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Editors' Introduction: Prevention as Altering the Course of Development and the Complementary Purposes of Developmental and Prevention Sciences

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Prevention and developmental sciences have many complementary goals and much to gain by collaboration. With random assignment to conditions and long-term multivariate follow-up of individuals across significant years in the life span, fundamental basic and applied research questions can now be addressed using new statistical methods. This special issue includes 4 empirical articles that used growth modeling techniques (hierarchical linear modeling, latent growth curve analyses) to examine direct and indirect effects of theory-based, longitudinal prevention experiments on developmental trajectories of children's and adolescents' substance use, delinquency, and school bonding.

A primary goal of the rapidly growing interdisciplinary field of prevention science is to prevent or moderate major human afflictions, primarily by understanding and altering risk and protective factors that make such problems more or less likely (Bryant, West, & Windle, 1997; Coie et al., 1993). With a developmental perspective on prevention, the goal is to alter the course of development in an optimal direction. Prevention and developmental sciences have many complementary goals and much to gain by collaboration. Both are concerned with change in human behavior: Whereas developmental sciences focus on understanding variations in naturally-occurring developmental change, prevention sciences aim to create positive change. When prevention efforts are planned and evaluated in the context of normative developmental changes and varied contexts, programs are more likely to be successful. Conversely, when prevention experiments consider how changes in suspected risk factors contribute to changes in targeted mediators and outcomes, developmental sciences may gain elusive insights into causal processes (Coie et al., 1993; Robins, 1992). Thus, both sciences can be advanced by focusing on how continuity and change in risk and protective factors relate to continuity and change in targeted behaviors (Schulenberg & Maggs, in press)

Increasingly, basic researchers, preventionists, and funding agencies recognize the value of collecting long-term follow-up data (Carolina Consortium on Human Development, 1996; McArdle & Bell, 2000). As a result, there is an increasing number of multivariate studies following individuals who received a theoretically-based program (or were part of a linked control group) longitudinally across pivotal years in the life course (Botvin, 1999). When guided by theory, such high quality prevention trials provide strong tests of causal hypotheses that in turn reciprocally inform and revise the original theory (Bryant et al., 1997; Coie et al., 1993; Kellam & Rebok, 1992; Robins, 1992). Methodological developments in statistical theory and software make it possible to test such hypotheses using these rich data sources in new and exciting ways (Bryk & Raudenbush, 1987; Muthén & Curran, 1997; Windle, 1997).

This special issue, titled *Prevention as Altering the Course of Development*, profiles four major prevention studies that have followed children and adolescents over multiple years, examining processes and conditions underlying prevention effects. Each program aimed to reduce anticipated increases in problematic behaviors during adolescence including substance use, aggression, and delinquency. The arti-

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cles describe large-scale, theoretically-based efforts contrasting individuals assigned to treatment and control conditions, with multiple follow-ups across several years. Because of these design characteristics, variation in developmental trajectories by treatment condition can be examined using growth curve modeling techniques.

A developmental trajectory is an individual's pattern of growth or decline in a particular attribute over a series of measurement occasions. Quantitatively, trajectories can be defined as slopes that take any mathematical function, with linear (and often quadratic) trajectories perhaps being the most commonly estimated shapes. Growth functions are defined by two or more parameters, the first indicating an intercept, which represents the individual's level of a variable at a particular researcher-selected time point (e.g., initial, average, or endpoint level), and others representing the slope for the individual over time (Bryk & Raudenbush, 1987; Muthén & Curran, 1997). Depending on the specificity of the theory and breadth of the data, the growth function can be parameterized in more complex ways—for example, a higher order polynomial that represents acceleration or deceleration in change.

Whereas repeated measures analysis of variance examine mean-level developmental trajectories for entire groups (e.g., males vs. females, treatment vs. control), the newer generations of growth modeling procedures (e.g., hierarchical linear and latent curve analyses) estimate developmental trajectories at the individual level, and then test whether variation in the parameters of these trajectories (e.g., initial level, linear rate of change) is systematically predicted by time invariant and time-varying predictors (Bryk & Raudenbush, 1987; Muthén & Curran, 1997). This allows researchers to ask not only whether a treatment was successful in changing a group's trajectory, but also for whom it was (most) helpful and for whom it may have had no (or an iatrogenic) impact (Flay, 1987; MacKinnon, Weber, & Pentz, 1989). Even a small reduction in an individual's developmental trajectory can have a consequential cumulative impact across multiple years if the rate or slope is altered. When programs can additionally delay onset or slow down an accelerating function, behaviors may be even more impacted.

Developmental Science Provides Basis for Theory-Based Interventions

Developmental theory and research can provide a solid foundation for systematic and powerful prevention trials (Bryant et al., 1997; Coie et al., 1993; Kellam & Rebok, 1994). Before attempting to change something, it is important to have a basic understanding of how it operates (Chassin, Presson, & Sherman, 1985; Rutter, 1997). For example, without a clear understanding of the risk and protective factors that causally increase the likelihood of some undesired behavior or outcome (e.g., drug abuse), a program is likely to leave these factors unchanged, and they will continue to increase the individual's risk. Moreover, given that it is possible to cause harm as well as good, accurate knowledge of the causes of targeted behaviors may provide essential information about the possible implications of intervening (Chassin et al., 1985). By building on knowledge from systematic theory-based empirical research on the psychosocial processes underlying behaviors of interest, prevention programmers can specifically target hypothesized causal factors, making success more likely (Botvin, 1999).

Developmental research commonly makes use of correlational designs, laboratory-based and field-based observational studies, and laboratory-based experiments. In the study of middle childhood and adolescence, correlational designs, many of them large-scale and longitudinal, are common. Broad-based longitudinal studies are ideal for providing information about naturally-occurring developmental sequences and processes as they unfold in lives over time, generating theory, and testing whether data are consistent with hypothesized patterns (Loeber & Farrington, 1997; Rutter, 1997). They also inform us about risk and protective factors that may influence the course of development, as well as how these may vary by age, stage, context, and other variables (Coie et al., 1993; Lerner, 1991; Windle & Davies, 1999). When diverse, representative samples are followed across multiple years external validity can be high.

Despite these major advantages, in passive correlational, longitudinal designs where the researchers have no control over the "independent" variables, there is an inability to equivocally rule out rival third variable explanations (Loeber & Farrington, 1997; Offord, 1997; Robins, 1992). Deliberate measurement followed by statistical control of likely third variables bolsters support for the purported causes of observed outcomes, and controlling for prior levels can assess whether the hypothesized predictor precedes and accounts for "change" in the outcome. However, these data analytic strategies are never able to satisfy the skeptical reader with a classic experimental training. In other words, correlational studies, even when longitudinal, remain vulnerable to the classic threats to internal validity (Cook & Campbell, 1979), despite efforts at statistical control of temporally prior third variables.

Laboratory-based experiments with random assignment to conditions are the traditional route to strong causal inferences. With random assignment to and careful control over study conditions, groups can be assumed to be initially equivalent and therefore all differences can be more easily attributed to the treatment,

independent of extraneous influences. Clearly, there is a central place in the behavioral sciences for such laboratory experiments. However, it is impossible, unethical, or both, to manipulate many of the behaviors and processes that are of fundamental interest to developmental psychologists, life-course sociologists, family researchers, and many other social scientists studying the etiology and prevention of problematic human conditions. Furthermore, there is the question of external validity. If developmental change is a function of complex interactions between individuals and their contexts (Lerner, 1991), then ruling out so-called extraneous influences may actually work against understanding cause–effect relations (Bronfenbrenner, 1977; Cairns, Costello, & Elder, 1996; Magnusson & Cairns, 1996).

A design that incorporates strengths of longitudinal, multivariate designs with experimental designs has therefore been proposed (Cook & Shadish, 1994; Kellam & Rebok, 1992; Loeber & Farrington, 1997). From the developmental tradition comes prospective tracking of individuals over significant periods of life, with broad assessments of antecedents, correlates, and consequences of functioning in many domains (Cairns et al., 1996). From the experimental tradition comes theory-based intervention with random assignment to conditions.

Interventions Help Us Understand Human Development

Carefully planned interventions can incorporate many of the characteristics of good experimental science, including directional hypotheses, random assignment to conditions, and systematic experimental manipulation of theoretically-targeted mediators and outcomes (Botvin, 1999; Farrington, 1992; Hansen, Graham, Wolkenstein, & Rohrbach, 1991). These design qualities establish strong internal validity (e.g., Cook & Campbell, 1979) and make it possible to rule out the third variable explanations that can plague passive correlational designs. At the same time, carefully planned interventions can also benefit from many of the advantages of large-scale field-based research, including representative samples, multiple measures, long-term follow-up, and the observation and measurement of individuals in natural settings (Bronfenbrenner, 1977; Farrington, 1992).

With such designs, researchers can ask what happens if a purported causal factor is changed (Coie et al., 1993). Specific hypotheses that stipulate developmental processes should predict how outcomes will be affected if the targeted risk or protective factors are successfully ameliorated in treatment conditions. Moreover, hypotheses about changes in developmental trajectories can be formed when the theoretical and empirical foundations are adequate (Cicchetti & Toth, 1992). Then, by manipulating suspected risk or protective factors and observing the effects in large samples of individuals as they live their lives in natural settings over long periods of time, theories about developmental processes can be tested much more rigorously than with either passive correlational designs or laboratory-based experimental studies (Bryant et al., 1997; Coie et al., 1993; Lerner, Ostrom, & Freel, 1997; Loeber & Farrington, 1997). Hypotheses about causal chains can be evaluated and strong inferences can be tested (Platt, 1964). Such experimental tests of developmental theory may indicate inadequacies or inaccuracies that suggest a need to revise the original theory (Cattell, 1966; Cowen, 1986). Basic and applied questions can be considered using the same designs and data, providing complementary information about human development and potential.

Longitudinal Prevention Experiments—Special Issue

This special issue of *Applied Developmental Science* contains four empirical articles in which groups of children and adolescents were assigned to treatment or control groups and followed longitudinally across multiple years. Vitaro, Brendgen, and Tremblay examine family and peer mediators of prevention success at lowering delinquency among young adolescents using latent growth curve analyses (LCA). Poulin, Dishion, and Burraston also use LCA to examine iatrogenic effects associated with aggregating high-risk youth together in peer intervention groups. Hawkins, Guo, Battin-Pearson, and Abbott use hierarchical linear modeling (HLM) to examine long-term effects of an intervention during elementary school on trajectories of school bonding through adolescence. Finally, Schulenberg and Maggs compare results from HLM and LCA, examining prevention effects on trajectories of and relations among alcohol misuse and related risk factors.

The articles share several important common elements: First, each intervention was based on developmental and other psychosocial theory and empirical research. Second, all were longitudinal prevention experiments: in three of four studies, individuals or schools were randomly assigned to conditions, and all followed participants longitudinally. Third, the targeted individuals were all in middle childhood or early adolescence, and the targeted behaviors included substance use or delinquency. Finally, each article modeled individual trajectories in these targeted behaviors across multiple years of adolescence, as well as examining between-person and between-group variation in these trajectories using growth modeling techniques.

In the past, many researchers were frustrated by a gap between substantive theory and readily available statistical theory and software. As these four articles illustrate, statistical tools now abound for answering important basic and applied developmental questions with multiwave longitudinal data. Readily accessible statistical tools can serve to advance developmental theory and expand success with interventions. We hope that this special issue offers some guidance and direction for ongoing efforts to understand the etiology and prevention of difficulties during childhood and adolescence.

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