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Learnin' 'bout my generation? Evaluating the effects of generation on encoding, recall, and metamemory across study-test experiences

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ABSTRACT

We explored how learning during an initial study-test experience with text materials shapes future encoding, recall, and metamemory. Differential recall of targets from generate and read sentences on a fill-in-the-blank test led participants to shift their encoding strategies such that differential recall was eliminated on a second study-test block using different materials. This shift was not contingent on experiencing a generation advantage on the first test: recall also improved across tests when groups studied and recalled only one target type, did not receive the initial test, or showed a null or negative generation effect on the initial test. Strategy reports suggest that a sentence-target linking strategy increased across tests. Importantly, metamemory measures failed to reveal awareness of differential performance for read and generate targets. Contrary to recent claims, then, our findings suggest that individuals can learn, perhaps even tacitly, to modify their study strategies based on an initial study experience.

Introduction

People have a multitude of strategies at their disposal for committing new information to memory, from rote repetition to mnemonics. Memory research has identified many effective study strategies such as elaboration (Craik & Lockhart, 1972), generation (Slamecka & Graf, 1978), and simple production (MacLeod, Gopie, Hourihan, Neary, & Ozubko, 2010). Although there has been extensive research on the effects of such strategies, there has been relatively little examination of their influence on future encoding and retrieval simply because most memory studies consist of a single study phase followed by a single memory test. More than one study-test block is needed to gauge what people learn from using a study strategy and how that experience modifies subsequent encoding and memory.

By using multiple study-test blocks, researchers can reveal how experience leads people to adapt their approaches to learning new information. Indeed, a number of important memory effects have been identified using multi-trial paradigms including the testing effect (e.g., Roediger & Karpicke, 2006), spaced retrieval-practice effects (e.g., Whitten & Bjork, 1977), retrieval-induced facilitation (e.g., Chan, 2009), and the practice effect (e.g., Postman, Burns, & Hasher, 1970). Research on metamemory—how people think about and monitor their encoding and retrieval processes—has also employed multiple study-test designs (e.g., Brigham & Pressley, 1988; Dunlosky & Hertzog, 2000; Hertzog, Price, & Dunlosky, 2008; Hertzog et al., 2009; Koriat, 1997; Tiede & Leboe, 2009).

Dunlosky and Hertzog (2000; see also Hertzog et al., 2008; Hertzog et al., 2009) developed a detailed metacognitive framework of strategy knowledge updating across

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study-test experiences. Their knowledge-updating framework assumes that study strategies vary in their effectiveness for enhancing memory (the *effectiveness assumption*), and individuals monitor their study and/or test experiences and use them to choose/update study strategies (the *utilization assumption*). These monitoring and evaluation processes yield knowledge updating if two conditions are met. First, individuals must monitor their strategies as they study and/or monitor their performance as their memory is tested (the *monitoring assumption*). Second, individuals must attribute their memory performance to the study strategies they used and then update their knowledge about those strategies (the *updating assumption*). By collecting both metamemory and memory measures at various points across two study-test blocks, and then using path analyses to chart the links between these measures, these researchers established a very useful, testable model. However, the encoding strategies they examined across study-test experiences was rote repetition vs. imagery, and importantly, although metamemory measures shifted across study-test experiences, the advantage of imagery over repetition did not.

We examined a different study strategy in the present work, namely *generation*, because de Winstanley & Bjork (2004; see also Bjork, de Winstanley, & Storm, 2007; Bjork & Storm, 2011; Bjork, Storm, & de Winstanley, 2011) revealed a striking shift in its effect on recall across study-test experiences. The generation effect refers to a typically robust memory advantage from self-generation of a target (e.g., k_tt_n) relative to simple reading (e.g., kitten; Hirshman & Bjork, 1988; McDaniel, Waddill, & Einstein, 1988; Slamecka & Graf, 1978; see Bertsch, Pesta, Wiscott, & McDaniel, 2007, for a review). Effective generation tasks include answering questions, solving anagrams, or, as was the case here, solving word fragments.

de Winstanley and Bjork's (2004) participants studied a paragraph on a particular topic. Each sentence contained a target in red. Half the targets were intact and were read silently (*read* targets), and half the targets had to be generated from word fragments (*generate* targets). Memory for the targets was then tested using a fill-in-the-blank test where the same sentences were presented with the targets left blank. This Block 1 procedure was then repeated in Block 2 using a different paragraph on a different topic.

de Winstanley and Bjork's (2004) key result was that a generation effect occurred on Test 1 but not on Test 2. The elimination of the generation effect on Test 2 was attributed to improved recall of read targets across tests. de Winstanley and Bjork argued that participants experienced the relative benefits of generation during Test 1 (i.e., *monitoring* as per Dunlosky & Hertzog, 2000), that lead them to develop an improved study strategy for the read targets during Study 2 (i.e., *updating* and *utilization* as per Dunlosky & Hertzog). As stated in the article title, their participants thus appear to have become "better readers" after experiencing the generation effect. Importantly, the generation effect persisted (albeit a between-subject generation effect) when participants received only one target type per block or across blocks, suggesting that directly experiencing the generation effect on Test 1 was critical to this strategy knowledge updating.

Using the same paradigm, Bjork and Storm (2011, Experiment 3) identified an important boundary condition (for another boundary condition, see Burnett, 2013): the generation effect persisted on Test 2 when Test 1 was a free recall test. The researchers argued that unlike a fill-in-the-blank test, free recall did not enable participants to learn that linking each target word with its sentence (what we term a *context strategy*) could benefit memory, thus they did not modify their study strategy for read targets on Block 2.

Bjork and Storm (2011, Experiment 4) provided further evidence that participants adopted a context strategy for Block 2. The design was the same as Experiment 3, except Test 2 tested participants' memory for a word from each sentence context rather than for the target itself. Participants recalled more context words on Test 2 when Test 1 was a fill-in the-blank test rather than free recall. Thus, exposure to a fill-in-the-blank test may have led participants to shift to a context strategy for Block 2. Bjork and Storm suggested that this strategy shift eliminated the generation effect on Test 2. Strategy reports provided some support for this possibility. However, Bjork and Storm did not provide direct evidence that use of a context strategy increased *target* recall on Test 2.

In sum, de Winstanley and Bjork (2004) posited that experiencing the benefits of a study strategy on an initial test (a monitoring effect) could spawn shifts in encoding strategies (an updating effect) that influenced subsequent memory performance (a utilization effect). We report three experiments using their paradigm that provide a detailed evaluation of this claim. In Experiment 1, we established a replication of de Winstanley and Bjork's (2004, Experiment 1) within group, and we then compared shifts in recall of read and generate targets in this group to pure-list read and generate groups who did not experience the generation effect. The increase in recall of read targets across tests should be larger in the within group than the read group if experiencing the generation effect is critical to the boost in read target recall on Test 2. de Winstanley and Bjork (2004) tested their within and between groups in separate experiments using different stimuli and thus were unable to evaluate these possibilities. Participants' self-reported study strategies were also collected in Experiment 1 (see Hertzog et al., 2008; Hertzog et al., 2009) to determine what study strategies people use, whether they shift strategies across blocks, and to evaluate whether the within group shifted to a context strategy selectively for the read targets.

Experiment 2 tested de Winstanley and Bjork's (2004) claim that participants become aware of the relative benefits of generation during Test 1. To this end, a within group was compared to a second within who did not receive a Test 1. If participants learn about the relative benefits of generation during Test 1, then only the within group who receives Test 1 should show the elimination of the generation effect on Test 2.

Finally, Experiment 3 collected several metamemory judgments (after Dunlosky & Hertzog, 2000) to determine whether and when participants become sensitive to the generation strategy. We also examined whether shifts in metamemory judgments were concordant with shifts in