Response from Singer

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On Science and Statistics

I read "Dualism, Science, and Statistics" (Singer 2007) with great interest and would like to comment on three points. First, I agree that we could do a better job emphasizing the early stages of scientific discovery, and the relationship between hypotheses and predictions. This point is echoed in the leading book on multimodel inference (Burnham and Anderson 2002). The real elegance in science often comes up front, and no amount of statistical sophistication will allow us to reap what we have not sown.

Second, I was uneasy with the article's suggestion for presenting results. Statistics are not results and should not be presented as such. Observations are results, and statistics are inferences about the generality of the observations. From this perspective, I had no stomach for even the improved description, "The t value of 5.83 and the p value of 0.001 allow us to reject [the null prediction], that ravens should yell equivalently for opened and unopened carcasses." I suggest that we give biology a starring role whenever reporting biological results, then insert the statistical details in parentheses—for example, "Ravens yelled far more at unopened than at opened carcasses ($t = 5.83$, $p = 0.001$)." In describing living systems, we can usually write prose with a living entity as the subject and its actions as the verb. We can strive for prose and figures that can be understood without statistics and then insert statistics as a form of technical validation.

Third, the article mentions confidence levels at the end but misses the opportunity to show how they bridge from probabilistic to dualistic thinking. Confidence intervals are continuous up to a cutoff, with 95 percent confidence intervals using the cutoff equivalent to the conventional $p < 0.05$. Confidence intervals are very useful in showing the range of parameter values suggested by the data. Each confidence interval summarizes which hypotheses are still "on the table," given the evidence in hand. Thus confidence intervals are both more informative and more intuitive than p values, and can be generally useful in teaching about how scientists make inferences from data.

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Singer F. 2007. Dualism, science, and statistics. BioScience 57: 778–782.

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Many thanks to Peter Bednekoff for his comments on my essay "Dualism, Science, and Statistics." I'd like to respond briefly to his second point about how data should be presented and to his third point about confidence intervals.

Regarding the second point, I applaud both the intent and the application of writing "prose with a living entity as the subject and its actions as a verb...and statistics as a form of technical validation." In my example, I described a weak student who was not sophisticated enough to follow this advice. My intent is to provide a framework in which the weak student is coerced into confronting and understanding the science, even if his presentation is weak. I agree that we must work on improving the quality of the presentation while addressing the quality of the science.

Regarding the third point, confidence intervals are very useful for reminding students that mean values of samples may be very different from actual mean values of populations. They also have an advantage over p *values in that they are easily represented in graphs. But for testing the predictions generated by research hypotheses, they still suffer from the drawback of having a sharply drawn line (at 95 percent). I would not want my students to think that a hypothesis is on or off the table on the basis of whether a sample mean value falls just within or just outside of a 95 percent confidence interval.*

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