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Effects of science interest and experience on pseudoscientific beliefs--An Empirical Test

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Magnetic Insoles

Sham Magnets As Effective as the "Real Thing"

According to Mark H. Winemiller, from the Department of Physical Medicine and Rehabilitation at the Mayo Clinic in Rochester, Minnesota, and his colleagues Robert G. Billow, Edward R. Laskowski, and W. Scott Harmsen, in an article that appeared in the *Journal of the American Medical Association* (2003;290:1474-1478) entitled "Effect of Magnetic v. Sham-Magnetic Insoles on Plantar Heel Pain. A Randomized Controlled Trial: Despite anecdotal reports, rigorous scientific evidence of the effectiveness of magnetic insoles for the pain of plantar fasciitis is lacking."

In order to determine whether magnetic insoles produced the same level of subjective improvement in the treatment of plantar heel pain when compared to insoles that contained no magnetized properties, the authors ran a "randomized, double-blind, placebo-controlled trial conducted from February 12, 2001, to November 9, 2001, of a volunteer sample of 101 adults with diagnoses of plantar heel pain for at least 30 days from a multispecialty group practice clinic in Rochester, MN. Daily pain diaries were kept for 8 weeks." Interventions included "Cushioned insoles, with either active bipolar magnets or sham magnets, which were worn daily by the participants for 8 weeks." The subjects then reported "average daily foot pain (by metered visual analog scale [VAS] and by categorical response of change from baseline) at 4 and 8 weeks, and impact of insoles on employment performance and enjoyment."

The results, not surprisingly, revealed "no significant between-group differences were found on any outcome variables studied when comparing active v. sham magnets. Both the nonmagnetic and magnetic groups reported significant improvements in morning foot pain intensity, with mean (SD) VAS scores improving from 6.9 (2.3) and 6.7 (2.0), respectively, at baseline to 3.9 (2.6) for each group at 8 weeks (p = .94). At 8 weeks, 33% of the nonmagnetic group and 35% of the magnetic group reported being all or mostly better (p = .78). At baseline, foot pain interfered moderately with participants' employment enjoyment (mean VAS, 4.2) and improved in both groups by 8 weeks (1.3 and 1.5, respectively; p = .68)."

In an understatement, the authors concluded: "Static bipolar magnets embedded in cushioned shoe insoles do not provide additional benefit for subjective plantar heel pain reduction when compared with nonmagnetic insoles." In other words, magnetic insoles are baloney.

Science Literacy and Belief in the Paranormal—An Empirical Test

By Travis J. Ryan, Jessica Brown, Angela Johnson, Colin Sanberg, and Megan Schildmier

A STUDY PUBLISHED IN SKEPTIC (Vol. 9, No. 3) by Walker et al. investigated the relationship (or lack thereof) between scientific literacy and pseudoscientific belief. The authors found no significant relationship between college students' performances on a test of basic science knowledge and their belief in superstitious, pseudoscientific, and non-scientific ideas. They did not, however, account for potential confounding factors in their research design, such as science background, level of education, or experience in science. Towards the end of their article, Walker et al. were equivocal as to whether a scientific background was sufficient to "ward off [pseudoscientific] belief." As a part of a course on Science, Pseudoscience, and Superstition, we designed and carried out a follow-up to the Walker et al. study.

We were interested in the same question as Walker et al., namely: does scientific literacy lead to increased skepticism of pseudoscientific beliefs? To that end, we repeated major elements of the Walker et al. study. We randomly pulled 10 questions from the Praxis Series National Series Exam in order to gauge basic scientific literacy. These questions come from the same source as those in the Walker et al. study, and though some questions on the exam may lack absolute accuracy (see SKEPTIC Vol. 10, No. 1), they do likely reflect a basic scientific literacy (hereafter, SL).

The questions in the SL portion of the test were multiple choice, each with four to six responses to choose from for each item. Respondents also completed a survey where they were asked to rank their belief in pseudoscientific ideas. We did not use the same questions as published in the Walker et al. study, but they were of a similar content and demeanor (e.g., "Some people can move objects with their minds" and "Some injuries can be cured by placing magnets on the skin near injured areas"). We also presented the respondents with 15 statements, and asked them to rate their agreement on a scale of 1 ("disagree completely") to 5 ("agree completely"); a response of 3 indicated respondents neither agreed nor disagreed with the statement. For each respondent, we determined the number of correct responses on the SL test and the average score on the pseudoscientific belief (hereafter, PB) survey.

The only major difference in our study from that of Walker et al. is that we asked respondents to identify their academic major and class standing (freshman, sophomore, junior, senior) in order to determine whether these

factors (i.e., primary area of academic interest and amount of training or experience) influenced the relationship between SL and PB. We then grouped students into four classes: freshman science majors, freshman non-science majors, senior science majors, and senior non-science majors. In total, 144 students completed the SL test and PB survey. We used two-way analysis of variance with academic major (science or non-science) and class standing (freshman or senior) to detect differences in SL and PB. We also used linear regression to determine whether SL and PB are significantly related. We expected to see an inverse relationship between SL and PB scores if basic scientific literacy also teaches critical thinking and wards off pseudoscientific belief.

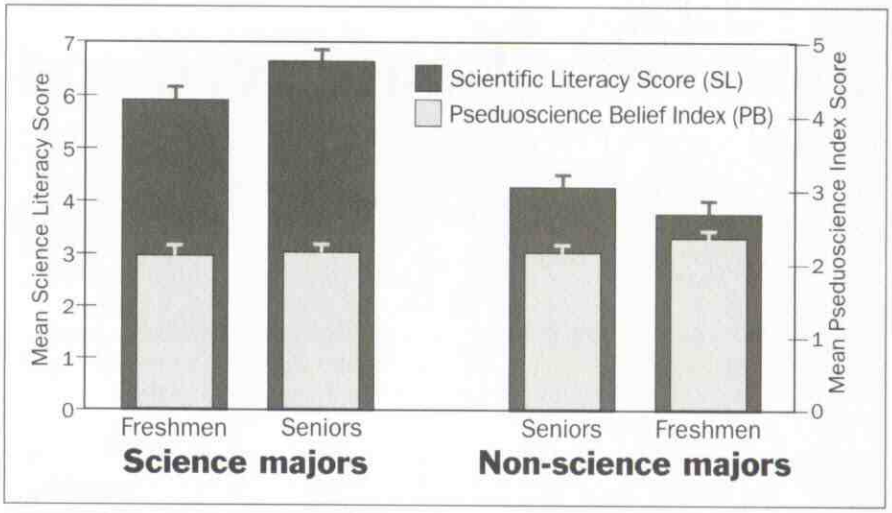
We found SL scores to be significantly higher among science majors ($F_{1,142} = 54.63$; $p < 0.0001$). The scores were not significantly different between freshmen and seniors ($F_{1,142} = 0.05$; $p = 0.822$), but there was a significant interaction between major and class standing, with SL scores increasing with class standing among science majors and *decreasing* with class standing among the non-majors ($F_{1,142} = 4.22$; $p = 0.042$). However, neither academic major nor class standing had a significant effect on PB (major: $F_{1,142} = 1.09$, $p = 0.298$; class standing: $F_{1,142} = 0.82$, $p = 0.368$). Accordingly, there was no significant relationship between SL and PB among any of the four groups (p-values ranged from 0.228 to 0.820) and SL accounted for less than 5% of the variation in PB in the best case (r^2 values ranged from 0.002 to 0.044).

The science majors clearly have a larger base of knowledge about physics, chemistry, and biology, but this did not influence their credulity about the concepts of the afterlife, ESP, alien abductions, and broken mirrors. Should science educators take this as a sign of failure? The goal of science education, after all, should not simply be to teach students only what they should know, but also how to decide what is worth knowing and why.

What we should recognize from both our study and the one that inspired it is that the students surveyed are actually moderately skeptical of pseudoscientific claims on the whole. In our study, a score of 3 on the PI is neutral. A one-way t-test shows that the students we surveyed had PB scores that were significantly less than neutral, in favor of a skeptical outlook ($t = 14.97$, $p < 0.0001$). In the language used on our PI survey, these students "somewhat disagree" with pseudoscientific ideas on average. Using the data from the Walker et al. study shows that students from all three schools used in their study were likewise not neutral, and indeed were skeptical ("I doubt very much that this is real") of the items with which they were presented (Christian Brothers University: $t = 53.87$; Kansas Wesleyan University: $t = 35.77$; Winston-Salem State University: $t = 37.96$; all $p < 0.0001$).

Most colleges and universities in the United States have a basis in the liberal arts and sciences. In the case of liberal arts colleges, it is indeed the very mission of the institution; in larger universities the liberal arts and sciences form the basis of a "core curriculum" or a "general education program." The liberal arts—literature, philosophy, history, art—and the natural sciences belong to the same intellectual tradition and as such, they have the same general goal according to philosopher Mortimer Adler, which is "to develop the faculties of the mind." It is not the aim, nor even the byproduct, of the humanities to weaken critical thought, anymore than it is the goal in general science education. Rather, the liberal arts teach reflective and critical thinking. Certainly the humanities invite reflection and personal experience as bases for decision-making; however, like the sciences, the humanities also require a rigorous approach to reasoning and reaching sound conclusions.

Our results indicate that science education increases the acquisition of factual, scientific knowledge but does not necessarily reduce credulity in pseudoscientific claims. However, the students in our study, and in the previous study by Walker et al., all demonstrate a basic level of moderate skepticism towards the superstitious and supernatural. We cannot thank science education in general for this result, but we may very well be indebted to the liberal arts tradition to which the natural sciences belong.



Results of scientific literacy test (SL, average number of correct answers out of 10) and pseudoscience belief index (response to 15 non- or pseudoscientific statements) for 144 students. Students are categorized with regard to class standing (freshman or senior) and academic major (science or non-science). Bars represent group means (+ 1 standard error).

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