Boneau C A. The effects of violations of assumptions underlying the *t* test.
Psychol. Bull. 57:49-64, 1960.
[Duke University, Durham, NC]

The paper presented the results of Monte Carlo studies of the effects of violating some assumptions upon which the statistical *t*-test is based. Except for a few specific cases that were examined in some detail, the theoretical robustness of the test was demonstrated. [The *Social Sciences Citation Index®* (*SSCI®*) indicates that this paper has been cited in over 115 publications.]

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In 1958, after completing my PhD in experimental psychology at Duke, I stayed on to do postdoctoral work, which mainly followed up on my dissertation research. I was also teaching a graduate course in statistics in the department and sitting in on courses elsewhere. One such course was in programming Duke's new IBM 650 that had arrived midway in the spring semester. That course entailed a final project that formed the basis for the *t*-test paper.

As I recall, the basic procedure for generating a distribution consisting of 1,000 random samples of the statistic *t* took about a half-hour on the 650, even though it had been "optimally" programmed. The time required now, of course, is a few seconds, at most, on a microcomputer. A substantial number of these distributions were generated for the study.

Since there were only a handful of us who knew how to program, there was little competition for computer time. I would put my program on late at night and retrieve the results the following morning after an all-night run.

I have often pondered the popularity of the paper, given its unconventional conception and its almost casual birth. Within psychology, it must have satisfied some deep-seated urges to sin and get away with it. At the time, statistics texts in psychology were rather steadfastly preaching against violation of the assumptions of normality and homogeneity of variance both in the *t*-test and in the closely related *F*-test of analysis of variance. On the other hand, the theoretical literature was indicating that the tests were probably more robust than they were being given credit for. Utilizing punched cards on a sorting machine, Norton, in a little-known early study[1] mentioned only in Lindquist's 1953 text,[2] had also concluded somewhat tentatively that violations of assumptions seemed to have minimal effects on the *F*-test of analysis of variance. The time seemed appropriate to bring into play the fruits of advanced technology and settle the question once and for all on the powerful 650. The time was probably right also for a defense of sin.

I do think, however, that I must have achieved about the right level of difficulty and interest in putting the paper together. It was written with students in mind and dealt in concrete terms with abstract concepts. It was almost simpleminded when making explanations, or at least reasonably detailed and didactic.

Possibly because it appeared in a core journal in psychology, it had a wide impact upon the field. Professionals in other areas, however, seem to have ignored the article completely. Within psychology, it was reprinted several times in books of readings, and obviously much good use was made of the results and conclusions. A standard review of the relevant literature can be found in an article by Glass, Peckham, and Sanders.[3] [Several recent books have made reference to this article.[4,5]]

1. Norton D W. *An empirical investigation of some effects of non-normality and heterogeneity on the F-distribution.* PhD dissertation, State University of Iowa, 1952. (Cited 40 times since 1955.)
2. Lindquist E F. *Design and analysis of experiments in psychology and education.* Boston: Houghton Mifflin, 1953. 393 p. (Cited 2,125 times since 1955.)
3. Glass G V, Peckham P D & Sanders J R. Consequences of failure to meet assumptions underlying the analysis of variance and covariance. *Rev. Educ. Res.* 42:237-88, 1972. (Cited 100 times.)
4. Walker J T. *Using statistics for psychological research: an introduction.* New York: Holt, Rinehart, and Winston, 1985. 585 p.
5. Wike E L. *Numbers: a primer of data analysis.* Columbus, OH: Merrill, 1985. 399 p.