TIPS, TRICKS & TECHNIQUES

The Use of a "Ringer" in Natural History Identification Tests

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Abstract

To encourage greater depths of both processing and retrieval by students during testing, the authors inserted one new, unfamiliar plant (i.e., a "ringer") into the pool of samples assembled for each plant-identification quiz. Each ringer was chosen to be superficially similar to – and yet distinctively different from – a plant species covered earlier in the course. The addition of the ringer made the tests both more authentic and more valuable by training students to look beyond the superficial details and make substantive, evidence-based identifications.

Key Words: *Natural history; identification tests; ringer.*

A recognition exam in a natural history course is a specialized kind of training. When we, as instructors, present samples for identification by recall (without the use of keys), we are hoping to develop a particular set of skills that our students will later apply to the messy diversity of the world around us. But what if the samples we use for testing are too limited? Are students developing real-world abilities if they only face a narrowly constrained set of options for identification?

These questions came to mind in the summer of 2015 when we taught an intensive, six-week survey course for undergraduates entering the School of Forest Resources & Conservation at the University of Florida. This was not a botany course, and we didn't have time to cover the use of dichotomous keys, but we wanted to introduce our students to the dominant flora of north Florida by teaching five new plants each week. The plant selections were guided by the content of the course and by the ecosystems we were visiting. Our first list, for example, included the species shown in Table 1.

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The first four species in Table 1 were selected to prepare students for a visit to a pine flatwoods ecosystem. The fifth species, poison ivy, was included as a basic precaution to prepare students for any outdoor experience in Florida. But those choices presented immediate problems for our educational objectives. The inclusion of only a single palm, for example, meant that students would likely restrict their attention to the superficial "palm-like" appearance without learning the more subtle, distinguishing features of the species. We would be ensuring that students could distinguish between a palm and a pine – hopefully something they already knew how to do – but we would not be teaching them to identify saw palmetto. Similarly, the absence of additional vines or trifoliolate plants on our list would make it unlikely that students would truly learn the distinguishing features of poison ivy. Without lengthening our plant list, we needed a way to encourage a greater level of attention to specific details in both studying and testing.

Psychologists have known for many years that retrieving information from memory under test conditions has the benefit of subsequently making the memory of that information more persistent and available (Roediger & Karpicke, 2006). This behavior of memory is sometimes called the "testing effect," and it has been described as "one of the most robust and reliable effects in all of memory research" (Soderstrom & Bjork, 2014, p. 99). But the benefits of the testing effect depend directly on both the depth and breadth of the retrieval. Facts that are close at hand in short-term memory will benefit less from retrieval than those that are deeper and less accessible. Similarly, the benefits of the testing effect depend on whether the task involves simply recognizing a correct answer (as on a multiple-choice test) or whether the task requires the production of specific information from memory (as on an essay or short-answer test):

> The results of several experiments show that the testing effect is greater when an initial test involves recall, or production of information, than when it involves recognition, or identification, presumably because recall involves more effortful retrieval than recognition. (Karpicke & Roediger, 2007, p. 717)

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Table 1. List of species taught during the first week of the "Foundations in Natural Resources and Conservation" course.

Scientific Name	Common Name
Pinus elliottii	Slash pine
P. palustris	Longleaf pine
P. taeda	Loblolly pine
Serenoa repens	Saw palmetto
Toxicodendron radicans	Poison ivy

The memory benefits of "effortful retrieval" are paired with the equally important benefits of "depth in processing." Perhaps more than in other subjects, a natural history exam is also a time of encoding. That is, as students interact with new specimens and observe natural variation, they gain new information and add that knowledge to their mental models. But the depth associated with that encoding – the degree to which students analyze information, enrich it with previous knowledge, and form new mental associations – is critical to ensuring the persistence of the memory:

> Retention is a function of depth, and various factors, such as the amount of attention devoted to a stimulus, its compatibility with the analyzing structures, and the processing time available, will determine the depth to which it is processed. (Craik & Lockhart, 1972, p. 676)

Together, these processes explain why we didn't want students to simply glance at a palm frond and write the scientific name for saw palmetto during our plant-identification exams. To give students a lasting educational benefit, we needed to (1) increase the amount of attention and depth of processing given to each specimen; and (2) make the task of identification dependent on the production of information, rather than just recognition. In short, we needed to create what Robert Bjork of the UCLA Center for Memory has called "contextual interference" or "desirable difficulties" during training (Bjork, 1994). To do that, we added a "ringer" – an unfamiliar look-alike plant – to the five plant samples assembled for each identification test (Figures 1 and 2 provide an example of such a test).

Students were told in advance that each test would include a single ringer that would need to be identified as such. And each ringer was chosen to match the superficial details of some species that had previously been taught. In Test 1, for example, the test specimens included saw palmetto and the three pines, but a trifoliolate section of boxelder (*Acer negundo*) was substituted for poison ivy. To recognize that the boxelder sample was the ringer, students needed to see beyond the trifoliolate leaves and notice that the leaf arrangement was opposite, rather than alternate.

The 55 students in our course were initially hesitant about having ringers on their quizzes. They expressed some anxiety about the unfamiliar approach, and scores on the first two quizzes were relatively low, with medians of 4.00 and 3.88, respectively (out of 5.00) and only seven perfect scores each time. But the students seemed to quickly adapt to the new approach. The final two quizzes shared a median of 4.50 (again, out of 5.00) and had 18 and 16 perfect scores, respectively.

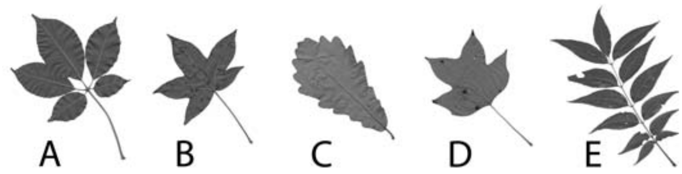

Figure 1. Want to try a test with a "ringer"? Here are five species: (**A**) White sapote (*Casimiroa edulis*) has a palmately compound leaf with five elliptic leaflets. (**B**) American sweetgum (*Liquidambar styraciflua*) has a simple leaf with five sharply pointed lobes. (**C**) Swamp chestnut oak (*Quercus michauxii*) has a simple, obovate leaf with large, rounded teeth. (**D**) Tuliptree (*Liriodendron tulipifera*) has a simple leaf with four sharply pointed lobes. (**E**) Pecan (*Carya illinoinensis*) has an odd-pinnately compound leaf with 9–17 leaflets.

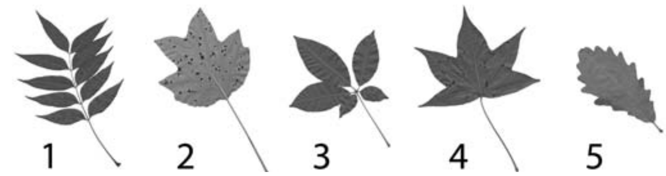

Figure 2. Here's your test. Four of these specimens are species that you learned in Figure 1, and one specimen is a "ringer" that needs to be identified. Answers are given at the end of the paper.

Even before the tests were graded, the most immediate and visible result of our approach was that students made remarkably careful examinations of each specimen they saw. Where a quick glance might normally have sufficed for a superficial identification, students now worked with the samples longer, examined more details, and applied more knowledge. The quizzes took 10–15 minutes longer than they might have under normal circumstances, but they likely produced greater depths of both processing and retrieval.

Feedback from the course evaluations was largely positive. Majorities of the students agreed that the presence of the ringer made the tests harder but also made them learn more identification features and look more closely at the plants during the quizzes (Table 2). Students were divided on whether they liked having the ringer, but a majority felt that it should be included on quizzes in future years. In written comments, several students said that they understood the need for a ringer, enjoyed the challenge, and looked forward to the quiz each week.

Perhaps the most interesting insight into the role of the ringer came from the final exam, when students were told in advance that there would be no ringer. The number of perfect scores on that exam dropped back to only seven. Most strikingly, many students misidentified paper mulberry (*Broussonetia papyrifera*) as air-potato (*Dioscorea bulbifera*). Both plants have large, ovate, simple leaves, but they differ widely in margins, venation, and surface texture. One likely explanation for the mistakes is that, freed from concerns about a ringer, students made quick identifications from a distance and didn't bother to closely examine the details of the samples. This corresponds to the behaviors we observed during the exam.

Table 2. Course evaluation feedback on the "ringer" (Likert scale).

No.	Statement	Percent Choosing "Agree" or "Strongly Agree"
1	The ringer made the quizzes harder.	94.4
2	I liked having a ringer on the quizzes.	40.7
3	The ringer made me look more closely at the plants during the quizzes.	87.0
4	The plant tests in this class were too hard.	16.7
5	I understood why the instructors put a ringer on the quizzes.	88.9
6	I already knew many of these plants before I took this class.	25.9
7	The ringer forced me to learn more plant details when I was studying.	68.5
8	The plants were too hard to tell apart.	16.7
9	The quizzes next year should include a ringer.	59.3

To help students become accustomed to the concept of a ringer, it might be useful for instructors to offer an initial practice test that doesn't count for credit. Students should also be encouraged to continually test themselves as they move through the natural world. The ultimate pedagogical objective of teaching a core group of species is to help students identify those particular organisms in the real world, amid all the real ringers that exist around us, and students should be given many opportunities to work with instructors and check how those skills are developing.

We should note that the technique described here is intended specifically for recognition tests in which students make identifications by memory, without the use of tools. Obviously, many natural history courses also teach students how to identify unknown organisms using keys, and a test of that skill would require a different approach. But for courses in ornithology, herpetology, horticulture, weed science, and a multitude of other subjects in which students are expected to recognize some "core group" of common species, instructors may find it worthwhile to include ringers on their recognition tests. Whether students accept the ringer and rise to additional challenge of identifying it will depend on the dynamics of the individual class. Our experience was that students accepted a ringer on a test when the reasons for including it were clearly explained. Under the right conditions, a ringer on a natural history test can make the test experience both more authentic and more rewarding.

○ Answers to the Test in Figure 2

(1) Ringer (Chinese pistache, *Pistacia chinensis*); (2) tuliptree; (3) white sapote; (4) American sweetgum; and (5) swamp chestnut oak. The ringer leaf has a paripinnate or "even-pinnate" structure, with all leaflets borne in pairs, that distinguishes it from the imparipinnate or "odd-pinnate" leaves of pecan, which have a single, terminal leaflet.

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