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On Moderating Effects in the Interactional and in the Confounding Sense: A Reply

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My paper 'Moderating effects in a multivariate normal distribution' has come under heavy attacks by Schmitt and Baltes-Götz. As far as I can see their main criticisms can be summarized as follows:

(i) the results in the paper are irrelevant because an uncommon definition of the term 'moderator' was used;
(ii) Schmitt's previous work was misinterpreted since he has been using the term moderator exclusively in an 'interactional sense'.

To (i): Their reaction to may paper emphasizes the need to give precise definitions to avoid misunderstandings. Moderating effects which I have been investigating for different distributional assumptions (Wermuth 1987, 1989a, 1989b) are based on a broad definition: an association between two variables is moderated by another variable if in the population *the association is changed by the presence of this variable.*

For instance, the two possible types of moderation of a linear regression coefficient by a binary variable A are illustrated in Figures 1 and 2.

In both situations, the regression coefficient of Y on X does not remain unchanged after excluding variable A from the analysis, i.e. it is moderated by variable A in the above broad sense. The situation in Figure 1 is an instance of moderation in the interactional sense because the slopes are different.

Figure 2 shows regression coefficients which are positive and equal in both subgroups of A, while the overall regression coefficient, i.e. the one obtained if A is ignored, is negative. The situation in Figure 2 is an instance of moderation in the confounding sense as it is termed in epidemiological literature (Breslow & Day, 1980, p. 95) or it is an instance of lack of collapsibility as it is called in statistical literature (Bishop, 1969; Whittemore, 1978; Geng, 1992). This will always occur unless either the lines are not only parallel but also coincident, i.e. unless the lines have the same intercepts and slopes, or both lines have zero slopes.

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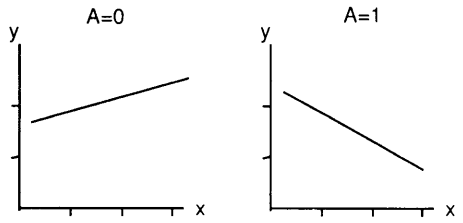

Figure 1: Schematic illustration of moderation in the interactional sense.

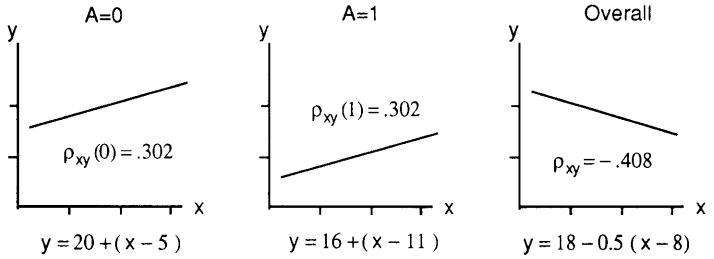

Figure 2: Example of moderation in the confounding sense with $\mu_y(0) = 20$, $\mu_x(0) = 5$, $\sigma_{yy}(0) = 11$, $\sigma_{xx}(0) = 1$, $\sigma_{xy}(0) = 1$, $\mu_y(1) = 16$, $\mu_x(1) = 11$, $\sigma_{yy}(1) = 11$, $\sigma_{xx}(1) = 1$, $\sigma_{xy}(1) = 1$, and $\Pr(A = 0) = \Pr(A = 1) = 0.5$.

Thus, Schmitt's narrow definition of moderation in the interactional sense is contained in the broad definition which I have been using.

A special situation occurs if all variables including the potential moderator follow a multivariate normal distribution. The properties of this distribution are such that there cannot be any moderation in the interactional sense because the slope of the conditional relation between Y and X given Z is the same for all values of Z. Thus, only moderation in the confounding sense can be of interest, and this is investigated for different possible measures of association in the criticized paper. Except for the interpretation in terms of independencies the given results for regression coefficients do not depend on the assumption of multivariate normality but apply, instead, to any linear regression. In particular, they tell that moderated regression equations (Zedeck, 1971) are incapable of detecting moderation in the confounding sense.

To (ii): For some purposes, it may be perfectly legitimate to use only the narrow interactional sense definition as suggested by Schmitt. However, in general, there are some objections:

(1) There is really no need to introduce a new term if 'moderating effect' just coincided with 'interaction effect'.

(2) While moderation in an interactional sense is always well defined whenever the potential moderator is a categorical variable – like A in Figure 1 –, this need not be the case if the potential moderator is quantitative.
(3) A restriction of moderating effects to the interactional sense would imply that the many important cases of changes in associations due to a third variable as described with Figure 2, i.e. those in the confounding sense, are excluded by definition.

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