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TOPICAL ARTICLES

The Effect of Refuting Misconceptions in the Introductory Psychology Class

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Students often come into the introductory psychology course with many misconceptions and leave with most of them intact. Borrowing from other disciplines, we set out to determine whether refutational lecture and text are effective in dispelling student misconceptions. These approaches first activate a misconception and then immediately counter it with correct information. We tested students' knowledge of 45 common misconceptions and then taught the course with lecture and readings of a refutational or standard format or did not cover the information at all. Students showed significant changes in their beliefs when we used refutational approaches, suggesting refutational pedagogies are best for changing students' misconceptions.

"Most people use only 10% of their brain power." "Mozart's music can increase infants' intelligence." "The right half of the brain is the creative side." Such claims are popular despite their lack of supporting evidence. Although unfortunate, it is at least understandable that the public believes such claims, given the predominance of unsubstantiated claims in the media (Lilienfeld, Lynn, & Lohr, 2004). As teachers of introductory psychology, we hope that presenting information supported by evidence will decrease psychological misconceptions. Sadly, this belief in our effectiveness in reducing student misconceptions is itself a misconception. Over 80 years of research suggests not only that students come into our classes with a wide variety of misconceptions, but that they also leave with their erroneous beliefs intact (Garrett & Fisher, 1926; McKeachie, 1960; Taylor & Kowalski, 2004; Vaughan, 1977).

Why do instructors see so little change in students' misconceptions following the introductory course? Some researchers have argued that this observation is an artifact of measurement (Barnett, 1986; Gardner & Dalsing, 1986; Griggs & Ransdell, 1987). Griggs and Ransdell (1987), for example, noted that misconception tests using a true–false format often include items that are not completely false or are not addressed in introductory psychology textbooks. In response, researchers have measured a variety of misconceptions, often taken directly from textbook resources (e.g., Miller, Wozniak, Rust, Miller, & Slezak, 1996), and have developed diverse instruments to measure student misconceptions (e.g., Gardner & Dalsing, 1986; McCutcheon, 1991; Taylor & Kowalski, 2004). Despite this diversity of instruments, researchers continue to find that students hold many misconceptions that are difficult to change.

Although it is clear that students hold misconceptions, it is less clear how to reduce those misconceptions. Neither McKeachie (1960) nor Vaughan (1977) found evidence that the introductory course promoted general thinking skills that allowed students to apply and generalize their learning. Even when instructors address topics in class, students appear not to see the relevance of the discussion to their current beliefs. The few misconceptions that changed in Vaughan's study tended to be those that were directly refuted in the readings. As a result, Vaughan suggested that instructors should identify student misconceptions, then directly refute them through readings and lectures.

Literature on conceptual change learning specifically addresses the value of targeting and refuting misconceptions as a way of altering false beliefs (Guzzetti, Snyder, Glass, & Gamas, 1993; Posner, Strike, Hewson, & Gertzog, 1982). According to this literature, when correct prior beliefs provide a foundation for information, learning is facilitated, but when prior beliefs contradict new information, the prior beliefs hamper learning. For change to occur, individuals must become dissatisfied with their prior belief and find new conceptions that are intelligible, plausible, and useful. Teaching for conceptual change, therefore, often involves engaging students in activities or demonstrations designed to create cognitive conflict between their prior knowledge and the information to be learned. In a meta-analysis of instructional strategies, Guzzetti et al. (1993) showed that such conceptual change instruction, when compared to standard instruction, had a greater impact on student misconceptions.

Some research on students' misconceptions in psychology confirms the value of classroom activities in decreasing beliefs in individual psychological misconceptions (e.g., 10% brain use; Higbee & Clay, 1998). However, others have found activities only slightly effective (e.g., "extramission" as the basis for vision; Winer, Cottrell, Gregg, Fournier, & Bica, 2002). Outside psychology, educational research (e.g., Bransford, Brown, & Cocking, 2000) suggests that despite the importance of activities, the lecture plays a critical role in promoting meaningful conceptual change because it helps students to organize and attend to the new information.

Few studies have addressed the role that various methods of presenting information play in changing psychological misconceptions. In one such study, Miller et al. (1996) identified a set of misconceptions and then addressed them in class by text, lecture, both, or neither. The study demonstrated the value of calling students' attention to their misconceptions and explicitly directing their attention to the evidence, but cautioned against reliance on reading alone to make the connections obvious to students.

Reading researchers have specifically explored whether text can facilitate change in student misconceptions. Guzzetti (2000), for example, noted the value of a particular kind of text, referred to as "refutational text" (p. 90), in dispelling misconceptions. Refutational text directly addresses a common misconception, and then refutes the misconception by presenting evidence supporting the correct information. Hynd, Alvermann, and Qian (1994) provided evidence that refutational text is superior to standard text (which discusses the concepts but does not activate the misconception). Guzzetti suggested that refutational text is superior to standard text in reducing misconceptions because it makes explicit the incongruence between the students' current thinking and the textbook, and students are therefore less likely to ignore the new information.

Similar to research on conceptual change, studies in the reading literature have found that refutational text alone might not be enough to change some students' misconceptions. Marshall (1989), for example, found that a condition in which students observed a demonstration and then read refutational text produced greater change than a condition in which students read first and then observed the demonstration. Both conditions, however, were superior to conditions in which students simply read refutational text or observed demonstrations. Other research also found that individuals might need guidance from the teacher to direct their attention to arguments that refute nonscientific conceptions (Alvermann, Hynd, & Qian, 1995; Guzzetti et al., 1993).

From this research on conceptual change and reading, it appears that although changing students' misconceptions is difficult, change can occur when instructors confront misconceptions directly with refutational text and direct student attention to the refutation in class. No study has addressed the use of refutational text and lecture in reducing student misconceptions in the introductory psychology class. In this study we used an in-class design that allowed us to compare students' change in misconceptions in introductory psychology in response to various combinations of pedagogies. We asked the following research questions: (a) Are students more likely to change their misconceptions with refutational text and lecture, compared with standard text and lecture, or with no coverage at all? (b) Do students' misconceptions change when they read refutational text alone, or does change require the refutational lecture?

Method

Participants

The participants were 65 introductory psychology students enrolled in sections taught by the authors during the fall semester of 2006 at the University of San Diego. The sample was 80% women, and the average age was 18. Participants completed the study as part of their course; however, we included data only from students who provided written consent (87% of all enrolled students).

Materials

Psychological Information Questionnaire. We used the true–false format, including both true and false items, in contrast to other questionnaires, on which all of the items appear as false to be correct. The questionnaire contained 100 true–false items assessing students' knowledge of psychological information. Fifty-five items reflected facts normally covered in an introductory psychology course (i.e., "Psychology is defined as the science of behavior and mental processes"). We included these items to minimize demand characteristics and to prevent a response set bias (for false). We then randomly embedded the 45 misconceptions items, which are the focus of this article, selecting items from previous instruments (e.g., "A schizophrenic is someone with a split personality"; Vaughan, 1977), from the popular literature (e.g., "Mozart's music increases infant intelligence"), and from an instructor's manual (Bolt, 2007; e.g., "Human intuition is remarkably accurate and free from error").

Readings. The course text was Melucci's (2004) *Psychology: The Easy Way*. This concise text allowed us to control the type and amount of information to which we exposed the students. We supplemented the text with 38 readings, 17 directly related to specific misconceptions assessed on the Psychological Information Questionnaire. The remaining 21 readings related to other information and masked the intent of the 17 readings targeting misconceptions. Reading length ranged from 1 to 15 pages. Sources for readings included chapters from books (e.g., Stanovich, 1998), periodicals (Wallis, 2004), and Internet sources (e.g., "Young Brains on Alcohol," 2002). Readings addressed claims in either a standard or a refutational manner, as described by Guzzetti (2000). Table 1 provides examples of refutational and standard text.

Lecture. Refutational lectures focused on the popular misconception and the scientific evidence supporting the correct information. Standard lectures covered items by addressing the scientific understanding of the concept but did not mention the common misconception.

Table 1. Examples of Refutational and Nonrefutational Texts

Refutational Text
Many introductory psychology books have a figure in the chapter on the senses that shows how sensitivity to salty, sour, sweet, and bitter tastes vary over the surface of the tongue. They show an area at the tip that is sensitive to sweet, two areas a little to either side that are sensitive to salty, two farther back along either side that are sensitive to sour, and a single area in the back of the tongue that is sensitive to bitter. Only one problem: It isn't so. It is true that sensitivity to the different taste qualities varies *somewhat* over the tongue, and the areas listed are for the most part the ones most sensitive to the various tastes. But with the exception of the middle of the tongue, which is totally insensitive to any taste, *all areas of the tongue are sensitive to all taste qualities.* (McBurney, 1996, p. 21)
Nonrefutational Text
It's generally (but not universally) agreed that there are four primary tastes: sweet, sour, bitter, and salty. Sensitivity to these tastes is distributed somewhat unevenly across the tongue, but the variations in sensitivity are quite small and highly complicated. Although most taste cells respond to more than one of the primary tastes, they typically respond best to one. Perceptions of taste quality appear to depend on complex patterns of neural activity initiated by taste receptors. (Weiten, 2004, p. 159)

Course Design

We designed the course to allow us to examine the different methods of addressing misconceptions in lecture and in readings. We covered items from the Psychological Information Questionnaire in either a refutational lecture, a standard lecture, or not at all. We also provided readings with refutational text, standard text, or none at all. Because of constraints created by the naturalistic setting of this study, we assessed five combinations of coverage, each with nine items, in a within-subjects design: (a) refutational lecture and refutational reading (R/R), (b) refutational lecture and no reading (R/N), (c) standard lecture and standard reading (S/S), (d) no lecture and refutational reading (N/R), and (e) no lecture and no reading (N/N).

Procedure

Participants completed the Psychological Information Questionnaire as a pretest during the first class. During the semester, we assigned readings in the Melucci (2004) text as well as additional articles. We covered item content in class with refutational lecture, standard lecture, or not at all. Exams included multiple-choice or short-answer items over the readings and lectures. On the last day of class, students again completed the Psychological Information Questionnaire in class.

Results

For all analyses we used $p < .05$ as the criterion for determining significance of findings. We calculated percentage correct on the 45 misconception items at both pretest and posttest, as well as for the subsets of items addressed by each of the five methods of coverage. Students averaged 30.09% ($SD = 8.37$) correct on the pretest, and 64.41% ($SD = 12.44$) correct at posttest.

In addition to percentage correct, for the misconceptions items we calculated average normalized gain scores according to the method described by Hake (2002, 2005) and implemented by Coletta and Phillips (2005) for evaluating pedagogical techniques in physics and by Grossman (2005) in psychology. This technique defines normalized gain <g> as actual gain divided by maximum possible gain (Hake, 2002). We computed each student's individual normalized gain and then averaged these gain scores across the group of students. This procedure resulted in average normalized gain scores ranging from 0.00 to 1.00, with 1.00 indicating a greater overall average normalized gain. The advantage of using average normalized gain scores is that the final evaluation of posttest scores takes into account the level of performance at pretest.

The initial analysis involved a one-way repeated measures ANOVA assessing the effect of the five different coverage methods on <g>. This overall ANOVA was significant, $F(4, 61) = 110.42$, $p < .001$, $\eta^2 = .88$. We then addressed the first two research questions by conducting tests of within-subjects contrasts, controlling α across all contrasts.

Question 1

Are students more likely to change their misconceptions with refutational text and lecture, compared with standard text and lecture, or with no coverage at all? This question involved comparing R/R to S/S and R/R to N/N. The results, with standard deviations noted in parentheses following means, showed a greater <g> for R/R = .72 (.24), compared with S/S = .37 (.28), $F(1, 64) = 65.93$, $p < .001$, $\eta^2 = .51$,

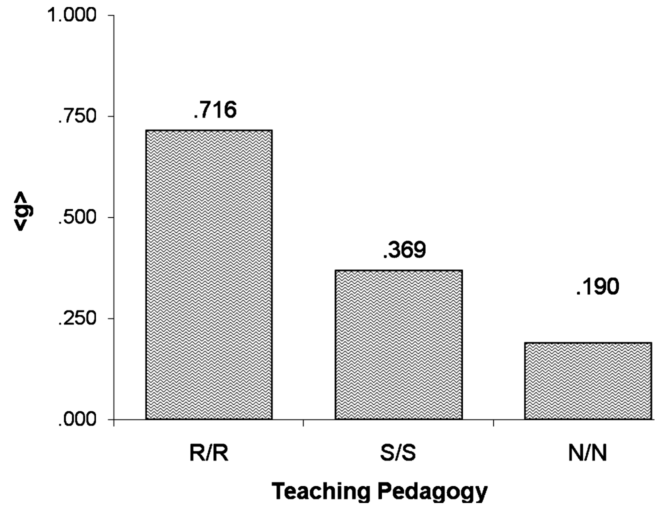

Figure 1. Mean average normalized gain scores (<g>) for material covered using refutational text with refutational lecture (R/R), standard text with standard lecture (S/S), and no text with no lecture (N/N).

and a greater <g> for R/R compared with N/N = .19 (.25), $F(1, 64) = 271.56$, $p < .001$, $\eta^2 = .81$. In addition, the relative gain comparing S/S to N/N was also significant, $F(1, 64) = 17.16$, $p < .001$, $\eta^2 = .21$. As Figure 1 more clearly shows, these results suggest little gain in scientific understanding for claims not covered in class. Students' misconceptions about psychological concepts decreased with the standard approach to covering topics, when covered both in text and in lecture. Further, the technique of directly refuting misconceptions in text and lecture was superior to the standard approach.

Question 2

Do students' misconceptions change when they read refutational text alone or does change require the refutational lecture? This question involved comparing R/R to R/N and comparing R/R to N/R. Test of within-subjects contrasts showed no difference in <g> with R/R = .72 (.24), compared to R/N = .68 (.23). In contrast, we did find a significant difference in gain when comparing R/R to N/R, <g> = .34 (.34), $F(1, 64) = 88.12$, $p < .001$, $\eta^2 = .58$. This finding, depicted in Figure 2, suggests that not only is the refutational lecture important in producing gains in students' understanding of psychological misconceptions, but also that refutational text might add little to the effect.

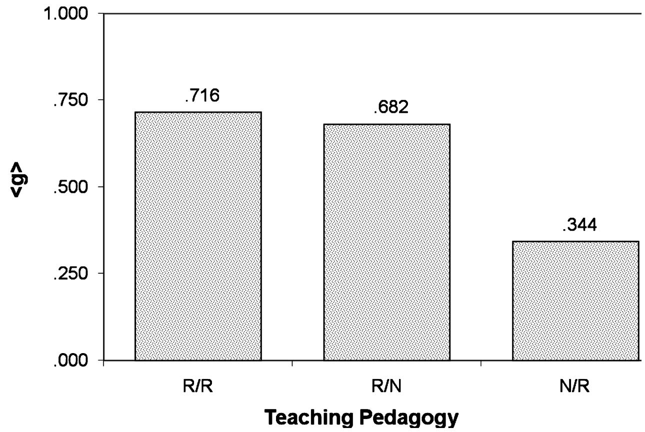

Figure 2. Mean average normalized gain scores (<g>) for material covered using refutational text with refutational lecture (R/R), refutational lecture with no text (R/N), and no lecture with refutational text (N/R).

Discussion

The purpose of this study was to determine whether a specific method of addressing psychological misconceptions in course text and lecture would produce gains in student understanding. Despite high levels of initial misconceptions, the refutational method for presenting new information influenced whether students developed accurate scientific knowledge. As others (e.g., Guzzetti, 2000) noted, we found that directly refuting misconceptions in class seemed to be particularly important. It could be that the lecture acts as an organizing tool, helping students to first activate their prior, incorrect knowledge and then allowing for storage of a second, stronger bit of information that contains the correct knowledge.

Although it is beyond the scope of this article, it is probable that both pieces of information coexist in memory, with the misconception now labeled as such and the new information labeled as "correct" (see Reed, 2007, for a discussion of replacing vs. updating schemata). The refutational lecture did result in greater understanding of the typically misunderstood concept compared with the standard lecture and text. In fact, although several past studies found only a 5% to 7% change in students' psychological misconceptions following the introductory class (Gardner & Dalsing, 1986; McKeachie, 1960; Vaughan, 1977), we found a 34.3% change. When we presented information in a refutational manner, students showed the greatest net change, improving performance by 53.7%. In addition, the overall ANOVA on <g> showed a very large effect size. Thus, if students are going to abandon misconceptions, it appears instructors must specifically tell them that preconceived notions are incorrect and then immediately provide clear evidence demonstrating the correctness of the new information.

In addressing the value of refutational text independently of refutational lecture, the conclusions are not as clear. Coverage by refutational lecture together with refutational text was superior to no lecture together with refutational text, which was equal to coverage with standard lecture and standard text. That is, refutational text alone produced about as much change as standard text and standard lecture together. This finding suggests that despite the value of refutational text, the refutational lecture alone produces greater change compared to text alone. Although this finding might suggest that students are not helped as much in reducing misconceptions by reading refutational text as they are by hearing a refutation lecture, the design of the study in the natural classroom environment does not eliminate alternative explanations.

In this context, we assigned readings to students as part of their introductory psychology course; we do not know the degree to which students actually completed the assigned readings. We emphasized the need to keep up with the readings and provided incentives to do so. Nevertheless, the nature of our comparison conditions leaves an assessment of this question unclear. We are currently conducting experimental studies, similar to those conducted by reading education researchers (Marshall, 1989). Such laboratory studies allow greater control over what students read and allow researchers to more clearly assess the value of refutational text. We are also looking at whether students who differ in ability differ in the degree to which they benefit from refutational pedagogy.

In addition, this study has other limits specific to the natural classroom environment. Because this study took place within a normal introductory psychology course, it was important that we cover the usual course content. As a result, we could not use a completely random method to determine the coverage method. We targeted some items (e.g., the 10% myth) because they represent major misconceptions in psychology. We did not target some items (e.g., baby sign language) because they were not essential to understanding the basic principles of psychology. Finally, we were simply unable to find existing readings of the proper type (refutational or standard) for some of the topics. For example, with regard to DARE, we found only refutational text. The experimental studies we have started address this limitation by randomly assigning students to read refutational or standard text we created specifically for the study.

Despite limitations, we believe this study contributes to the literature on psychological misconceptions. Much of the past research on misconceptions has focused on measuring or dispelling individual misconceptions. Although activities are effective in reducing individual misconceptions, it is impractical to think that instructors can address all misconceptions with classroom activities. By relating research on psychological misconceptions to the larger literature on science education and reading research, this study suggests a more general approach to dispelling misconceptions. Targeting misconceptions with a refutational approach, a method shown to be valuable in the education literature, also appears to be a valuable method for dispelling psychological misconceptions. Identifying the factors that influence meaningful change is critical if students are to relinquish popular notions of human behavior and develop a more scientific understanding of psychology.

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Notes

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