**"A SIMPLIFIED TIME-SERIES ANALYSIS FOR EVALUATING
TREATMENT INTERVENTIONS": A REJOINDER TO BLUMBERG**

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Blumberg's (1984) first problem with the C statistic is that a condition exists where C is a function only of the number of data points in the series and not the slope of the series. This is the unlikely case where all the data points form an exact linear sequence. This special condition shows that the C statistic is not a measure of effect size. Rather, the C statistic evaluates the probability that the time series is random. Tryon (1982) put the matter thus: "The main logical question answered by the C statistic is whether or not the time series contains any trends, i.e., any systematic departures from random variation" (p. 425). The C statistic is significant ($p < .01$) given 8 points (the smallest usable number) all lying on the same straight line because this is such an unlikely random result.

Blumberg's (1984) second problem with the C statistic is that it allegedly is not significant when comparing a linear baseline series and a linear treatment series having the same slope but a different intercept. This is not true if the treatment series is appended to the baseline series and the composite series is analyzed. A shift in slope alone also produces a significant C value. It follows that changes in both slope and intercept produce significant C values.

Blumberg's (1984) third problem with the C statistic is that it is significant under a special "no change" condition. This condition exists when the behavioral data equal the square, or some other power, of the session number. Let us assume that baseline data were collected during Sessions 1, 2, 3, and 4 resulting in behavioral frequencies of 1, 4, 9, and 16. Let us further assume that we im-

plemented treatment during Sessions 5, 6, 7, and 8 resulting in behavioral frequencies of 25, 36, 49, and 64. Blumberg's criticism is that no change from baseline exists because the exponent remained the same, yet the C statistic is significant. The question here is whether or not it is wise to define "no trend change" in terms of "the same exponent." Let us reconsider the above-mentioned example as a case in point. A frequency of 16 was recorded during the last baseline observation (Session 4) compared to a frequency of 1 recorded during the first baseline observation (Session 1). This yields an average slope of $(16 - 1)/(4 - 1) = 5$. A similar analysis of the treatment data yields an average slope of $(64 - 25)/(8 - 5) = 13$. Blumberg asks us to equate an average behavioral change of 5 units/session during baseline with an average behavioral change of 13 units/session during treatment. The average change during treatment is 260% of that during baseline, yet Blumberg asks us to conclude that no change has occurred because the exponent remains constant from baseline to treatment. The C statistic is significant under these conditions, but I seriously doubt that such a result will mislead many behavior analysts.

Blumberg correctly observes: (a) the power of the C statistic is directly proportional to the number of data points in the series, (b) baseline plus treatment contain more data points than baseline alone, (c) hence, the baseline plus treatment analysis is more powerful than the baseline alone analysis. The result is to make statistical significance more likely when baseline plus treatment data are analyzed than when baseline data alone are analyzed even when the trend remains the same. Suppose 10 baseline and 10 treatment points were collected. The baseline alone analysis is performed on 10 points, whereas the baseline plus treatment analysis is performed on 20 points. Blumberg ar-

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gues that if the baseline plus treatment analysis is significant, then perhaps a 20-point baseline would also be significant. My first comment on this issue is that it pertains to all forms of statistical analysis, including all forms of time-series analysis, because statistical power is always a function of the size of the data set. Any statistic will be significant if it is based on a large enough set of data. Hence, Blumberg's concern is with statistical analysis in general rather than with the C statistic in particular. My second comment pertains to one solution to this matter. One could use the standard error calculated during the baseline analysis to test for the presence of a trend during the baseline plus treatment analysis. This conservative procedure ignores the reality that more information comes with more data, resulting in greater precision and statistical power. However, this resolution does put the baseline alone and baseline plus treatment analyses on a more even footing.

CONCLUSION

In sum, the C statistic is an omnibus statistic that establishes the probability that a time series is random. Rejecting this null hypothesis leads to the conclusion that some type of trend exists. The C statistic is sensitive to changes in slope and intercept when the treatment series is appended to the baseline series and the aggregate series is evaluated. However, C is not a measure of effect size and under special conditions it is entirely a function of the sample size.

REFERENCES

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