

## 9.11: Summary

Null hypothesis testing is one of the most ubiquitous elements to statistical theory. The vast majority of scientific papers report the results of some hypothesis test or another. As a consequence it is almost impossible to get by in science without having at least a cursory understanding of what a p-value means, making this one of the most important chapters in the book. As usual, I'll end the chapter with a quick recap of the key ideas that we've talked about:

- Research hypotheses and statistical hypotheses. Null and alternative hypotheses. (Section 11.1).
- Type 1 and Type 2 errors (Section 11.2)
- Test statistics and sampling distributions (Section 11.3)
- Hypothesis testing as a decision making process (Section 11.4)
- p-values as “soft” decisions (Section 11.5)
- Writing up the results of a hypothesis test (Section 11.6)
- Effect size and power (Section 11.8)
- A few issues to consider regarding hypothesis testing (Section 11.9)

Later in the book, in Chapter 17, I'll revisit the theory of null hypothesis tests from a Bayesian perspective, and introduce a number of new tools that you can use if you aren't particularly fond of the orthodox approach. But for now, though, we're done with the abstract statistical theory, and we can start discussing specific data analysis tools.

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### References

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- Ellis, P. D. 2010. *The Essential Guide to Effect Sizes: Statistical Power, Meta-Analysis, and the Interpretation of Research Results*. Cambridge, UK: Cambridge University Press.
- Lehmann, Erich L. 2011. *Fisher, Neyman, and the Creation of Classical Statistics*. Springer.
- Gelman, A., and H. Stern. 2006. “The Difference Between ‘Significant’ and ‘Not Significant’ Is Not Itself Statistically Significant.” *The American Statistician* 60: 328–31.

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156. The quote comes from Wittgenstein's (1922) text, *Tractatus Logico-Philosophicus*.
157. A technical note. The description below differs subtly from the standard description given in a lot of introductory texts. The orthodox theory of null hypothesis testing emerged from the work of Sir Ronald Fisher and Jerzy Neyman in the early 20th century; but Fisher and Neyman actually had very different views about how it should work. The standard treatment of hypothesis testing that most texts use is a hybrid of the two approaches. The treatment here is a little more Neyman-style than the orthodox view, especially as regards the meaning of the p value.
158. My apologies to anyone who actually believes in this stuff, but on my reading of the literature on ESP, it's just not reasonable to think this is real. To be fair, though, some of the studies are rigorously designed; so it's actually an interesting area for thinking about psychological research design. And of course it's a free country, so you can spend your own time and effort proving me wrong if you like, but I wouldn't think that's a terribly practical use of your intellect.
159. This analogy only works if you're from an adversarial legal system like UK/US/Australia. As I understand these things, the French inquisitorial system is quite different.
160. An aside regarding the language you use to talk about hypothesis testing. Firstly, one thing you really want to avoid is the word “prove”: a statistical test really doesn't *prove* that a hypothesis is true or false. Proof implies certainty, and as the saying goes, statistics means never having to say you're certain. On that point almost everyone would agree. However, beyond that there's a fair amount of confusion. Some people argue that you're only allowed to make statements like “rejected the null”, “failed to reject the null”, or possibly “retained the null”. According to this line of thinking, you can't say things like “accept the alternative” or “accept the null”. Personally I think this is too strong: in my opinion, this conflates null hypothesis testing with Karl Popper's falsificationist view of the scientific process. While there are similarities between falsificationism and null hypothesis testing, they aren't equivalent. However, while I personally think it's fine to talk about accepting a hypothesis (on the proviso that “acceptance” doesn't actually mean that it's necessarily true, especially in the case of the null hypothesis), many people will disagree. And more to the point, you should be aware that this particular weirdness exists, so that you're not caught unawares by it when writing up your own results.

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