, 1984). Individuals may worry both about failing to meet an objective standard and about performing poorly relative to their peers (Sarason, 1984). The emotionality component involves perceptions of increased arousal (such as increased heartbeat) and uncomfortable feelings (Minor & Gold, 1985).

Although test anxiety is typically associated with lower levels of academic achievement (Hembree, 1988), some research suggests it to be a moderator variable that affects achievement in certain settings, such as those that involve evaluative pressure (Cassady, 2004). In particular, Grooms and Endler (1960) found no overall relationship between test anxiety and test performance across all levels of test anxiety, but did find that participants with high levels of anxiety showed a relationship between test anxiety and performance. Attentional control theory suggests that anxiety disrupts the activity of several functions in working memory, but not all. The central executive, the inhibition function, the shifting function, and the processing efficiency of working memory may function less efficiently during anxiety, while other functions of working memory remain unaffected (Eysenck & Derakshan, 2011).

Some of these puzzling findings could be a result of an effect similar to the Yerkes-Dodson Law, which states that increasing physical and mental arousal is positively related with performance up to a point, beyond which higher arousal is associated with lower performance, forming an inverted-U curve (Yerkes & Dodson, 1908). Although test anxiety may or may not be associated with physiological arousal (Leininger & Skeel, 2012), the effect may be conceptually similar (Sung, Chao, & Tseng, 2016). For example, Keeley, Zayac, and Correia (2008) found that an inverted-U curvilinear relationship between statistics anxiety and college exam performance instead of a linear relationship. This result suggests that some level of test anxiety may facilitate performance, while excessive anxiety has a negative impact on performance.

One possible mechanism behind this inverted curve could be the vigilance and avoidance behaviors often seen in those who struggle with anxiety (Mogg & Bradley, 1998). More specifically, test anxiety has been associated with both allocating attention to avoid testing related stimuli and allocating attention towards testing-related stimuli (Putwain, Langdale, Woods, & Nicholson, 2011). A recent eye tracking study found that test anxiety was associated with a pattern of initial attentional bias towards test-related stimuli, followed by subsequent avoidance of similar stimuli (Dong, De Beuckelaer, Yu, & Zhou, 2017). Finally, certain situational factors, such as exam stakes, may be able to increase anxiety and push some individuals over to the negative side of the Yerkes-Dodson curve (Putwain, 2008).

1.3. Incentives and testing performance

An incentive usually involves the application of some type of contingent external reward to enhance motivation, which is basically the desire to move (Ryan & Deci, 2000). Quite a few studies have shown that testing performance can be affected when test-takers are motivated by incentives (Cameron, 2001; O'Neil et al., 1995; Putwain, 2008; Wolf & Smith, 1995). Wolf and Smith (1995) conducted an experiment on the effect of consequences on the performance and motivation of college students while taking both graded and ungraded exams. The researchers found that while overall performance and motivation were higher on the graded exam, they also found that one-third of the students performed better on the inconsequential test. In a similar study, O'Neil et al. (1995) found that paying 8th grade students for performing well improved their test scores. Sundre and Kitsantas (2004) included both self-reported motivation and self-regulation strategies as predictors in conditions with differing incentives. When the test was not going to contribute to their course grades (no incentives), the self-reported variables predicted performance. When the test did contribute to their course grades (incentives), these self-reported variables did not continue to predict overall performance.

These studies suggest that incentives may have an important impact on learning performance. Therefore, the current study was designed to explore the role of incentives in retrieval-enhanced learning in a simulated classroom environment.

1.4. Incentives and the learning disruption hypothesis

Only a few studies have investigated how incentives may interact with the aforementioned effect of retrieval practice (Clark, Crandall, & Robinson, 2012; Clark & Svinicki, 2015; Hinze & Rapp, 2014; Kang & Pashler, 2014). Both Clark et al. (2012) and Hinze and Rapp (2014) conducted between-subjects experiments in which both incentives and study methods were randomly assigned by the researchers. Before they began the experiment, Clark et al. (2012) told some of the lab sessions that their performance on the final test during the second session the following week would determine the amount of time they would spend during that session. The other half was simply reminded to return for the next session. In these conditions, the undergraduate participants who were randomly assigned to take a brief quiz over the computer security lecture video they viewed surprisingly scored higher if they did not receive the incentive. Conversely, the participants who simply viewed the lecture script after seeing the lecture performed better if they were in one of the lab sessions that was given a verbal incentive to perform. Clark et al. suggested that test anxiety may have been the reason for this surprising result, but it was not directly measured in the study.

In a similar design but with different methods, Hinze and Rapp (2014) had undergraduates read passages from biology texts, then they were told they would receive a $5 bonus simply for participation (low stakes), whereas others were told that receiving the bonus was contingent on their performance (high stakes). After being informed of the rewards for participation, some of the participants took practice quizzes concerning the material, while others read the material a second time. Participants in the high stakes condition underperformed when compared to the low stakes condition on the final memory tests that occurred a week after the initial studying. Interestingly, there were no differences between the conditions on the initial quiz performance. Therefore, Hinze and Rapp suggested that the negative effect of the