Instructors can use the demonstration in sensation, perception, and cognitive courses, as well as introductory courses, and can implement the demonstration in lecture or in a laboratory assignment in which students manipulate the lens and screen themselves. Instructors may even assign the construction of a classroom-sized or traditional-sized pinhole camera as a class project. Regardless of how instructors choose to use it, we conclude that the pinhole camera demonstration is well received and empirically validated as an effective teaching aid on the visual system.

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Notes

1. We thank Melissa Clearfield, Katalina Diamond, and Kathleen Felton, in whose classes we demonstrated the pinhole camera. We also thank Deborah DuNann Winter for editorial suggestions.

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Using Kitchen Appliance Analogies to Improve Students' Reasoning About Neurological Results

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This article describes and evaluates a new technique for teaching students to interpret studies of patients with brain injuries. This technique asks students to consider how knives and blenders lose specific functionality when they are damaged. This approach better prepares students to make proper inferences from behavioral deficits observed after brain injury, specifically with reference to single and double dissociation. Significantly improved performance on multiple-choice and identification questions included in midterm examinations suggests that the impact of these thought experiments was substantive and long lasting.

Studies of patients with brain injuries have greatly influenced psychology and other allied fields over the past several decades (Shallice, 1988). For instance, loss of short-term memory capacity observed in patients with damage to the hippocampus has fundamentally influenced how psychologists conceive of normal human memory (Squire, 1992). Visual agnosia, the loss of ability to recognize objects after lesions to inferotemporal cortex, has suggested the presence of dedicated brain systems for this process (Farah, 1994). Neuroscientists have found that the pattern of deficits exhibited by patients after brain injuries can provide important clues about the normal function of uninjured brains (Shallice, 1988). However, in addition to knowing the power of studying patients with brain injuries, neuroscientists know that determining the real meaning of a patient study is a complex process. Given the interdisciplinary nature of psychological science, it is important to teach students to evaluate neurological work carefully and skeptically.

A staple of neuropsychology is *dissociation,* wherein a patient loses one mental ability while others are spared. For instance, DF is a patient who, after suffering damage to the ventral portion of her visual cortex, lost the ability to perceive and make judgments about a large region of her visual field. Even after the injury, however, she retained the ability to reach out and grasp targets placed within this "blind spot" (Milner & Goodale, 1995). To move her hand to the correct location while shaping her fingers into a properly scaled grip, DF must be able to register the size and location of the target. Visual judgment (VJ) and visually guided grasping (VG) can thus be said to be dissociated in DF. Many students initially interpret this single dissociation pattern as evidence that the damaged cortical area in DF is responsible for VJ and not VG in normal, uninjured brains. An alternative interpretation can be offered for this type of finding, however, based on differences in task difficulty. According to this interpretation (a) the brain region under consideration participates in both VJ and VG activities, (b) the damage has diminished the patient's general capacity for both types of visual processing, and (c) VJ is simply more difficult than VG. Such an interpretation predicts the observed pattern of deficits without proposing the presence of localized and separate VJ and VG systems.

A more compelling type of finding that does not suffer from this task-based alternative interpretation is *double dissociation,* in which a second patient (or population of patients) is found with damage to a different brain region and the opposite set of disorders. For instance, RV is a patient who exhibited the opposite pattern of deficits after suffering damage to the dorsal region of his visual cortex, exhibiting normal VJ but impaired VG (Milner & Goodale, 1995). The task-difficulty-based argument applies individually to RV, but the argument is invalid when DF and RV are considered together because VJ cannot simultaneously be harder and easier than VG.

Even double dissociation is open to alternative interpretations, however. Shallice (1988) described many of the possibilities; Farah (1994) expanded on this work, presenting an alternative framework of reasoning based on the assumption that human information processing is not localized, but rather graded, distributed, and interactive. Plaut (1995) provided an excellent demonstration of the limitations of double dissociation data. After training a neural network simulation to perform two different word-reading tasks, he simulated damaging it by deleting a randomly selected portion of the network's connections. He then tested the network to assess how that damage affected its performance on the two different tasks. As he repeated this process thousands of times, Plaut found that double dissociations occasionally emerged even when lesions were focused within the same processing region of the network. "If non-modular systems can also give rise to double dissociations when damaged, the observation of such a dissociation in patients, in and of itself, does not provide evidence for a modular organization of the cognitive system" (Plaut, 1995, p. 314). Much research supports the notion that the human brain consists of many specialized subcomponents, but double dissociation evidence alone cannot provide a conclusive understanding of the identity and structure of those components (Farah, 1994; Plaut, 1995; Shallice, 1988; Uttal, 2001; Van Orden, Pennington, & Stone, 2001).

My experience has been that cognitive psychology students are able to understand these ideas in isolation, but dissociation evidence, particularly double dissociation evidence, often inspires inaccurate reasoning. Cognitive psychology texts typically mention the complexity of reasoning from double dissociation evidence, but only in a few brief sentences before launching into compelling patient cases and theories based on them (Eysenck & Keane, 2000; Groome, 1999; Parkin, 2000; Sternberg, 2003). Whether the object of study is a car engine, a computer, or the human nervous system, typically human thinkers take a "divide and conquer" approach: (a) identify subcomponents, (b) analyze the function of these subcomponents individually, and (c) examine the ways in which the subcomponents interact to produce the behaviors of the entire system. Most human strategies for understanding complex systems possess this structure at their core (for consideration of the hierarchical decomposition constraint, see Kosslyn, Flynn, Amsterdam, & Wang, 1990). Given the tendency to seek encapsulated, decomposable subcomponents, students find it difficult to internalize the limitations of double dissociation evidence.

I assessed the use of kitchen appliance analogies to improve reasoning about dissociations. Rather than immediately applying dissociation reasoning to a system that students do not understand well (i.e., the human brain), the analogies challenge them to apply the reasoning to appliances that they do understand well. Students might not completely understand the precise electrical and mechanical details of these machines, but because the devices perform familiar functions and consist of specific, recognizable parts, the students can more fully focus on reasoning about dissociation.

For the first analogy, I describe a kitchen knife, which, after suffering an injury to its edge region, loses the ability to cut steak while retaining the ability to cut butter. When I later present students with a description of patient DF in isolation, I predict they will be less likely to jump to the conclusion that the ventral visual cortex is responsible for VJ and not VG.

For the second analogy, I describe a double dissociation involving two blenders. Blender A suffers damage to its electric motor and can thereafter no longer generate enough force to grind walnuts. It can still, however, make milkshakes and other beverages. Blender B suffers a hairline crack in its pitcher component, such that it can no longer make a milkshake because the fluid leaks out of the pitcher onto the counter. Blender B can still, however, grind walnuts. Thus, Blenders A and B exhibit a double dissociation (see Figure 1). I then invite students to decide whether the motor should be referred to as the "walnut grinding region" and the pitcher as the "milkshake region," a conclusion that is false because the whole blender is needed to accomplish either task. A better conclusion, which one could reach with additional drink-making experimentation, is that the pitcher is responsible for containing materials and the motor is responsible for generating the force to turn the mixing blades. By itself, however, an isolated double dissociation cannot allow one to reach these conclusions. When I later present students with patients DF and RV together, I predict they will remain cautious about concluding that the ventral and dorsal regions of the visual cortex are the VJ and VG regions of the brain.

Does a double dissociation at least allow one to infer the presence of two separate mental components? I refute this idea by asking students to consider Blender C, from which the plastic pitcher is left sitting on a hot stove, resulting in a large warp in the side of the pitcher. If one attempts to grind walnuts in this pitcher, the nuts get stuck in the indentation, preventing most of the walnuts from being ground properly. Blender C, however, retains the ability to make milkshakes

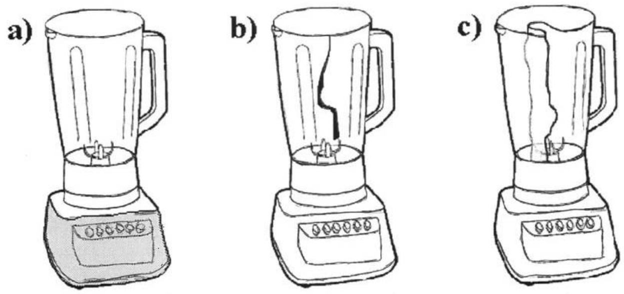

Figure 1. Three different patterns of blender damage and deficit. Due to damage to the motor component, Blender A can no longer grind walnuts. Due to the crack in its pitcher component, Blender B can no longer make milkshakes. Due to its misshapen pitcher component, Blender C can no longer grind walnuts.

and other fluid drinks that circulate more easily than walnuts. Blenders B and C exhibit a double dissociation even though the same component is damaged in both cases. An assumption that students often make in interpreting neurological cases is that there is only one way to damage any brain region. If there is more than one way to damage a pitcher, it seems possible that there is also more than one way to damage a subsystem of the brain.

Method

Participants

One-hundred seven undergraduate students (72 women, 35 men) in a midlevel cognitive psychology course volunteered to participate (9 freshmen, 64 sophomores, 29 juniors, 5 seniors).

Materials and Apparatus

I delivered all lectures in the 115-seat classroom in which the course met. I first presented a brief description of patients DF and RV, followed by an invitation to infer the presence of separable systems for VJ and VG. I presented students in the control condition with a diagram presented by Shallice (1988) and a description of the computational lesion experiment performed by Plaut (1995). I presented students assigned to the analogy condition with the three kitchen appliance analogies. The last portion of both lectures emphasized the same conclusions that (a) double dissociation can provide good clues to the organization of the brain, but (b) by itself, is not sufficient to demonstrate the presence of separable cognitive modules. Both the control and analogy presentations lasted approximately 10 min.

Design and Procedure

I randomly assigned students to either the control or analogy group. During the second class meeting, I delivered the analogy and control lectures to each group in immediate succession. The analogy group left the room during the control presentation and vice versa. Two exams taken by the students during class meetings 8 and 15 included probe questions. Exam 1 included a single multiple-choice question; Exam 2 included a second multiple-choice question and a short-answer identification question (see Appendix).

Results

I used chi-square tests to assess the proportion of students who answered each multiple-choice question correctly in the analogy and control groups. Participants in the analogy group performed significantly better in both cases, Question 1: $\chi^2(1, N = 107) = 5.11, p = .024$; Question 2: $\chi^2(1, N = 107) = 4.82, p = .028$ (see Table 1). Coding of the short essay question yielded more frequent mentions of the limitations of double dissociation evidence, although this result did not achieve statistical significance, $\chi^2(1, N = 107) = 2.05, p = .15$.

Discussion

Previous experiments have shown that easily visualized mental models can enhance understanding of a variety of topics (Gigerenzer & Hoffrage, 1995; Gigerenzer, Hoffrage, & Ebert, 1998; Hoffrage & Gigerenzer, 1998). This study assessed such a method for teaching students about single and double dissociations, based on kitchen appliance analogies. The analogy group produced significantly more correct answers, although their performance was generally mediocre, suggesting that additional instruction is warranted. Similar issues arise in the interpretation of neuroimaging studies (for review, see Sarter, Berntson, & Cacioppo, 1996), such that the understanding gained from this exercise has the potential to be valuable in that context as well.

Critics of this approach may argue that brains are not blenders. This statement is irrefutable, but both brains and blenders are systems that perform certain tasks through an interaction of many subcomponents. If it is possible to generate challenging interpretation problems by damaging a simple blender, it seems likely that something as complex as the human brain will produce similar difficulties. The key difference between the blenders and brains in this context is that, in the case of the blender, the tasks and subcomponents are easily identifiable and well understood. By practicing dissociation reasoning using these simple systems, students are better prepared to apply that reasoning to the human brain.

Table 1. Performance on Exam Probe Questions

Question	Control Group[a]	Experimental Group[b]	*p*
Multiple choice 1[c]	3.7	17.0	.02
Multiple choice 2[c]	83.3	96.2	.03
Short answer[d]	9.3	18.9	.15

[a] $n = 54$. [b] $n = 53$. [c] % correct. [d] % mention of limitations of dissociation reasoning.

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Notes

1. This work was supported in part by a Northwestern University Faculty Research Grant and the National Institutes of Health (Award 1–R01–HD40827–01).
2. I thank Daniel Levin, Elizabeth Spelke, James Cutting, Barbara Finlay, and Jennifer Stevens for helpful discussions and comments on this material.

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Applying Social Psychological Concepts Outside the Classroom

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This article evaluates a writing assignment in which social psychology students gathered examples from outside the classroom (e.g., cartoons, movies) and analyzed them with course material. Compared to a control group, students who completed the assignment learned that it was easier to apply social psychology to the real world. A follow-up survey 9 months later demonstrated that this effect persisted. Students who completed the assignment also valued social psychology more and believed they had learned more in their social psychology course.

Given the ubiquity of social phenomena, everyday situations and events contain many examples of social psychological concepts. Teachers of social psychology strive to provide students with an understanding of these principles so that students are able to recognize social psychology in action outside of the classroom.

To accomplish this goal, instructors can emphasize the applicability of social psychology to real-world situations (i.e., the nonacademic environment) throughout the course by incorporating contemporary social events into daily lectures. However, complementary techniques also exist. For example, students could complete a paper assignment that requires them to find examples of social psychology in the real world and then analyze these examples using knowledge gained in the course. This article evaluates the utility of this type of assignment.

Assignments designed to show students the relevance of social psychological material to their nonacademic lives are common. To the extent that these assignments decrease the perceived difficulty of applying social psychology to the real world, self-efficacy should increase. As self-efficacy increases, motivation, effort, perseverance, and performance