Notes and Comment

Commentary on "Accepting the null hypothesis"

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Frick (1995) propounds two theses: that null hypotheses can be true and that they can be accepted by using a good-effort criterion. That null hypotheses can be true is correct, but Frick's argument is incorrect and irrelevant. It is certainly true that a population parameter can be equal to a hypothesized value or that two or more population parameters can be equal (i.e., that an independent variable has no effect). However, from the perspective of the relative frequency approach to probability, which is the more common one and clearly the one that Frick takes throughout, population parameters are constants and not random variables.¹ Either a constant is equal to a specified value or it is not. There is no probability associated with it. Hence Frick's discussion of this does not apply, even though the conclusion is the same.

On the other hand, if one adopts a Bayesian approach, then one's belief in values that the parameter can assume may be a random variable. Under the Bayesian approach, one can consider such belief to be a continuous random variable. Then, as noted analogously by Frick, the probability of belief in each particular value (or any countably infinite collection of particular values) would be zero.² Certainly, as Frick notes, this random variable could be considered to be a mixed one, where a particular value or values have nonzero probabilities.³ Since this is a model of one's belief, these choices are obviously open to the researcher and no argument to justify such is needed.⁴ It should be noted further that there is nothing special about the number zero.

As for the second thesis, it is well known (and recognized by Frick) that it is sometimes possible to demonstrate that the probability of failing to detect a very small deviation from the null hypothesis (i.e., making a Type II error) is within tolerable limits (most commonly .05). (Frick refers to this as a range hypothesis and uses the confidence interval to test it.) I propose that this procedure is satisfactory for both applied (as accepted by Frick) and theoretical work, and, more importantly, that it is the best that can be done. Theoretical work does not demand that we establish any value to an exact amount. We are not capable of doing that. The philosophy of science does not require it. Scientific theories are not pre-

cise statements of exact fact, but representations of the empirical world. Regardless of whether the work is applied or theoretical, there is a value so small that most can probably agree that it is close enough. Yes, this introduces subjectivity in the judgment of how small is small enough. However, this is a single number with clear scientific meaning. Hence we should be able to make reasonably rational decisions about it. Certainly there will be disagreements, but that is true of all of science.

Frick argues for the criterion of a good effort for accepting the null hypothesis. The reason for developing statistics was to avoid good-effort criteria. Statistics quantifies the decision-making process and makes it rigorous. As Frick points out, as the null-hypothesized value approaches the true parameter value, the power must approach, in the limit, the alpha level of the test.⁵ Hence, no matter how many subjects are run, or whatever other efforts are made, there will always exist a nonzero difference between the actual and hypothesized value for which the probability of making a Type II error is as close to one minus alpha as one would like. Clearly this is way too large a chance of an error for one to base decisions upon it. Thus no statistically quantified good effort that has a reasonable chance of success is possible, if one insists on finding the null hypothesis exactly.

REFERENCES

- FRICK, R. (1995). On accepting the null hypothesis. *Memory & Cognition*, 23, 132-138.

NOTES

1. For example, the most common population parameter in null hypotheses is the population mean. The population mean is the expected value of a random variable, and the expected value of a random variable is a constant.

2. It should be noted that the probability would be *exactly* zero, not *essentially* zero as stated by Frick. The mathematical area of analysis was made rigorous long ago, and this resulted in the deletion of the concept of infinitesimals. It might also be noted that, contrary to Frick's assertion, it is not true that only intervals can have nonzero probability. An uncountably infinite collection of points, which is not an interval and does not contain any intervals, can have a nonzero probability.

3. There can be at most a countably infinite number of points with nonzero probability.

4. It should be noted that there is a long history in the psychology literature of assuming that a random variable must be either discrete or continuous. In discussing null hypotheses, several authors have argued from this that no single point can have nonzero probability mass (or measure). This error is not surprising, given the usual treatment of this subject in psychology statistics courses.

5. Frick discusses the power when the two values are equal. Power is not defined for that condition, but the limit argument given here suffices to make the same point.

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