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Stimulus Recognition May Mediate Exposure Effects

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Moreland and Zajonc presented stimuli with differential numbers of exposures to subjects and obtained measures of affect (e.g., ratings of liking) and ratings of familiarity. Exposure frequency and ratings of familiarity were both significant predictors of affect in a multiple regression equation. Moreland and Zajonc concluded that there are two independent effects, and thus the exposure effect could not be explained by a stimulus recognition factor alone. However, these results can be explained by the theory that exposure frequency affects a single mediator that is imperfectly correlated with ratings of familiarity and affect. Thus, the null hypothesis that recognition mediates the exposure effect cannot be refuted by the partial correlation and regression analyses of Moreland and Zajonc.

Moreland and Zajonc (1977) varied the frequency with which stimuli were presented and obtained several dependent variables including ratings of familiarity and a measure of liking (affect). Since the rating of affect could be predicted from rated familiarity and exposure frequency and since both regression coefficients were significant, it was argued that there are two "independent" effects. However, the present article shows that the theory that one factor, subjective recognition, mediates the effect of the independent variable on both dependent variables can predict this outcome.

Single-Mediator Theory

Suppose the manipulated variable, exposure frequency, affects a mediator, subjective recognition,

$$S = g(A^*) + s, \tag{1}$$

where S is subjective recognition, A^* is actual exposure frequency, s is a random residual, and g is some function (e.g., logarithmic) of actual frequency.

We thank Richard Moreland for providing us with the correlation matrices in Table 1.

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Suppose that ratings of liking (L) and ratings of familiarity (R) are correlated with subjective recognition,

$$L = aS + l, \tag{2}$$

and

$$R = bS + r, \tag{3}$$

where a and b are linear constants, and l and r are residuals that are uncorrelated with S, s, or each other.

It follows that the intercorrelation between each pair of variables can be expressed as the product of the correlations between the two variables and the mediating factor, subjective recognition:

$$\rho_{ij} = f_i f_j, \quad i \neq j, \tag{4}$$

where ρ_{ij} is the correlation between variables i and j; f_i and f_j are the correlations between the variables and subjective recognition. Since each correlation is the product of the correlations with a mediating factor, S, the path model defined by Equations 1, 2, and 3 is equivalent to a one-factor model.

Interpretation of Partial Correlations in Single-Mediator Theory

The least squares regression coefficient in the (standardized) equation predicting ratings of liking from transformed exposure frequency, $A = g(A^*)$, and rated familiarity is given by

Table 1
Correlations of Variables from Moreland and Zajonc (1977)

	1	2	3	4	5
1. Frequency		.42	.64	.53	.41
2. Affect	.66		.40	.35	.25
3. Familiarity	.58	.53		.47	.54
4. Confidence	.34	.25	.29		.48
5. Accuracy	.41	.30	.55	.42	

Note. Correlations above and below diagonal are for Experiments 1 and 2, respectively. Frequency represents log $(f + 1)$, where f is actual exposure frequency. Liking and affect are corresponding dependent variables for Experiments 1 and 2, respectively.

the expression:

$$\beta_{LR \cdot A} = \frac{\rho_{LR} - \rho_{RA}\rho_{AL}}{1 - \rho_{RA}^2}, \quad (5)$$

where $\beta_{LR \cdot A}$ is the beta coefficient for rated familiarity in the equation predicting rated liking with transformed frequency (A) partialed out. (The corresponding partial correlation has the same numerator as Equation 5.)

Substituting Equation 4 into Equation 5 yields

$$\beta_{LR \cdot A} = \frac{f_L f_R(1 - f_A^2)}{1 - f_R^2 f_A^2} = \frac{\rho_{LR}(1 - f_A^2)}{1 - \rho_{RA}^2}, \quad (6)$$

which shows that unless subjective recognition is perfectly correlated with frequency ($f_A^2 = 1$), the beta is expected to be non-zero and to have the same sign as ρ_{LR}.

Similarly, the beta for A in the equation predicting liking will be given by

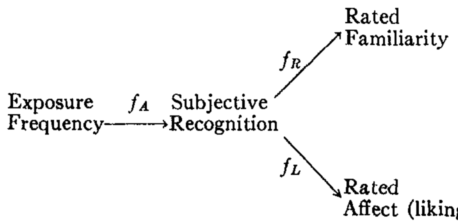
$$\beta_{LA \cdot R} = \frac{\rho_{LA}(1 - f_R^2)}{1 - \rho_{RA}^2}, \quad (7)$$

which shows that the coefficient of frequency is expected to be non-zero and to have the same sign as the correlation between exposure frequency and liking, unless rated familiarity is perfectly correlated with subjective recognition ($f_R^2 = 1$). Thus, the finding of a positive partial correlation between liking and frequency with rated familiarity partialed out is consistent with both the single-mediator (null) hypothesis and the alternative. This partial correlation is therefore not diagnostic of the presence of two independent effects on liking, as contended by Moreland and Zajonc (1977).[1]

One or Two Mediators?

The correlations between exposure frequency, rated familiarity, and affect (liking) for Experiments 1 and 2 of Moreland and Zajonc (1977) are shown in Table 1. The off-diagonal correlations among these three variables can be perfectly fit by the single-mediator model in each case.[2] For Experiment 1, the correlations with the mediator are .82, .78, and .51, respectively; for Experiment 2, the correlations with the recognition mediator are .85, .68, and .78 for frequency, rated familiarity, and affect (liking), respectively.

Consequently, the three correlations are consistent with the representation shown below, in which each correlation among observed variables is the product of their correlations with subject recognition (Equation 4):



. (8)

This model can be extended to describe the intercorrelations among the other dependent variables measuring recognition.

The alternative to Equation 4 is that there is an additional effect of frequency on liking that operates independently of the effect of

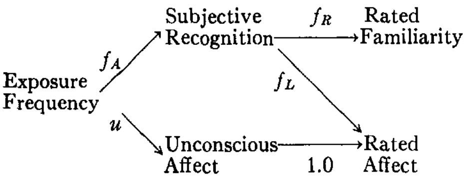
[1] Should a partial correlation have a sign opposite to that of the original correlation (i.e., $\rho_{ij \cdot k}\rho_{ij} < 0$), it would not be consistent with a one-mediator model. Though it may seem counterintuitive, a *negative* partial correlation between exposure frequency and rated familiarity with liking partialed out would have been inconsistent with the single-mediator model, but in agreement with the presence of a second effect of frequency on liking.

[2] For a three-variable, positive intercorrelation matrix, the path coefficients (factor loadings) are given by the following equation:

$$f_i = \sqrt{\frac{\rho_{ij}\rho_{ik}}{\rho_{jk}}},$$

where f_i is the correlation between Variable i and the mediating variable.

frequency on recognition. This theory can be represented as follows:



. (9)

The single-mediator model (Expression 8, Equation 4) implies that the correlations satisfy the following:

$$\rho_{ij} \le \frac{\rho_{ik}}{\rho_{jk}} \le 1/\rho_{ij}, \qquad (10)$$

since the correlations with subjective recognition (f_i) are less than or equal to 1.0, and Equation 10 is equivalent to the following:

$$f_i f_j \le f_i/f_j \le 1/f_i f_j. \qquad (11)$$

For example, the single-mediator model would not be able to account for correlations for ρ_{LR}, ρ_{LA}, and ρ_{RA} of .7, .7, and .35, respectively, since $\rho_{LA}/\rho_{RA} = 2$, which is outside the limits set by .7 and 1/.7. However, Equation 10 was satisfied for exposure, affect, and any of the three recognition measures for both experiments.

These analyses show that the regression and partial correlation results reported by Moreland and Zajonc (1977) can be explained by the null hypothesis of a single mediator. Good fit of the null hypothesis (Expression 8) that recognition mediates the exposure effect does not rule out the possible presence of unconscious affect (as in Expression 9). However, the burden of proof clearly remains on those who would conclude, with Moreland and Zajonc (1977, p. 191), that "the relationship between stimulus exposure and affect does not depend on the operation of higher order cognitive processes."

Parallel With Subception

The present issue has interesting parallels in perception (Garner, Hake, & Eriksen, 1956) and learning (Dulany, 1968). Eriksen (1956, 1960) replicated and reinterpreted an experiment of Lazarus and McCleary (1951) that claimed to demonstrate subception. In Eriksen's (1956) replication, subjects were trained to give a verbal response to each of several squares, one of which was paired with shock. In the testing phase, galvanic skin response (GSR) and verbal responses were measured to each stimulus. It was found that the stimulus–GSR relationship was maintained when verbal response was partialed out. Eriksen (1960) noted that the results are consistent with the hypothesis that the stimulus leads to a perception that is imperfectly correlated with the two dependent variables with uncorrelated errors. To find an *absence* of the partial correlation between stimulus and GSR with verbal response partialed out would require that the verbal response be perfectly correlated with perception. In terms of Thurstone's law of categorical judgment, the category boundaries would have to show zero variance. Should the subject shift the limens during the experiment, the partial correlation will be expected to be non-zero.

Causation and Correlation

Brewer, Campbell, and Crano (1970) have cautioned against the use of multiple regression and partial correlation in nonexperimental settings. They reviewed 10 psychological studies in which partial correlations had been used inappropriately to argue for multiple effects without testing the rival, one-factor hypothesis. This paper shows that the criticisms of partial correlation analysis made by Brewer et al. (1970) can apply to certain experimental as well as nonexperimental studies.

Although factor and path analyses may be useful for examining the number and nature of the *effects* in the dependent variables, they do not allow one to draw inferences about causation. Unless the variables are experimentally manipulated, numerous alternative causal models remain consistent with the data. To argue for *multiple causes*, an investigator must demonstrate that *two* or more experimentally *manipulated* variables contribute independently to the measured dependent variables. One should not draw causal inferences from correlations unless the independent variables are truly independent, that is, manipulated experimental variables.

Conclusions

The present article shows that the one-mediator model may be a reasonable null hypothesis for data obtained in experimental studies in which one variable is manipulated and several are measured. Indeed, a positive partial correlation between exposure frequency and liking with rated familiarity partialed out does *not* evaluate the null hypothesis that a single variable mediates the effect of the independent variable on both dependent variables, as shown by Equation 7. Thus, the theory that stimulus recognition mediates the exposure effect on liking is not refuted by the partial correlation and regression analyses of Moreland and Zajonc (1977).

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