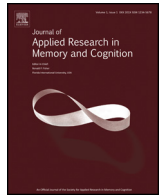


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When Does Practice Testing Promote Transfer on Deductive Reasoning Tasks?

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Tran et al. (2015) evaluated whether engaging in practice testing versus restudy promotes transfer and concluded that testing does not enhance performance on a deductive reasoning task. The current research further evaluated Tran et al. (2015) and an alternative explanation for the observed effect—namely, that testing did not enhance memory for the information required to complete the deductive reasoning task. Learners studied premises from four scenarios and engaged in testing or restudy during practice. Following practice, learners completed a multiple-choice test that required them to deductively reason from premises. Results replicate Tran et al. (2015) by demonstrating that fill-in-the-blank testing does not promote transfer on a deductive reasoning task. Results also provide evidence suggesting that deductive reasoning depends on complete memory for requisite pieces of information and that testing effects on deductive reasoning are more likely to obtain under conditions that yield a memory advantage for testing versus restudy.

General Audience Summary

This research evaluated whether practice testing is better than restudy for facilitating deductive reasoning, a process that involves reasoning from several facts to reach a conclusion. Specifically, we investigated whether practice testing enhances memory for facts necessary to complete a deductive reasoning task. Learners studied various sets of facts from fictional scenarios (for example, facts about three fictional tribes called Zippers, Dinkos, and Goopies), followed by practice testing or restudy. Learners then completed multiple-choice test questions that each required making an inference based on information from several of the practiced facts. For example, to answer the question “If a Dinko pays \$5000 in taxes, what was his earned income?” the learner needs to remember that “Everyone is required to pay a 10% tax” and “Dinkos pay a \$1,000 yearly surtax” to arrive at the correct answer. Results suggest that deductive reasoning depends on accurately remembering the necessary facts and that benefits of practice testing for deductive reasoning are more likely to occur under conditions in which practice testing boosts memory more than restudy. Given that the ability to engage in deductive reasoning is required across a range of academic disciplines, the current study has important implications for student learning.

Keywords: Testing effect, Deductive reasoning, Transfer, Practice testing

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A substantial amount of research has established that practice testing enhances learning and retention. The *testing effect* (also referred to as *retrieval practice*) is a robust effect, manifesting across different kinds of materials, different age groups, and different test formats (for reviews, see Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013; Rawson & Dunlosky, 2011; Roediger & Butler, 2011; for meta-analyses, see Adesope, Trevisan, & Sundararajan, 2017; Rowland, 2014). Although research has established that engaging in practice testing produces memorial benefits, a majority of prior research has tapped the same material during practice and on the final test. Explored to a much lesser extent is whether practice testing promotes transfer to other types of learning and reasoning. Accordingly, the current research investigates the extent to which engaging in practice testing promotes transfer on a final test that requires deductive reasoning.

Barnett and Ceci (2002) provided an instructive framework for classifying different types of transfer based on various dimensions of content and context. Concerning transfer and testing effects in particular, previous research has demonstrated that engaging in practice testing promotes transfer on several dimensions (for a review, see Carpenter, 2012). Indeed, transfer and testing effects have been investigated using different methodological approaches, such as examining transfer across different test formats (Kang, McDermott, & Roediger, 2007) and examining transfer across different knowledge domains (Butler, 2010). For example, Butler (2010; Experiment 3) had learners study text passages and then engage in practice testing or restudy. One week later, learners took a final test which included novel questions that tapped information from a knowledge domain different from that practiced one week earlier. Results showed that final test performance was greater for learners who previously engaged in practice testing versus restudy.

Although outcomes from prior research exploring testing effects and transfer is promising, only a small amount of test-enhanced learning research has examined the transfer of knowledge. In addition, transfer may not occur for different types of learning and reasoning. Therefore, further evaluation of the extent to which practice testing promotes transfer for different types of learning and reasoning has important implications from an educational standpoint. Indeed, a primary goal of education is to facilitate students' ability to take the information they have learned and apply it to new learning situations. The ability to engage in (successful) deductive reasoning in particular is a necessary skill for a range of educational disciplines (e.g., mathematics, science), with research suggesting that students are often unaware when deductive reasoning is a necessary component (for reviews, see Dreyfus, 1999; Hanna & Jahnke, 1996). Accordingly, investigating whether different learning techniques promote transfer for deductive reasoning tasks has important implications for student learning.

Interestingly, a recent study by Tran, Rohrer, and Pashler (2015) revealed a potential boundary condition to testing effects and transfer—namely, that practice testing does not promote transfer on a deductive reasoning task. Tran et al. (2015) asked learners to study small sets of premises from four different scenarios (Table 1 provides a sample of the material set used

Table 1*Sample of Material Set Used in Tran et al. (2015) and Experiments 1–2*

Premises

1. The local school has 4 kinds of kids: Nerds, Preps, Goths, and Loners.
2. If any Preps attend a party, then any Goths who might be present immediately leave.
3. If there are 10 or more people at any party, then Loners will not be in attendance.
4. At any party, there are more Preps than Nerds.
5. Two Nerds never wear the same color shirt.
6. Goths always wear all black, and no one else ever does.
7. Preps always wear at least one pastel colored item, and no one else ever does.
8. Loners always wear a purple shirt, and no one else ever does.

Fill-in-the-blank practice question

If there are ___ or more people at any party, then ____ will not be in attendance.

Multiple-choice test question

If there are 12 people at a party, might one of them be wearing a purple shirt?

- a. Yes
- b. No [correct response]
- c. Maybe

in Tran et al., 2015). After initial study of each set, learners either completed fill-in-the-blank tests (i.e., practice testing) for the premises or restudied the premises. On a final multiple-choice test, learners answered questions that required them to deductively reason from the premises. Across four experiments, outcomes showed no advantage of having previously engaged in practice testing versus restudy, suggesting that practice testing may not promote transfer when the final test requires deductive reasoning.

One possibility is that the failure to find transfer may have been due to the use of a fill-in-the-blank practice test, leaving open the possibility that other practice test formats may produce transfer on a task requiring deductive reasoning. Consistent with this possibility, a recent study by Eglington and Kang (2018; Experiment 3) used a methodology similar to Tran et al. (2015) but instead of completing fill-in-the-blank questions during practice, learners engaged in free recall. Performance on the final multiple-choice test was greater for learners who had previously engaged in free-recall practice testing versus restudy. This outcome suggests that practice test format may moderate whether practice testing facilitates transfer on a deductive reasoning task.

Why were the fill-in-the-blank test in Tran et al. (2015) not sufficient to yield transfer to deductive reasoning? The potential explanation under examination in the current research is that practice testing did not enhance memory for the information required to successfully complete the deductive reasoning task. More specifically, completing fill-in-the-blank questions during practice may not have enhanced memory for all of the necessary information required to answer the multiple-choice questions. To illustrate, one deductive reasoning question used in Tran et al. (2015) was, "If there are 12 people at a party, might one of them be wearing a purple shirt?" Participants were given the response options "Yes," "No," or "Maybe" and asked to select the

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