Misconceptions and Conceptual Change in Undergraduate Students’ Understanding of Psychology as a Science

ERIC AMSEL¹, TODD BAIRD, AND AARON ASHLEY

Weber State University, US

¹ Correspondence concerning this article should be addressed to Eric Amsel at: Department of Psychology, Weber State University, 1202 University Circle, Ogden UT 84408-1202 USA. Email: eamsel@weber.edu.
American undergraduate psychology students’ \((N = 438)\) beliefs about the scientific nature of the discipline were assessed as a function of their year in college (first- to fourth-year) and academic status in psychology (a comprehensive, limited, or minimal program of study in psychology). Students completed the Psychology as a Science (PAS) questionnaire, in which they evaluated 15 Likert-type statements about scientific psychology. There was a main effect of year in college and academic status, suggesting that those who are academically advanced and committed to a comprehensive study of psychology had a stronger belief that psychology is a science. The results are discussed in terms of the process of conceptual change by which students overcome their misconceptions about psychology as a science.
Research in science learning has documented that students enter science classrooms with misconceptions about core ideas of the disciplines (Driver, 1983; Duit, 2003; Posner, Strike, Hewson, & Gertzog, 1982; Strike & Posner, 1993). That is, rather than being merely uninformed about key ideas of a given scientific discipline, students have alternative ideas which conflict with the material to be learned. Student misconceptions about scientific disciplines are ubiquitous, having been demonstrated in the life and physical sciences and in children and college students (for reviews see Carey, 2000; Vosniadou, 2008).

A defining feature of student misconceptions of a discipline, distinguished from their mere lack of disciplinary knowledge, is that misconceptions are resistant to instruction. For example, students predict that the free fall of heavier objects is faster than lighter ones, despite instruction to the contrary (Gunstone & White, 1981; Selman, Krupa, Stone, & Jacquette, 1982). These misconceptions do not exist in isolation but are connected to and supported by a network of ontological assumptions, explanatory concepts, and causal mechanisms, which form an alternative intuitive or folk theory (Nesessarian, 1989; Slotta & Chi, 2006; Smith, Carey, & Wiser, 1985). Misconceptions about free fall are embedded in an intuitive or folk theory of gravity as a property of substances (Amsel, Savoie, Deak, & Clark, 1991; Reiner, Slotta, Chi, & Resnick, 2000) that fuels its motion and dissipates over the course of such motion (McClosky, 1983). Overcoming misconceptions involves adjusting, restructuring, or reworking the network of interconnected assumptions, concepts, and beliefs, a process called conceptual change. Although there have been a number of theoretical accounts of conceptual change (Chi, 2008; Limon & Mason, 2002), each assumes that science learning is challenging because it entails reflecting on and transforming a conceptual network.
The present study is a preliminary study of undergraduate students’ misconceptions and conceptual change in learning psychology. Previous studies on student misconceptions about psychology have used items which assess students affirming psychological claims which have been proved false by research (Gardner & Dalsing, 1986; Kowalski & Taylor, 2006; McCutcheon, 1991; McCutcheon, Apperson, Hanson, & Wynn, 1992; Taylor & Kowalski, 2004; Thompson & Zamboanga, 2004). For example, psychology students readily affirm that good hypnotists can force you to do anything they want you to do, and that genius is akin to insanity, despite evidence disconfirming such claims (cf., Gardner & Dalsing, 1986). A central weakness of the research is that an error on these items may not be connected to and supported by an alternative intuitive theory of the discipline, as suggested by conceptual change theory. For example, students who affirm that hypnotists can make someone do anything they want may be merely ignorant about hypnosis, but not hold an intuitive theory which endorses such a belief.

Problems with the items used in the misconceptions research are also revealed in reports of there being no relation between performance on misconceptions questionnaires and students’ academic achievement in their psychology classes (Thompson & Zamboanga, 2004). If, as theoretically proposed, misconceptions index a constraint on learning which can only be overcome through a process of conceptual change, then one would expect that more errors on misconceptions questionnaires would be related to lower grades. Finally, additional concerns about the items arise from evidence of sizable decreases in error rates among students taking psychology classes with instructors who explicitly teach to the specific misconceptions (Kowalski & Taylor, 2006, 2009; Miller, Wozniak, Rust, Miller, & Slezak, 1996). The ease with which instruction can promote correct responses seems to cast doubt that the items measure misconceptions that were revised through a process of conceptual change.
To test whether undergraduate students overcome misconceptions about the psychology through a process of conceptual change, we assessed their appreciation of psychology as a science. The misconception that psychology is not scientific may be rooted in an intuitive theory of the mind, called folk psychology (D’Andrade, 1987; Premack & Woodruff, 1978). Folk psychology holds that behaviour is explained by assuming that agents act rationally with respect to personally controllable, immaterial, subjective, and private mental states such as beliefs, desires, hopes, and wishes, among others (Bennett, 1991; Bloom, 2004; Nichols, 2004). As such, folk psychology is inconsistent with many of the assumptions of those who engage in the scientific study of the mind. Scientific psychologists, or those who accept their findings, would have to hold as at least working assumptions that behaviour is somewhat predictable (as opposed to agents having complete free will), due to physical (as opposed to immaterial) causes that can be objectively measured (as opposed to be subjectively experienced) and which may be outside of one’s awareness (as opposed to be privately accessible).

Preliminary evidence suggests that, consistent with folk psychology, undergraduate psychology students have misconceptions about the scientific status of the discipline (Amsel et al., 2009; Friedrich, 1996; Holmes & Beins, 2009). These studies have employed the Psychology as Science (PAS) questionnaire (Friedrich, 1996), which is a reliable and valid assessment of students’ beliefs about the assumptions of scientific psychology, such as, psychological research can enable us to anticipate people’s behaviour with a high degree of accuracy and research conducted in controlled laboratory settings is essential for understanding everyday behaviour. Students have shown relatively low PAS scores in entry level psychology classes (Amsel et al., 2009; Friedrich, 1996), with limited (Friedrich, 1996) or no (Holmes & Beins, 2009) differences in PAS scores between students in lower-division introductory-level and upper-division
advanced-level classes in the undergraduate psychology curriculum. This finding suggests that the disciplinary misconceptions tapped by the PAS questionnaire are resistance to instruction. The findings confirm that psychology students hold misconceptions of the scientific nature of the discipline which are only slowly revised, if at all. However, the studies do not control for various student characteristics which may be confounded in the previous research. For example, there is no control over students’ commitment to the discipline, which may make them more motivated to learn about the scientific foundations of the discipline and revise their folk psychology beliefs. Moreover, there is no control over students’ year in college. Independently of their commitment to the discipline, students with more years in college may be more skilled in learning core disciplinary ideas.

The present study assessed students’ beliefs about the scientific status of psychology as a function of their year in college (first to fourth year) and academic status in psychology (potential or actual psychology major, potential or actual psychology minor, or neither potential nor actual major or minor). If the psychology curriculum has had an impact on students’ beliefs about the discipline’s scientific nature, we would expect both variables to predict PAS score, with perhaps the highest scores from the most advanced and committed students.

Methods

Participants

The participants were sampled from psychology classes at a regional American university. A total of 438 participants completed the PAS questionnaire. They were sampled from regularly scheduled face-to-face classes across the psychology curriculum. Approximately

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2 In American and Canadian universities a major is a comprehensive course of study and entails core required courses and electives. These courses are a sizable percentage of all university credit hours required for the bachelor degree. A minor is a much more limited program of study, consisting of fewer required courses and credit hours than the major. Typically students choose a major and minor in their first or second years of college.
half the sample (51.6%) was recruited from lower-division introductory-level courses, with the remaining students recruited from upper-division advanced-level courses. Most of the participants were females (53.8%) and most were between 18 to 21 years old (59.4%), followed by those who were 22 to 27 years (28.3%) and 28 and older (12.3%). The sample had more first-year (33.1%) than second-year (20.6%), third-year (24.1%), or fourth-year (22.2%) students.

Participants’ academic status in psychology was determined by their answers to two questions: whether they were presently a psychology major, psychology minor, or neither, and (if they were neither) whether they were considering becoming a psychology major or minor. From these questions students were categorised into one of three groups: potential or actual psychology major (37.1%), potential or actual psychology minor (17.7%), or neither a potential nor actual psychology major or minor (45.1%). The distribution of participants by academic status and year in college is presented in Table 1.

Table 1 inserted here

Procedure and Materials

Students completed Friedrich’s (1996) Psychology as a Science scale, with Friedrich reporting a reliability (coefficient alpha) of .77 with 239 students, and test-retest reliability of .76. Holmes and Beins (2009) reported a coefficient alpha of .73, and in the present research it was .83. In addition to a host of validity data described in Friedrich (1996), Amsel et al. (2009) report that PAS scores were positively correlated with perceived sixth-week Introductory Psychology grade (.22), independently of a host of demographic and academic variables.

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3 Year in college is defined in terms of the credit hours completed towards the bachelor degree. First-year students are defined as those who have yet to complete 25% of the credit hours required for the bachelor degree; second-year students have completed more than 25% but less than 50%; third-year students have completed more than 50% but less than 75%, and fourth-year students have completed more than 75%.
Prior to completing the scale, participants answered demographic questions about their age, gender, year in college, psychology major or minor status, and interest in becoming a psychology major or minor. The instructions to complete the PAS scale directed participants to read each of 15 experimental and 5 filler statements and respond to each by circling a number from 1 (*strongly disagree*) to 7 (*strongly agree*) that accurately described the extent of their agreement or disagreement with the statement. The questionnaire used the same statements and presented them in the same order as Friedrich (1996). The 15 experimental statements included 7 negatively keyed (reverse scored) and 8 positively keyed items. The instructions were taken from Friedrich (1996), but edited to remove reference to the claim that statements were not “correct or incorrect” but “represent an opinion regarding some aspect of psychology” (p. 8). We found the former language invited intuitive reactions to the statements rather than the preferred reflective evaluation of them.

Students were assessed approximately halfway through the 14-week semester. This was well beyond the time when students learn about the scientific nature of the discipline, which is typically given in the first or second week of the semester. Most participants completed the questionnaire during their regularly scheduled class, with some having completed the questionnaire at home and then returned it to the experimenter. Those in Introductory Psychology classes earned research credit for completing the questionnaire. Consent forms and questionnaires were distributed to the participants and collected afterwards. The entire procedure took about 10 minutes.

Results

The average scores of student groups reported by Friedrich (1996) were compatible with the present results (see Figure 1). The average first-year PAS score in the present study ($M =$
5.01) is compatible with Friedrich’s finding of the performance of Introductory Psychology students at the end of their class ($M = 5.11$). Similarly the average PAS scores of third- ($M = 5.55$) and fourth- ($M = 5.72$) year psychology majors in the present study (who are required to take a research methods course) were compatible with Friedrich’s report of the average scores of psychology students after they complete a research methods course ($M = 5.55$).

Participants’ PAS scores were positively correlated with the number of psychology courses taken, $r(412) = .21, p < .001$. But to further assess the impact of the psychology curriculum on PAS scores, a 4 (year in college) by 3 (academic status in psychology) way ANCOVA was performed, with gender and number of psychology classes as covariates. Gender was treated as a covariate because there were fewer female ($n = 26$) than male ($n = 51$) potential or actual psychology minors, whereas the other categories revealed fairly equal distributions of males and females. The number of psychology classes completed was treated as a covariate to isolate the effect of students’ level of commitment to the study of the discipline (academic status) and general academic knowledge acquired from years in college (year in college) from their exposure to the discipline. However, age was not treated as a covariate because it remained strongly correlated with year in college, despite controlling for the number of psychology courses completed.

Results revealed a main effect of year in college, $F(3, 398) = 3.81, p = .01, \eta^2_p = .03$, and academic status in psychology, $F(2, 396) = 19.12, p < .001, \eta^2_p = .09$. As can be seen in Figure 1, Bonferroni posthoc tests revealed that potential or actual majors had significantly higher PAS scores than the other two groups, and that fourth-year students had significantly higher PAS scores than first-year students. There was no year in college by academic status interaction effect, $F(6, 396) = 0.23, ns$. 
Discussion

The purpose of the present study was to explore whether undergraduate students overcome folk psychology-based misconceptions about the discipline’s scientific status through a process of conceptual change. To test the claim, over 400 students completed a Psychology as a Science questionnaire which had been used previously by Friedrich (1996). The present data are compatible with previous research using the PAS questionnaire. The internal consistency of the questionnaire in the present study was similar to the findings of Friedrich (1996) and Holmes and Beins (2009), and overall student performance on the questionnaire was comparable with student performance in Friedrich’s study.

PAS scores were weakly related to the number of psychology course taken, but two additional findings challenge any simplistic explanation that mere exposure to the discipline promotes overcoming folk psychology-based misconceptions. First, irrespective of students’ gender and the number of psychology courses taken, fourth-year students held a stronger belief in the scientific nature of psychology than did first-year students. It remains unclear whether academically advanced students enter into psychology classes with a stronger belief in psychology as a science than less advanced students or whether, as successful students, they are more receptive to core disciplinary claims once they are instructed in the discipline. Future research could explore the question by tracking longitudinal change in students’ beliefs about psychology over their undergraduate years.

Second, independently of students’ gender and the number of psychology courses taken, potential or actual psychology majors held a stronger belief in psychology as a science than did the other students. Future research could explore whether the ‘major effect‘ is due to psychology students’ intrinsic curiosity about the discipline, decision to major due to early success in
understanding the material and performing well in classes, extracurricular preparation for graduate school or a career in the discipline, experiences in a specific course required of majors, or other experiences associated with majoring in the discipline.

The two factors of year in college and academic status in psychology may promote students to reflect on and evaluate their misconceptions in a similar way. In recent research, Introductory Psychology students were asked to complete the PAS from their own (self) and their professors’ (professor) perspectives (Amsel et al., 2009). PAS scores were higher in the professor than the self condition, suggesting that Introductory Psychology students understand core disciplinary beliefs in psychology but are reticent to adopt them. Correlations between PAS scores and self-reported sixth-week and anticipated final course grades were stronger in the professor than the self condition, further suggesting that course performance is related to students’ understanding of core disciplinary beliefs irrespective of them adopting the beliefs.

The perspective effect on PAS scores ($M_{\text{professor}} - M_{\text{self}} = 0.36$) among Introductory Psychology students was compatible in magnitude to the present year in college ($M_{\text{fourth-year}} - M_{\text{first-year}} = 0.38$) and academic status in psychology ($M_{\text{potential or actual major}} - M_{\text{neither potential nor actual major or minor}} = 0.52$) effects. One possibility we are exploring in ongoing research is that advanced students, like committed ones, may be more likely to spontaneously entertain their professor’s beliefs about the discipline and reflect on the ways they conflict with their own beliefs. Students who engage in such a form of critical thinking may also be more likely than those who do not to then evaluate and revise their own conceptual network. The work being performed assesses students; PAS performance in the self and professor conditions over the course of the semester, to allow for a direct test of the influence of instruction in the discipline on students’ acceptance of core disciplinary beliefs (i.e., an increase over the semester
in PAS scores in the self condition) and/or their understanding of core disciplinary beliefs (i.e., an increase over the semester in PAS scores in the professor condition).

The present findings confirm those of other studies documenting that students hold misconceptions about the scientific status of psychology which appear resistant to instruction (Amsel et al., 2009; Friedrich, 1996; Holmes & Beins, 2009). These misconceptions go beyond students merely affirming beliefs about empirically falsified psychological claims to challenge core disciplinary beliefs of scientific psychology, based on an alternative intuitive theory of folk psychology. The findings were explained by a process of conceptual change in which committed (potential or actual psychology majors) or advanced (fourth-year students) students are more likely to entertain their psychology professor’s ideas about the discipline and revise their own disciplinary beliefs. One implication of the research is that psychology instructors throughout the undergraduate curriculum should remained focused on helping students to overcome misconceptions they may harbour about the discipline and to accept discipline-related beliefs.

The recent spotlight on the importance of using psychological evidence to correct students’ myths about psychological phenomena (Lilienfeld, Lynn, Ruscio, & Beyerstein, 2009; Mercer, 2010) underscores the importance of the present research. In order for students to fully appreciate the myth-busting evidence, they need to overcome their misconceptions and adopt core beliefs about scientific psychology.
References


Table 1: Distribution of Students by Academic Status in Psychology and Year in College.

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<thead>
<tr>
<th></th>
<th>Potential or Actual Major</th>
<th>Potential or Actual Minor</th>
<th>Neither Potential nor Actual Major</th>
<th>Total</th>
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<td>77</td>
<td>195</td>
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<sup>a</sup> Students who are neither potential nor actual majors or minors in Psychology may take certain psychology courses (Introductory Psychology among others) even into their third- or fourth-year in college.
Figure 1: PAS scores by Academic Status in Psychology and Year in College.