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Communication Deviance in the Families of Schizophrenics: A Comment on the Misuse of Analysis of Covariance

Abstract. *Serious contradictions in recent research programs concerning communication anomalies in parents of schizophrenics have been generated by invalid statistical analyses. The method of analysis used, the analysis of covariance, can lead to erroneous conclusions in the context of these studies, and thus, other means must be sought for bringing these important research programs into common focus.*

A growing body of research is devoted to establishing the existence and etiological significance of abnormal styles of communication in the families of schizophrenics (*1–3*). A hypothesis underlying much of this research is that when speech anomalies such as vagueness, irrelevance, and lack of closure characterize ongoing parental transactions, the likelihood of schizophrenia in the offspring is greatly increased. These communication difficulties are believed to create a poor sense of reality and a difficulty in modeling patterns of clear and logical thinking so that when the offspring is faced with life stress, more primitive cognitive mechanisms are likely to appear. Thus, it is hypothesized that deviant parental communication styles lay the groundwork for the subsequent appearance of the core symptoms of a schizophrenic psychosis.

It is generally acknowledged that conclusive testing of the etiological aspects of the hypothesis must await the completion of longitudinal studies that can determine whether parental communication deviance precedes, and therefore is not reactive to, the onset of schizophrenia in the offspring (*4*). Because such prospective studies are difficult to carry out and take many years to complete, early studies have been based upon the more readily accomplished (though weaker) cross-sectional strategy in which the communication deviance of parents of schizophrenics is contrasted with that observed in parents of severely disturbed, nonschizophrenic offspring (*5*). The initial series of these cross-sectional studies carried out by Wynne and Singer and their colleagues (*1*) have provided support for the communication deviance hypothesis and have lent great importance to the conduct of the etiologically more informative longitudinal research programs.

Communication deviance, as employed in these studies, is measured by counting the number of units of abnormal verbal behavior that fit preestablished categories. Typically used are projective test data, in which there is wide variability in the number of verbal units of all kinds observed; the question has been raised as to whether the communication deviance index is simply an artifact of the number of words spoken. Hirsch and Leff (*2*, *3*), in a carefully conducted replication of the Wynne-Singer procedures with an English sample of parents of schizophrenics and parents of neurotics, found group differences in communication deviance in the expected direction but with considerable group overlap. These investigators then raised the question of whether these group differences in communication deviance are, in fact, artifacts of verbosity differences between the groups in their sample. The question posed by Hirsch and Leff was, "If both groups had spoken the same mean number of words, would we expect there to be any difference between their mean deviance scores?" (*2*, p. 144). Analysis of covariance, a statistical technique for estimating group differences with the effects of a correlated variable removed, was applied to these data. The previously found significant differences between groups in communication deviance disappeared, leading Hirsch and Leff to conclude that they had disconfirmed the Wynne and Singer findings.

Wynne and Singer and their colleagues also applied the analysis of covariance to their own data, but found that differences in parental communication deviance did *not* vanish but were slightly accentuated when verbosity was employed as a covariate (*1*, p. 43). Thus, a major source of disagreement between these studies has been generated by attempts to use the analysis of covariance to control statistically for group differences in verbosity.

We will demonstrate that the analysis of covariance is not applicable in these cross-sectional studies, even though the traditional analysis of covariance assumptions of linearity and equality of within-group regression coefficients were met. Although the problems involved are subtle, it is nevertheless important that the analysis of covariance be avoided in research studies in which the technique can lead to erroneous conclusions.

The inapplicability of the analysis of covariance in these research programs stems from two problems. First, the groups (for example, the parents of schizophrenics and the parents of disturbed nonschizophrenics) are not created through random assignment. Under these circumstances, observed group differences in verbosity (the covariate) may arise from complex effects of selection, from genetic differences among parents, or from the illnesses of the offspring. In fact, the same factors that are responsible for differences in communication deviance (the dependent measure) may be responsible for differences in verbosity.

Second, the "true" relationship between verbosity and communication deviance cannot be known for a given sample of individuals. Except in the extreme where only a few words are spoken, this relationship could vary as a function of innumerable situational factors such as the nature of the stimulus cards, the instructions, and the recent experiences of subjects. These multiple, possibly interacting sources of measurement error can be given explicit recognition, as in the theory of generalizability where reliability is conceptualized and estimated in a multifaceted framework (*6*). In the studies under discussion, the

number of words spoken and the number of "deviant" communications may have been counted or scored correctly, but replicate measurements on the same individuals under varying conditions of measurement could produce a variety of different regression weights, each of which might be used as a basis for the analysis of covariance. Perhaps in the case of determining the sex and age of subjects we can imagine procedures that would yield the same results across replications under practical circumstances, but the same cannot be said for most behavioral measurements.

The importance of these conditions for the analysis of covariance is as follows. If we represent the mean communication deviance score (the dependent measure) in the ith groups as $\bar{Y}_{i.}$ and the mean verbosity score (the covariate) as $\bar{X}_{i.}$, then the adjusted mean (θ_i) that is estimated and tested in the analysis of covariance is

$$\theta_{i.} = \bar{Y}_{i.} - b'\bar{X}_{i.}$$

where b' is the observed linear regression coefficient relating verbosity and deviance for this sample. The expected value of this expression [$E(\theta_i)$] can be shown to equal

$$E(\theta_{i.}) = \alpha_{i.} + (\beta - \beta')\alpha_{i.}'$$

where $\alpha_{i.}$ is a population parameter representing the deviation of the ith group mean about the grand mean on the dependent measure independent of the covariate, β is the true population regression weight, β' is the expected value of the error attenuated regression weight, and $\alpha_{i.}'$ is the deviation of the ith group mean about the grand mean on the covariate for the population. Detailed derivations of the above expression can be found in Overall and Woodward (*7*) and in Cochran (*8*).

As can be seen, the bias term $(\beta - \beta')\alpha_{i.}'$ will vanish if the true regression weight is known (that is, $\beta - \beta' = 0$) or if there is random assignment to groups under conditions in which the deviation of the group means about the grand mean on the covariate is zero in the population (that is, if $\alpha_{i.}' = 0$). It also has been shown that the bias term will vanish when the assignment to groups is nonrandom but, rather, based entirely on the observed covariate score (*7*). Otherwise, the covariance adjustment does not remove all of the original bias but leaves a fraction $(\beta - \beta')/\beta$. This remaining bias can produce either an *overestimate* or an *underestimate* and will disturb tests of significance. In the Wynne and Singer and in the Hirsch and Leff studies the bias term in the analysis of covariance cannot be assumed to be zero since the true regression coefficient is not known, and/or since differences in the intact groups may have caused the observed group differences on the covariate. Thus, the analysis of covariance can lead to erroneous conclusions when applied in these studies, and it should not be employed even as a partial basis for deciding if the Hirsch and Leff study has confirmed the findings of Wynne and Singer.

The above problem is serious and has stimulated several attempts to devise corrections that will remove all of the bias when the analysis of covariance is applied under these circumstances (*9*). In principle, these corrections could have been employed here. However, prior to such correction, a strong logical case must be made for testing the communication deviance hypothesis by using the analysis of covariance to partial out verbosity as if it were a conceptually distinct source of behavioral differences among groups. Among the 41 categories of responses that were summed to form the communication deviance score are a number of specific categories that could be interpreted as "causes" of wordiness. Among them are "extraneous questions and remarks," "odd, tangential, inappropriate remarks," "wordplay," and "repetition of words or phrases" (*1*, table 1). To the extent that communication deviance causes wordiness, it would seem inappropriate to attempt to use differences in wordiness as an explanation for observed differences in communication deviance. In fact, just the reverse might be true for a number of the 41 categories that make up the total deviance score of Wynne and Singer.

Finally, we note that the analysis of covariance would be desirable here only if it were clear that the Wynne and Singer hypothesis requires that the proportion of deviant responses be greater among the parents of schizophrenics, which is analogous to the hypothesis tested by the analysis of covariance. It can be argued that the significant difference between groups in total number of deviant responses is, in fact, consistent with the Wynne and Singer hypothesis, even if it is mediated through verbosity of the parents (*1*, p. 24). As Wynne and Singer have stated, their interest is in repeated forms of communicating and relating that would contribute over the years to the formation of character and personality.

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Social Communication in Canids: Evidence for the Evolution of a Stereotyped Mammalian Display

Abstract. *The variability in the duration and form of the canid play bow was studied in infant coyotes, wolves, wolf-dog hybrids, beagles, and adult free-ranging dogs. Both duration and form showed marked stereotypy. It appears that the role of this context-specific social signal in the communication of play intention has been fostered by selection for "morphological" stereotypy.*

Despite a history of considerable interest in animal social communication (*1–3*), few data are available on the "anatomy" or form of signals that are used. Indeed, one of the basic concepts of classical ethology, the "fixed" action pattern, rarely has been studied quantitatively (*4–7*). The form of visual displays has been studied quantitatively in invertebrates, lizards, and birds (*4–7*); however, there