Title
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Examining the Specificity of the Seductive Allure Effect

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Abstract

Previous work has found that people feel significantly more satisfied with explanations of psychological phenomena when those explanations contain neuroscience information — even when this information is entirely irrelevant to the logic of the explanations. This *seductive allure effect* was first demonstrated by Weisberg, Keil, Goodstein, Rawson, & Gray (2008), and has since been replicated several times in independent labs (e.g., Fernandez-Duque, Evans, Christian, & Hodges, 2014; Rhodes, Rodriguez, & Shah, 2014; Weisberg, Taylor, & Hopkins, 2015). However, these studies only examined psychological explanations with added neuroscience information. The current study thus investigated the generality of this effect and found that the seductive allure effect occurs across several scientific disciplines whenever the explanations include reference to smaller components or more fundamental processes. These data suggest that people have a general preference for reductive explanations.

Keywords: seductive allure; explanations; decision-making

Introduction

What is the relationship between the form of an explanation and its content? In ideal circumstances, the quality of an explanation should be determined by its success at generating understanding of the target phenomenon; form should matter less, if at all. However, there are many cases where the form of an explanation erroneously influences people's judgment of its quality, as when people judge longer explanations as better (Kikas, 2003; Langer, Blank, & Chanowitz, 1978). Similarly, people often feel that they have gained a sense of understanding from statements or situations that aren't actually explanatory (see Trout, 2002). For example, both adults (Lombrozo & Carey, 2006) and children (Kelemen, 1999) preferentially endorse teleological explanations that refer to goals or end-states, even when mechanistic explanations would be more appropriate.

One particularly interesting instance of this kind of error is the *seductive allure effect* in psychology: People judge explanations of psychology findings as better when those explanations contain logically irrelevant neuroscience information (Weisberg et al., 2008). That is, people feel that they understand a psychological phenomenon better when it is described using the language of neuroscience, although this language should make no difference. Further, this effect is much stronger for poor-quality, circular explanations. Participants judged bad explanations as significantly better when they contained added neuroscience terminology. Ratings of explanations that were already of high quality — in most cases, these were the explanations that researchers themselves gave for the psychological phenomena — were unaffected by added neuroscience information.

Although this finding has been replicated several times, demonstrating its robustness (Fernandez-Duque et al., 2015; Rhodes, Rodriguez, & Shah, 2014; Weisberg, Taylor, & Hopkins, 2015), it is still unclear why this effect happens. One possibility is that it is specific to psychology and neuroscience; something about neuroscientific language in particular plays a role in improving explanations of psychological phenomena. However, recent work has failed to identify the mechanism by which neuroscience content may have this effect. Although early evidence suggested that neuroscience images influence people's judgments (McCabe & Castel, 2008), these results have failed to replicate (see Farah & Hook, 2013, for review). Additionally, neuroscience jargon (e.g., "fMRI imaging") has no effect over and above references to the brain in plain language (e.g., "brain scans"; Weisberg, Taylor, & Hopkins, 2015, Study 3). Therefore, neither appealing imagery nor scientific jargon is responsible for making neuroscience information seductive. Although it is still possible that some other property unique to the pairing of psychology and neuroscience is responsible for the seductive allure effect, an alternative explanation is that this effect is representative of a more general bias in judging explanations.

The current work investigates one candidate for this general bias: a preference for reductive explanations (see Craver, 2007). Scientific reductionism holds that explanatory elements from one discipline may be *reduced* to elements of a more fundamental or basic discipline if the laws of the "higher" discipline follow as logical consequences of the more fundamental one (Nagel, 1961). People may thus judge explanations of psychological phenomena that contain irrelevant neuroscience information as better because the brain plays this reductive role for psychological states. To test the hypothesis that the seductive allure effect is indicative of a general preference for reduction, we presented subjects with descriptions of phenomena across a range of sciences in a plausible reductive hierarchy (Figure 1); in this hierarchy, each science is most immediately explainable in terms of the one below it. If people do have a general preference for reduction, the seductive allure effect should be seen any time an explanation contains reference to the next level down on the hierarchy, leading to preferences of chemical explanations for biological phenomena, for example.

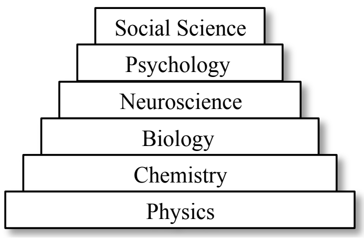

Figure 1: Hierarchy of sciences.

For each phenomenon, we constructed four explanations, according to a Quality (good/bad) x Explanation Level (horizontal/reductive) design. Horizontal explanations refer only to the science from which the phenomenon itself is drawn (e.g., biological explanations for biological phenomenon). Reductive explanations include reference to the next level downwards in the hierarchy (e.g., chemical explanations for biological phenomenon). If participants show a general preference for reduction, they should judge reductive explanations as better than horizontal explanations for all sciences, even though the explanatory content of both is the same. If the seductive allure effect is unique to the pairing of psychology and neuroscience, however, we should observe this preference only for psychology and not for the other sciences.

Method

Participants

Participants were recruited from two different populations: Workers on Amazon's Mechanical Turk (n = 167) and undergraduate students enrolled in psychology classes at the University of Pennsylvania (n = 152). MTurk workers were paid for their participation, and undergraduate students received course credit. Some of these participants (20 MTurk workers and 40 undergraduates) were excluded from the sample for failing attention check questions (described in the Procedure). The final sample used for all analyses thus consisted of 147 MTurk workers and 112 undergraduates. MTurk workers (80 women, 55 men, 12 did not report gender) were 39.8 years of age on average (range: 19-71), and undergraduates (64 women, 44 men, 4 did not report gender) were 19.8 years of age on average (range: 18-23). Most of the MTurk workers (89.8%) had completed at least some college. Among the undergraduates, 36.0% were freshmen, 28.8% were sophomores, 20.7% were juniors, 13.5% were seniors; 1 participant did not report his or her year.

Design

All participants completed an online survey hosted by Qualtrics. The explanations task used a 2 (Explanation level: horizontal, reductive) x 2 (Quality: good, bad) x 6 (Science: physics, biology, chemistry, neuroscience, psychology, social science) design. Explanation level was between-subjects: Participants were randomly assigned to either the horizontal (74 MTurk workers, 54 undergraduates) or reductive (73 MTurk workers, 58 undergraduates) condition. Quality and Science were within-subjects variables: All participants rated two explanations from each science, one good and one bad.

Materials

The Rating Explanations task used 24 phenomena (four per science). The phenomena described concepts, principles, or research findings from each of the six sciences. Each phenomenon had four corresponding explanations: horizontal-good, horizontal-bad, reductive-good, reductive-bad (Table 1). The good versions of the explanations were the ones that researchers or textbooks provided for the phenomena; all explanations were verified by experts in the respective fields. The bad explanations were worded so as to provide no information regarding why the phenomena occurred. They were either circular restatements of the phenomenon, or they provided additional information that was irrelevant with no mechanistic information that could explain the phenomenon. Experts in each field confirmed that the bad explanations were non-explanatory.

Both horizontal-good and horizontal-bad explanations used only terminology and concepts from the same discipline as the phenomenon. That is, biological phenomena were described only in biological terms, chemical phenomena were described only in chemical terms, etc. Explanations in the reductive condition used terminology from the discipline below that of the phenomena in our reductive hierarchy: biological explanations were supplemented with chemistry information, chemistry explanations were supplemented with physics information, etc. For phenomena from the domain of physics, the reductive explanations referred to smaller particles and/or more fundamental forces (e.g., reducing "friction" to "vibration of molecules"). Importantly, the reductive information did not add any additional explanatory information beyond what was already contained in the horizontal explanation; this was also verified by experts.

For each phenomenon, the four versions of the explanation were matched as closely as possible outside of the manipulations for quality and explanation level. The added reductive text was identical for good and bad versions of the explanation. Length of explanation was carefully

Table 1: Sample Phenomenon from Biology

<table>
<tr><td colspan="3">Male anole lizards bob their heads up and down rhythmically as part of a mating ritual to attract females. They typically increase their rate of head-bobbing when they see a female lizard of their species. However, their rate of head-bobbing also increases when they see another male lizard of the same species, even if no female lizards are present.
Why do male lizards bob their heads when other males are nearby?</td></tr>
<tr><td></td><td>Good</td><td>Bad</td></tr>
<tr><td>Horizontal</td><td>This happens because the male lizards are extremely territorial, and head-bobbing is a distinctive behavior typical of this particular species of lizard. During mating season when they are in competition with each other for females, males use various dominance displays to defend their territory. They perceive other males as a threat and engage in increased head-bobbing, which is a sign of aggression.</td><td>This happens because the male lizards are seeking mates, and head-bobbing is a distinctive behavior typical of this species of lizard. During mating season when they are trying to attract females, males use a variety of behaviors that are characteristic of anole lizards. They perceive the presence of other males and engage in increased head-bobbing, which is commonly seen during mating season.</td></tr>
<tr><td>Reductive</td><td>This happens because the male lizards are extremely territorial. During mating season when they are in competition with each other for females, males use various dominance displays to defend their territory. They perceive other males as a threat and engage in increased head-bobbing, which is a sign of aggression. Aggressive behavior is known to be associated with elevated levels of testosterone and other aggression-enabling hormones.</td><td>This happens because the male lizards are seeking mates. During mating season when they are trying to attract females, males use a variety of behaviors that are characteristic of lizards. They perceive the presence of other males and engage in increased head-bobbing, which is commonly seen during mating season. Aggressive behavior is known to be associated with elevated levels of testosterone and other aggression-enabling hormones.</td></tr>
</table>

matched; within a phenomenon, the four versions of the explanation never differed in length by more than 4 words. Additionally, there were no significant differences in average word count among the six sciences.

The 24 phenomena were divided into two pre-determined sets of 12 (two per science), and participants were randomly assigned to receive one of the two sets. Each set was further subdivided into two blocks of six phenomena (one per science); the order in which these two blocks were presented was randomly determined for each participant. Within each block, the six phenomena were presented in a random order. Each participant saw one good and one bad explanation from each science; two combinations of good and bad explanations were pseudorandomly determined ahead of time and participants were randomly assigned to one of the two different permutations. Participants were randomly assigned to either the horizontal or reductive condition, and all 12 explanations that they rated came from their assigned explanation level. This counterbalancing method led to 16 different randomly-assigned presentation orders in a 2 (Item Set: A or B) x 2 (Block Order) x 2 (Good/Bad combination) x 2 (Explanation Level: horizontal, reductive) design.

Procedure

Participants used a sliding scale ranging from -3 to 3 to indicate their ratings of each explanation. They were first given instructions on how to use the slider; this also served as a check that participants were reading instructions. They were told to use the slider to select 0 on the first page in order to proceed with the survey. If they selected anything other than 0, they were directed to another page asking them again to select 0. Participants who did not select the correct response on this second page (3 MTurk workers and 9 undergraduates) were excluded from analyses.

After these general instructions on using the slider, participants were given instructions for the explanations task (modified from Fernandez-Duque et al., 2015):

> You will now be presented with descriptions of various scientific findings. All the findings come from solid, replicable research; they are the kind of material you would encounter in a textbook. You will also read an explanation of each finding. Unlike the findings themselves, the explanations of the findings range in quality. Some explanations are better than others: They are more logically sound. Your job is to judge the quality of such explanations, which could range from very poor (-3) to very good (+3).

On each trial, participants were presented with a description of a scientific phenomenon, which was displayed for 10 seconds before participants could advance to the next screen. On the next screen, an explanation was displayed below the phenomenon, and participants were instructed to rate the quality of the explanation. Participants rated 12 explanations, with an attention check trial administered after the first six (Oppenheimer, Meyvis, & Davidenko, 2009). This trial was similar in format to the others. First, a description of a phenomenon was presented for 10 seconds. When participants advanced to the next screen, instead of seeing an explanation, they saw text

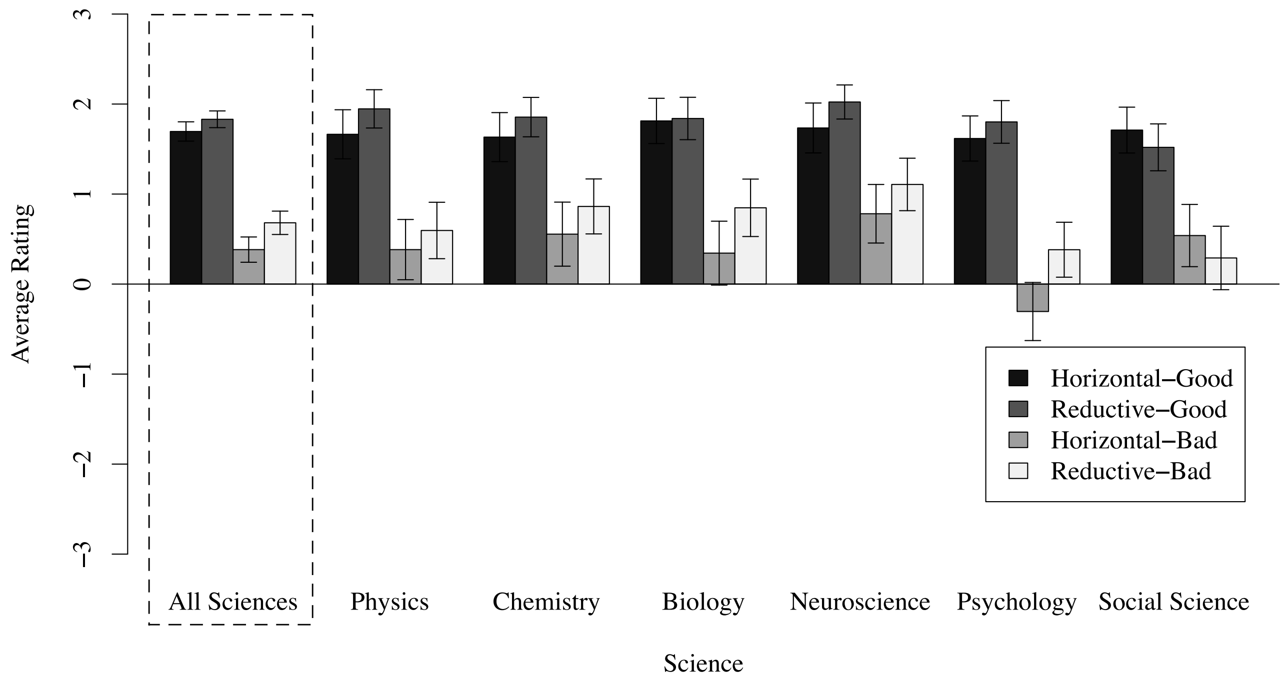

Figure 2: Average ratings of explanations by science, condition, and quality. Error bars are 95% CIs.

instructing them to select 3 on the scale. Participants who did not select 3 (17 MTurk workers and 31 undergraduates) were excluded from analyses.

Perceptions of Science. After the explanations task, participants responded to three questions designed to assess their views of 10 scientific disciplines: physics, chemistry, biology, neuroscience, psychology, sociology, economics, and political science (measure adapted from Fernandez-Duque et al., 2015). Participants rated the perceived scientific rigor of each discipline, the extent of the knowledge gap between a novice and an expert in each discipline, and the societal prestige of each discipline (presented in a random order). For each discipline, the ratings of the three items were made on a 10-point scale, which were summed to create a single score (out of 30).[1]

Results

Data from the explanations task (Figure 2) were analyzed using a mixed-effects linear regression model predicting the rating given on each trial from the sample (MTurk, undergraduates), explanation level (horizontal, reductive), explanation quality (good, bad), and science (physics, chemistry, biology, neuroscience, psychology, and social science). Sample and explanation level were between-participants variables; quality and science were within-participants variables. All possible interactions were tested, but the four-way interaction and most of the three-way interactions did not significantly improve model fit and were dropped. The best-fitting model included random intercepts by participant and item and a random effect of item on the slope for the quality variable. The science variable was backwards-difference coded to test five planned contrasts between pairs of adjacent sciences: chemistry vs. physics, biology vs. chemistry, neuroscience vs. biology, psychology vs. neuroscience, and social science vs. psychology (Figure 1). Significance levels were determined by generating bootstrapped confidence intervals around the regression coefficients.

Main Effects

There were significant effects of Sample ($\beta = -0.25$, 95% CI [-0.44, -0.07]), Quality ($\beta = 1.27$, 95% CI 1.07, 1.47]), and Explanation Level ($\beta = 0.21$, 95% CI [0.02, 0.42]). Undergraduate students ($M = 1.01$, $SD = 1.85$) gave significantly lower ratings on average than MTurk workers ($M = 1.26$, $SD = 1.76$). Good explanations ($M = 1.76$, $SD = 1.43$) were rated significantly higher than bad explanations ($M = 0.53$, $SD = 1.93$). Reductive explanations ($M = 1.26$, $SD = 1.71$) were rated significantly higher than horizontal explanations ($M = 1.04$, $SD = 1.88$). Finally, the contrast between psychology and neuroscience was significant ($\beta = -0.55$, 95% CI [-1.06, -0.06]): Neuroscience explanations ($M = 1.41$, $SD = 1.67$) were rated higher than psychology explanations ($M = 0.88$, $SD = 1.85$). No other contrasts between adjacent pairs of sciences were significant.

[1] Participants also completed measures of reflective thinking, logical reasoning, and general scientific literacy. For brevity, data from these measures will not be discussed here.

Interactions

A significant Sample x Quality interaction (β = 0.54, 95% CI [0.30, 0.76]) indicates that the difference in ratings between MTurk workers and undergraduates was driven primarily by their ratings of the bad explanations. Ratings of good explanations were similar between the two groups (M_M = 1.76 and M_U = 1.77), but the MTurk workers gave higher ratings to bad explanations than undergraduates did (M_M = 0.76 for and M_U = 0.24).

There was also an Explanation Level x Science interaction, wherein the contrast between social science and psychology was significant (β = -0.60, 95% CI [-0.97, -0.27]). This indicates that the effect of reductive information was significantly different between these two sciences. In psychology, as well as in physics, chemistry, biology, and neuroscience, the reductive explanations were rated higher on average than the horizontal explanations. However, the opposite was true for social science: Reductive explanations (M = 0.90, SD = 1.91) were rated *lower* than horizontal explanations (M = 1.13, SD = 1.84).

Finally, there was a significant, three-way Sample x Quality x Explanation Level interaction (β = 0.49, 95% CI [0.01, 0.94]), indicating that the magnitude of the Quality x Explanation Level interaction was larger for MTurk workers than for undergraduates. Separate analyses of the two groups revealed a significant Quality x Explanation Level interaction in the MTurk sample, but not in the undergraduate sample. Among MTurk workers, there was a larger difference between the horizontal and reductive conditions for bad explanations (M_H = 0.52 and M_R = 0.99) than for good explanations (M_H = 1.71 and M_R = 1.80).

Analyses by Science

To further investigate whether the seductive allure effect, which was previously observed with psychology explanations augmented by neuroscience information, occurred for other pairs of sciences, we conducted separate regression analyses for each science testing for main effects of Quality, Explanation Level, and a Quality x Explanation Level interaction. These models also included random intercepts for participant and item to account for repeated measures and differences between the individual stimuli used within each science.

There was a significant, positive effect of Quality in all six sciences, mirroring the strong effect of Quality observed in the earlier regression. The effect of explanation level was statistically significant for psychology (β = 0.43, 95% CI [0.12, 0.71]), and marginally significant ($p < .10$) for physics, chemistry, biology, and neuroscience. Also consistent with the prior analyses, the Explanation Level effect was in the opposite direction for social science compared to the other five sciences.

As has been observed in some previous studies on this effect (Fernandez-Duque et al., 2015; Weisberg et al., 2008), there was a marginally significant Quality x Explanation Level interaction for biology (β = -0.48, 90% CI [-1.00, -0.01]) and psychology (β = -0.50, 90% CI [-1.00, -0.07]). Post-hoc tests found significant differences between reductive-bad and horizontal-bad explanations in biology, $t(257) = 2.07$, $p < .05$, and psychology, $t(257) = 3.03$, $p < .01$, but there was no significant difference by explanation level for good explanations in either biology or psychology. For stimuli from the other sciences, the effect of explanation level was not moderated by the quality of the explanation.

Perceptions of Science

As described in the Method section, each science was rated on a 10-point scale for three different questions; the three ratings were summed to give a single score out of 30 for each science. The summed scores for sociology, economics, and political science were highly correlated (alpha = .79 for undergraduates and .82 for MTurk workers), and the three were averaged to create a "social science" score. By and large, these ratings mirror our predicted reductive scale of the sciences, with the more fundamental sciences being rated as more rigorous, difficult, and prestigious (Figure 3). The exception to this is neuroscience, which was rated higher than physics, chemistry, and biology. Paired t-tests were conducted on all adjacent pairs of fields; all comparisons were statistically significant ($p < .001$).

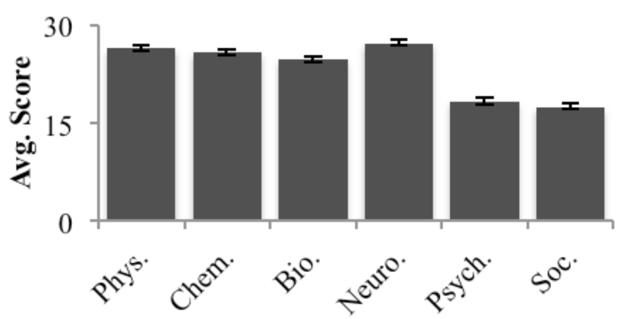

Figure 3: Avg. perception scores. Error bars are 95% CIs.

Discussion

The main goal of the current study was to investigate the generality of the seductive allure effect. Prior research has demonstrated that adding irrelevant neuroscience information to explanations of psychological phenomena makes these explanations seem better to naïve participants. We hypothesized that this effect is due to a general preference for reductive explanations, which should manifest across different scientific domains. Our data support this hypothesis: Participants judged explanations containing irrelevant reductive information as better across a range of sciences. The seductive allure effect is thus not unique to the pairing of psychology and neuroscience.

However, we did find that the preference for reductive information was strongest for the psychology/neuroscience pairing. In addition, the effect for the social science/psychology pairing was in the opposite direction, with participants preferring the horizontal (non-reductive) explanations in this case. Taken together, these results point to a general disinclination for person-level explanations. This is in line with previous work finding generally poor public opinions about psychology as a science (Keil, Lockhart, & Schlegel, 2010; Lilienfield, 2012).

Regardless, participants were reliably able to discriminate good from bad explanations across all sciences, demonstrating an intact ability to sense explanation quality. However, even bad explanations tended to be rated positively on average. Undergraduate students were more critical of bad explanations than MTurk workers, perhaps because being in an academic environment encourages more skepticism. Interestingly, participants were less critical of bad neuroscience items than bad items from other sciences. Together with the high prestige ratings for neuroscience, this suggests that neuroscience information may exert some unique allure, even if this does not fully explain its appeal in explanations of psychological phenomena.

Future work should investigate this particular effect, as well as why reduction is so appealing as an explanatory form in the sciences. One interesting set of questions concerns the proper level for reduction: Are explanations seen as more appealing when they contain information only from the immediately adjacent science (e.g., chemistry for biology), or would further reduction make explanations seem even better (e.g., physics for biology)? Alternatively, do people prefer explanations that reference an additional field of science, regardless of whether that field is more fundamental? A current study is investigating these questions; participants were asked to select the methods that would be useful for investigating phenomena from various sciences. Preliminary results show that participants most often selected methods from the field of the phenomenon (46% of the time) or the immediately reductive field (37%), suggesting that they believe there is a particular level of reduction for each science that is maximally explanatory.

Finally, future work should examine the potential role of training in ameliorating the seductive allure effect. Previous work (Weisberg et al., 2008, Study 3) found that neuroscience experts were not seduced by irrelevant neuroscience. Ongoing work in our lab expands this investigation to experts in all six of our target sciences to determine the role of expertise: Does training in a particular science protect against the seductive allure effect for that science, or in general? Answering this question can provide further insight into the nature of the effect itself and into people's judgments of scientific explanations in general.

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References

Craver, C. F. (2007). *Explaining the brain: Mechanisms and the mosaic unity of neuroscience*. Oxford: Clarendon Press.

Farah, M. J., & Hook, C. J. (2013). The seductive allure of "seductive allure." *Perspectives on Psychological Science*, *8*(1), 88–90.

Fernandez-Duque, D., Evans, J., Christian, C., & Hodges, S. D. (2015). Superfluous neuroscience information makes explanations of psychological phenomena more appealing. *Journal of Cognitive Neuroscience*, *27*(5), 926–944.

Keil, F. C., Lockhart, K. L., & Schlegel, E. (2010). A bump on a bump? Emerging intuitions concerning the relative difficulty of the sciences. *Journal of Experimental Psychology: General*, *139*(1), 1–15.

Kelemen, D. (1999). Why are rocks pointy? Children's preference for teleological explanations of the natural world. *Developmental Psychology*, *35*(6), 1440–1452.

Kikas, E. (2003). University students' conceptions of different physical phenomena. *Journal of Adult Development*, *10*(3), 139–150.

Langer, E. J., Blank, A., & Chanowitz, B. (1978). The mindlessness of ostensibly thoughtful action: The role of "placebic" information in interpersonal interaction. *Journal of Personality and Social Psychology*, *36*(6), 635–642.

Lilienfeld, S. O. (2012). Public skepticism of psychology: Why many people perceive the study of human behavior as unscientific. *American Psychologist*, *67*(2), 111–129.

Lombrozo, T., & Carey, S. (2006). Functional explanation and the function of explanation. *Cognition*, *99*, 167–204.

McCabe, D. P., & Castel, A. D. (2008). Seeing is believing: The effect of brain images on judgments of scientific reasoning. *Cognition 107*(1), 343-352.

Nagel, E. (1961). *The Structure of Science. Problems in the Logic of Explanation*. New York: Harcourt, Brace & World, Inc.

Oppenheimer, D. M., Meyvis, T., & Davidenko, N. (2009). Instructional manipulation checks: Detecting satisficing to increase statistical power. *Journal of Experimental Social Psychology*, *45*(4), 867–872.

Rhodes, R. E., Rodriguez, F., & Shah, P. (2014). Explaining the alluring influence of neuroscience information on scientific reasoning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *40*(5), 1432–1440.

Trout, J. D. (2002). Scientific explanation and the sense of understanding. *Philosophy of Science*, *69*, 212–233.

Weisberg, D. S., Keil, F. C., Goodstein, J., Rawson, E., & Gray, J. R. (2008). The seductive allure of neuroscience explanations. *Journal of Cognitive Neuroscience*, *20*(3), 470–477.

Weisberg, D. S., Taylor, J. C. V., & Hopkins, E. J. (2015). Deconstructing the seductive allure of neuroscience explanations. *Judgment and Decision Making*, *10*(5), 429–441.