



Published in final edited form as:

*Health Psychol.* 2008 March ; 27(2 Suppl): S99. doi:10.1037/0278-6133.27.2(Suppl.).S99.

## How and for Whom? Mediation and Moderation in Health Psychology

David P. MacKinnon and Linda J. Luecken

Department of Psychology, Arizona State University, Tempe

The field of health psychology blossomed following ground-breaking studies that demonstrated relations among biological, psychological, behavioral, and social forces. Within the last few decades, it has become widely accepted that a variety of psychological and social factors influence physical health. Historically, health psychology studies focused on documenting major relations between an independent variable (e.g., stress) and an outcome variable (e.g., blood pressure). Similarly, intervention efforts have shown significant program effects on health-related measures.

As the field of health psychology matures, there is corresponding growth in attention to the underlying causal mechanisms and processes by which psychosocial factors influence health. Another important direction in the field of health psychology involves acknowledgment and investigation of individual differences in the relations among biological, psychological, behavioral, and social factors. It is commonly found in medical and psychological research that one size does not fit all, whether investigating response to an intervention, perceptions of stress, or the influence of a personality trait on cardiovascular health. Research questions that ask *how*, *when*, *for whom*, *which*, and *under what conditions* require attention to additional (“third”) variables that can explain how two variables are related. Mediation and moderation are two examples of this detailed examination of relations between variables (Kraemer, Kiernan, Essex, & Kupfer, 2008). There has been a surge of interest in third variable analyses because they offer the potential to unpack the “black box” and provide a more sophisticated understanding of interdependencies between psychological processes and health. Despite the frequent occurrence of mediation and moderation hypotheses in published articles relevant to health psychology, there remains some confusion about the meaning and proper analysis of these and other third variable effects.

Analyses of mediation can, for example, allow researchers to move beyond merely asking “Does this intervention lead to improved health?” to ask *how* the intervention influences health. This movement is a sign of the field progressing from investigation of overall relations among variables to detailed explanations of the causal pathways by which one variable brings about change in another. In addition to the theoretical interest inherent in understanding causal pathways, these investigations have practical significance for the development of efficient and effective intervention programs by identifying and subsequently targeting critical program components.

Mediation can be simply defined as a relation such that an independent variable causes a mediating variable, which then causes a dependent variable (MacKinnon, 2008). For mediation to exist, the following conditions must be met. First there must be a substantial relation between an independent variable and the mediating variable, and there must be a relation between the

mediating variable and the dependent variable when accounting for the independent variable. Second, by definition, mediation requires a causal precedence such that the independent variable precedes and is a cause of the mediator, and the mediator must precede and be a cause of the dependent variable. Ideally, repeated measures of the mediator and dependent variable are available to investigate temporal relations, but often these causal relations must be inferred based on theory or prior research. Other important assumptions are discussed elsewhere, including the use of valid and reliable measures, accurate modeling of the distributions of variables, and sufficient sample size (see MacKinnon, 2008).

Barerra, Strycker, MacKinnon, and Toobert (2008) use analyses of mediation to evaluate the mechanisms by which the Mediterranean Lifestyle Program facilitates lifestyle modifications for patients with diabetes. Their approach evaluates if the intervention is successful in bringing about change in social-ecological resources (putative mediators), and if increased social-ecological resources then predict improved health behaviors. Such an approach facilitates refinement of the program by building on active components and either modifying or minimizing components that appear less effective in bringing about the desired effects.

In contrast, examination of moderating factors considers the unique conditions under which two variables are related. A moderator variable is one in which the relation between the independent variable and dependent variable changes across levels of the moderator. Although often confused with mediation, a moderator is not intermediate in the causal sequence from the IV to the DV. Moderators are included in statistical models as an interaction term. For the assessment of moderation effects, the relation between the independent and dependent variable must be different at different levels of a third variable. When the third variable is a grouping variable, then the relation between the independent and dependent variable is simply different between the two groups, for example, if the relation differs for males and females. If the third variable is continuous (see, e.g., Manne, Ostroff, & Winkel, 2007), then the relation between the independent and dependent variable may differ across the values of the third variable. More on moderator variables can be found in Aiken and West (1991).

Analyses of moderation are useful for asking questions such as “*When* is stress dangerous to one’s health?”; “*Under what conditions* are hostile people at greatest risk?”; and “*For whom* is this intervention effective?” In the current issue, Mausbach and colleagues (2008) use analyses of moderation to evaluate when stress levels are associated with biological markers of cardiovascular disease risk. Alzheimer’s caregivers who felt less of a sense of mastery over life circumstances were more negatively biologically affected by stressful life events than those who felt a stronger sense of control. Vella, Kamarck, and Schiffman (2008) report on the moderating effects of social support on blood pressure for people high in hostility. Although hostility levels did not predict average blood pressure during social interactions, more hostile people showed elevated blood pressure during interactions rated higher in instrumental support (i.e., when someone was offering or providing help). For prevention and intervention programs, understanding critical moderators of program effects has the potential to help direct limited resources to those who are most likely to benefit from them. For example, Manne et al. (2007) report analyses of moderation suggesting that a couples-focused program is more effective for breast cancer patients who display higher level emotion-processing skills at the start of the intervention.

There are two other types of variables that are relevant to discussion of third-variable effects, and that are often confused with mediators or moderators: confounding variables and covariates. A *confounding* variable is one that changes the relation between an independent and dependent variable because it is related to both variables, but is not theoretically in a causal sequence between the independent and dependent variable. When considering whether a variable is a mediator or a confound, the presumed presence or lack of a causal mediation

relation should be taken into account. Confounders explain a significant relation between the independent and dependent variable by a third variable that predicts both variables, whereas a mediator explains a relation between variables because it is intermediate in a causal sequence. Age, gender, and income are often included in statistical models because of their potential to act as confounding variables. For example, due to its significant associations with both their IV and DV, Surtees, Wainwright, Luben, Khaw, and Day (2006) evaluate participant age as a potential confound of the relation between personal mastery and all-cause mortality. However, the relation did not change, suggesting that age was not a confound that would explain the observed association between mastery and mortality.

One other type of third variable is a *covariate*, which has a relation with one or both of the independent and dependent variables, but does not appreciably change the relation between an independent and dependent variable when included in a statistical analysis. Covariates are generally not of theoretical interest, but are often included in a model to explain additional variability in a dependent variable. For example, Vella et al. (2008) include a number of covariates, including posture, caffeine intake, and body mass index, in their analyses of the influence of hostility and social interactions on ambulatory blood pressure. One final note regards interpretation of third-variable effects, which requires careful consideration of the theorized role of the third variable in the relation between the IV and DV. The commonly used-term “explain” can fail to distinguish the third-variable’s proposed role. The term historically referred to a confounding variable that explained the relation between an IV and a DV because it was related to both of them (Lazarsfeld, 1955). However, in modern literature it is frequently used as a catch-all term with respect to mediators, confounds, or other third variables, and as such provides little precision in explaining the nature of an observed relation between the IV and DV.

## Summary

Health psychology is maturing to include both major studies relating IVs to DVs as well as in-depth investigation of how these relations occur and for whom. These analyses reflect the richness of data collected in investigations of health and hold the promise of uncovering important pathways by which psychological factors influence health. From a methodological standpoint, investigation of mediation and moderation represents how a third variable may be incorporated in statistical analyses to uncover underlying mechanisms, differing effects on unique populations, or conditions under which an effect may be pronounced or diminished. Often the addition of these measures to research projects costs very little, but offers tremendous potential to yield detailed information critical to the advancement of theory and practice in health psychology.

## References

- Aiken, L.S.; West, S.G. *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage; 1991.
- Barerra M, Strycker LA, MacKinnon DP, Toobert DJ. Social-ecological resources as mediators of two-year diet and physical activity outcomes in Type 2 Diabetes patients. *Health Psychology* 2008;27(2):S118–S125. [PubMed: 18377153]
- Kraemer HC, Kiernan M, Essex M, Kupfer DJ. How and why criteria defining moderators and mediators differ between the Baron & Kenny and MacArthur approaches. *Health Psychology* 2008;27(2):S101–S108. [PubMed: 18377151]
- Lazarsfeld, PF. Interpretation of statistical relations as a research operation. In: Lazarsfeld, PF.; Rosenberg, M., editors. *The language of social research: A reader in the methodology of social research*. Glencoe, IL: Free Press; 1955. p. 115-125.
- MacKinnon, DP. *Introduction to statistical mediation analysis*. Erlbaum: Mahwah, NJ; 2008.

- Manne S, Ostroff JS, Winkel G. Social-cognitive processes as moderators of a couple-focused group intervention for women with early stage breast cancer. *Health Psychology* 2007;26(6):735–44. [PubMed: 18020846]
- Mausbach BT, von Känel R, Patterson TL, Dimsdale JE, Depp CA, Aschbacher K, et al. The moderating effect of personal mastery on the relations between stress and plasminogen activator inhibitor-1 (PAI-1) Antigen. *Health Psychology* 2008;27(2):S172–S179. [PubMed: 18377159]
- Surtees PG, Wainwright NWJ, Luben R, Khaw KT, Day NE. Mastery, sense of coherence, and mortality: Evidence of independent associations from the EPIC-Norfolk prospective cohort study. *Health Psychology* 2006;25(1):102–110. [PubMed: 16448303]
- Vella EJ, Kamarck TW, Shiffman S. Hostility moderates the effects of social support and intimacy on blood pressure in daily social interactions. *Health Psychology* 2008;27(2):S155–S162. [PubMed: 18377157]

## Recommended Readings

- Aiken, LS.; West, SG. *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage; 1991.
- MacKinnon, DP. *Introduction to statistical mediation analysis*. Mahwah, NJ: Erlbaum; 2008.
- MacKinnon DP, Fairchild AJ, Fritz MS. Mediation analysis. *Annual Review of Psychology* 2007;58:593–614.