

Supporting Documentation for

***Comparing Three Modern Approaches to Longitudinal Data Analysis:***

***An Examination of a Single Developmental Sample***

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***Chair:*** Patrick J. Curran

***Participants:*** Mark Appelbaum, Patrick J. Curran, John J. McArdle,

Stephen W. Raudenbush & Michael H. Seltzer

***Discussant:*** C. Hendricks Brown

Supporting documentation written by Patrick J. Curran

Supporting documentation and raw data available to download from

**<http://www.duke.edu/~curran/>**

## Introduction

The empirical study of human development is nearly synonymous with longitudinal data analysis. To study development, one must consider the study of change over time. Despite the critical role longitudinal data analysis plays in developmental research, how to best accomplish this task has been a long and sometimes hotly debated issue in the social sciences. In addition to the existence of many traditional data analytic techniques, the past decade has given rise to remarkable advances in the development of new and powerful methods for studying change over time. Such developments include latent variable growth modeling, hierarchical linear modeling, general mixture modeling, generalized estimating equations, and exploratory growth modeling. Although many of these more modern techniques are characterized by distinct dissimilarities relative to one another, there are also many important key commonalities that are shared among all of these techniques. The existence of both similar and dissimilar characteristics has resulted in a great deal of confusion among applied researchers with regard to which techniques best address various types of research questions given differing theoretical questions and methodological conditions. It is thus very important that a greater understanding be cultivated with regard to the role that these modern data analytic techniques can play in developmental research. The goal of this symposium is to highlight the converging and diverging characteristics of three important methods of modern longitudinal data analyses: latent growth modeling, hierarchical linear modeling, and exploratory data analysis. These three techniques will be applied to a single data set to examine the development of antisocial behavior and reading ability in children over an 8-year period, and both substantive and analytical questions will be explored.

The general organization of this document is as follows. First, because of the critical role that developmental theory plays in the selection and execution of appropriate data analytic

techniques, a brief introduction to the theoretical issues related to the shared data set will be presented. This is followed by a set of suggested substantive questions about the development of antisocial behavior over time that might be of interest to explore using your particular analytical technique. An additional set of suggested questions is then presented about the advantages and disadvantages of your analytic approach relative to the other two approaches presented by the other participants. Next, a methods section details information about the specifics of the sample, the selected measures, and the formatting of the enclosed raw data file and SAS code. Finally, three appendices present the full SAS code for inputting and outputting the raw data, the SAS log that results from running the SAS code, and the output from the SAS code that includes basic descriptive statistics on all of the variables of interest.

### The Development of Antisocial Behavior in Children

It has been well documented that the onset and escalation of delinquent and antisocial behavior during early childhood can place a child at increased risk for experiencing a variety of negative developmental outcomes such as academic problems, depression, hyperactivity, substance abuse, impairments in social functioning, psychiatric disorders, divorce, unemployment, and continued delinquent and criminal behavior throughout adolescence and into adulthood (Caspi, Bem, & Elder, 1989; Caspi, Elder & Bem, 1987; Graham & Rutter, 1973; Kazdin, 1987; Loeber and Dishion, 1983; Moffitt, 1993; Reid, 1993). Childhood deviance has been hypothesized to be a developmental process (Patterson, Reid, & Dishion, 1992, p. 21). Developmental trajectories for conduct problems are likely to be initiated early in childhood and, without intervention, become increasingly difficult to modify over time (Coie and Jacobs, 1993).

Because aggressive and antisocial behaviors become more and more difficult to modify as the child matures, it is important to attempt to intervene with high risk children early in the

developmental process (Conduct Problems Prevention Research Group (CPPRG), 1992; Reid, 1993; Kazdin, 1993). However, many previous attempts to prevent and treat childhood delinquency have met with failure (CPPRG, 1992; Kazdin, 1985, 1987, 1993). Several reasons have been hypothesized to account for these ineffective treatment programs including the failure to explicitly incorporate developmental theory in the design and implementation of the treatment programs, the focus on only a single component thought to be involved in the development of antisocial behavior, and a lack of attention paid to potentially important heterogeneity among high risk children (Cicchetti, 1984; CPPRG, 1992; Dodge, 1986, 1993). Thus, further work is needed to better understand specifically what role these various factors play in the onset, development and maintenance of antisocial behavior in children over time.

The development of antisocial behavior in children is thought to be related to a series of complex reciprocal relations between parents, children and teachers set within the contexts of the home, school and peer group (see, e.g., CPPRG, 1992; Patterson et al., 1992). For example, previous research has suggested that the parents' emotional support of the child and the provision of a home environment that is supportive of the child's cognitive stimulation might be key contributors to the child's lack of academic readiness upon entry to school (CPPRG, 1992). This lack of academic readiness at school entry, often combined with pre-existing inattentiveness, antisociality and hyperactivity, can impede the child's ability to learn at school (Moffitt, 1990; Moffitt & Silva, 1988).

As the child progresses through school, continued aggressive and antisocial behavior decreases the time children spend on school related tasks which further interferes with appropriate developmental learning processes (Patterson, 1982; Patterson et al., 1992; Wilson and Herrnstein, 1985). Because of this, conduct disordered children are more likely to display a number of

academic deficiencies, particularly in the development of age appropriate reading skills (Kazdin, 1993). Although both theory and empirical evidence suggest that, once started, earlier antisocial behavior is associated with later disruptions in academic achievement, it is not known whether there is a reciprocal relation such that earlier academic failure promotes further antisocial behavior (Patterson et al., 1992, p. 130). Regardless, such skills deficits and ongoing academic failure are likely to result in greater rejection of the antisocial child by peers, teachers, and even parents (Patterson et al., 1992). Accompanied with this social rejection is an increased alienation of the child from important positive socializing agents such as appropriate goal setting and development of healthy bonds between the family and the school, which in turn increases the likelihood that the child will affiliate with deviant peers (Patterson, 1986). Affiliation with deviant peers is a key launching pad into further behavioral problems when entering early adolescence that can continue well into adulthood (Elliott, Huizinga, and Ageton, 1985). A better understanding of both the early predictors of antisocial behavior and academic failure as well as the functional reciprocal relations between these constructs over time is critically needed to better inform future prevention and treatment programs.

The current study. Although a great deal of information has been accumulated about the predictors and correlates of antisocial behavior in childhood and beyond, much is left to be learned about the specific mechanisms that are involved in the development and maintenance of antisocial behavior over time. Further knowledge of these factors is critical to better inform the development and application of intervention and treatment programs targeted at antisocial behavior in children. It has been hypothesized that the child's initial entry into school may be an ideal time to attempt to intervene and potentially modify the developmental trajectories of antisocial behavior over time (Reid, 1993). Thus, the current study examines a sample of 405

children who are within the first two years of entry to elementary school. Further, it has been hypothesized that the degree to which a parent can provide emotional support and cognitive stimulation to the child at home may influence academic readiness upon entry to school (CPPRG, 1992). Thus, the current study examines measures of emotional support and cognitive stimulation provided to the child by the mother near the time of school entry. Finally, the development of academic deficiencies, especially reading skills, are thought to be involved with the development and maintenance of antisocial behavior in children over time (Kazdin, 1993). The current study thus examines four repeated measures of both the child's antisocial behavior and the child's reading recognition skills.

Data was collected using face-to-face interviews of both the child and the mother taken at two-year intervals between 1986 and 1992. The general substantive goal of this study is to try to better understand the relations between parental emotional and cognitive support, child antisocial behavior, and child reading recognition, and to attempt to draw conclusions that might inform developmental theory and to guide future treatment intervention research in this area. The general analytic goal of this study is to compare and contrast three modern approaches to longitudinal data analysis when applied to the same empirical data set. What follows are a set of suggested substantive questions followed by a set of suggested analytic questions relating to the three longitudinal approaches used here.

### Suggested Substantive Research Questions to be Examined

1. Is there evidence for systematic change and individual variability in change in antisocial behavior over the four time points?
2. Is there evidence for systematic change and individual variability in change in reading recognition over the four time points?
3. Is the child's gender, the child's age, or the mother's age related to the initial levels or rates of change in antisocial behavior or reading recognition?
4. Is emotional support and/or cognitive stimulation provided to the child related to the initial levels or rates of change in antisocial behavior and reading recognition. Might these relations vary as a function of gender?
5. Are rates of change in reading recognition related to rates of change in antisocial behavior?
6. Do earlier levels of reading recognition predict later rates of change in antisocial behavior?
7. Do earlier levels of antisocial behavior predict later rates of change in reading recognition?
8. Based on these observational data, what specific conclusions might be made to help inform the design and implementation of future prevention and intervention programs aimed at decreasing the likelihood that a child will develop antisocial behavior over time?

### Suggested Analytic Questions to be Examined

1. What are the strengths associated with your particular approach to the analysis of change over time?
2. What are the limitations associated with your particular approach to the analysis of change over time?
3. What characteristics of your technique are shared with the other two approaches being considered in this symposium?
4. What characteristics of your technique are unique in comparison to the other two approaches being considered in this symposium?
5. Under what general methodological or theoretical conditions might your approach be expected to perform well?
6. Under what general methodological or theoretical conditions might your approach encounter difficulties or limitations?
7. What specific conclusions and recommendations can you make to the applied developmental researcher about the potential application of your analytic approach to the study of change over time?

## Method

### Subjects

Subjects for the present study were drawn from the National Longitudinal Survey of Youth (NLSY) of Labor Market Experience in Youth, a study which was initiated in 1979 by the U.S. Department of Labor to examine the transition of young people into the labor force. The NLSY is a multistage, stratified, clustered probability sample of housing units drawn to be representative of the non-institutionalized U.S. population of young people aged 14 to 21 as of January 1, 1979, with supplemental samples of persons in the same age cohort who were serving in the military, Hispanic, Black, and economically disadvantaged non-Black, non-Hispanic youth. The original 1979 panel included a total of 12,686 respondents, 6283 of whom were women.

Beginning in 1986, an extensive set of assessment instruments was administered to the children of the 6283 female respondents of the original NLS Youth sample. A total of 4971 children were assessed in 1986, which represented approximately 95% of those children eligible for interview. These child assessments were again administered every other year following the 1986 interview: 6266 children interviewed in 1988, 5803 in 1990 and 6509 in 1992. The mothers of the children continued to participate in the NLS Youth annual interviews during this time. As of 1992, at least one interview was obtained on 9360 biological children of the original 6283 women first interviewed for the NLSY in 1979.

Although a very large number of children of the original NLS Youth mothers have been interviewed at least one time to date (N=9360 by 1992), a much smaller number of mother-child pairs were considered for the present study. Three key criteria were required for inclusion in the present sample. First, children must have been between the ages of 6 and 8 years at the first wave of measurement. This choice of age range insured that all children were eligible to be assessed on



the measures of interest to the present study. (For example, a large number of children from the total sample of N=9360 were not of reading age by the first wave of measurement, and reading skill is a key variable in the present study.) Second, children must have reported complete data on all measures of interest to the present study *at the first wave of measurement*. Subjects were included in the present sample if they were missing data on some or all measures *after* the first wave of measurement. Finally, only one biological child was considered from each mother. A large proportion of the N=9360 children interviewed by 1992 were siblings from the same family. Multiple siblings from the same family were not included here so as not to introduce a complex data structure (e.g., nested data) into the sample. Based upon these three criteria, a total sample of N=405 children were considered for the present analyses. All N=405 children and mothers were interviewed at Time 1, N=374 were interviewed at Time 2, N=297 were interviewed at Time 3, N=294 were interviewed at Time 4, and N=221 were interviewed at all four assessments. (Note that it was possible for a child to be missing at one time point but be present at a later time point.) Of the total sample of N=405, 49.9% were female, the average child age at Time 1 was 6.9 years (sd=.64), and the average mother's age at Time 1 was 25.5 years (sd=1.9).

### Procedure

Data for the NLSY Child survey were primarily collected using personal home interviews administered by trained interviewers. A small percentage of interviews were administered over the phone (e.g., 12.6% in 1990). The child interviews were typically administered simultaneously with the NLS Youth interviews. Most interviews could be completed on the same day, but additional days were scheduled if necessary. Each interview of the NLS youth lasted approximately one hour, and the mother's interview about the child was approximately 30 minutes more. The mother was paid \$10 for her participation in the NLSY interview, and she received an

additional \$5 in exchange for her involvement in the child interview. The mother would thus complete an assessment for her own NLSY interview, she would complete a second assessment for her interview about the child, and the interviewer would complete a third assessment directly with the child.

### Measures

Measures used in the present study were a subset drawn from the much larger complete battery of assessments administered to the NLSY mothers and children.

Antisocial behavior. Antisocial behavior was measured using the Behavior Problems Index (BPI) antisocial behavior subtest, one of six subtests of the BPI developed by Zill and Peterson (Baker, Keck, Mott, & Quinlan, 1993). The BPI consisted of both newly created items and adaptations of items drawn from the Achenbach Behavior Problems Checklist and other child behavior scales. The antisocial behavior subscale consisted of the mother's report on six items that assessed the child's antisocial behavior having occurred over the previous three month time period. The items measured the extent to which the child: *cheats or tells lies, bullies or is cruel or mean to others, does not seem to feel sorry after he/she misbehave, breaks things on purpose or deliberately destroys his/her own or another's things, is disobedient at school, and has trouble getting along with teachers.* The three possible response options were *not true* (scored=0), *sometimes true* (scored=1) or *often true* (scored=2). These six items were summed to compute an overall measure of antisocial behavior, and scores could range in value from zero to 12. Measures of antisocial behavior were computed within each of the four time periods. This variable is labeled ANTI $t$  in the enclosed SAS code (see Appendix A), where  $t$  ranges from 1 to 4 to denote the wave of measurement.

Reading recognition. The child's reading recognition skill was measured using the Peabody Individual Achievement Test (PIAT) Reading Recognition subtest, one of five subtests of the PIAT. The reading recognition subtest measures word recognition and pronunciation ability, components considered essential to reading achievement. Children would first read each word silently, then say it aloud. PIAT Reading Recognition consists of 84 items, each of which has four possible response options, one of which is the correct response. The items are of increasing difficulty ranging from preschool to high school level. Skills that are assessed include reading individual words out loud, matching specific letters and naming names. The reading recognition measure was computed by summing the total number of correct items for the 84-item subtest, and scores could range in value from zero to 84. The final reading recognition scores were divided by 10 to better equate these variances with the other variables under consideration for later analyses. Measures of reading recognition were computed within each of the four time periods. This variable is labeled  $READ_t$  in the enclosed SAS code (see Appendix A), where  $t$  ranges from 1 to 4 to denote the wave of measurement.

Emotional support. Emotional support provided to the child was assessed using the Home Observation for Measurement of the Environment-Short Form (HOME-SF). The HOME-SF is a modified version of the HOME Inventory (Baker et al., 1993) that provides a measure of the overall quality of the emotional support and cognitive stimulation provided to the child by the family. Emotional support was computed as a summation of 13 dichotomously scored items as reported by the mother and as observed by the interviewer. Scores could range in value from zero to 13. Sample items include *The mother encouraged the child to contribute to the conversation*, *The mother answered the child's questions or requests verbally*, and *The mother's voice conveyed positive feelings about the child*. The emotional support measure was computed

within just the first time period. This variable is labeled HOMEEMO in the enclosed SAS code (see Appendix A).

Cognitive stimulation. The degree of cognitive stimulation provided to the child at home was assessed using the cognitive stimulation subscale of the HOME-SF. Cognitive stimulation was computed as a summation of 14 dichotomously scored items as reported by the mother. Scores could range from zero to 14. Sample items include *Does your family get a daily newspaper?*, *Does your family encourage your child to start and keep doing hobbies?*, and *About how often did/do you read stories to your child?*. The cognitive stimulation measure was computed within just the first time period. This variable is labeled HOMECOG in the enclosed SAS code (see Appendix A).

Mother's age. Mother's age was measured in years at Time 1. This variable is labeled MOMAGE in the enclosed SAS code (see Appendix A).

Child's age. Child's age was measured in years at Time 1. This variable is labeled KIDAGE in the enclosed SAS code (see Appendix A).

Child's gender. Child's gender was dichotomously scored such that female was coded as zero and male was coded as one. This variable is labeled GEN in the enclosed SAS code (see Appendix A).

## Summary

To summarize, in order of appearance in the enclosed data file SRCDDATA.DAT (ASCII code, DOS format, 405 records, one record per case, 14 variables per record), the variable names, measured attributes, data formats and missing data codes are:

Variable Name	Measured Attribute	Format	Missing
<i>anti1:</i>	child's antisocial behavior at Time 1	(f8.2)	no missing data
<i>anti2:</i>	child's antisocial behavior at Time 2	(f8.2)	missing=999
<i>anti3:</i>	child's antisocial behavior at Time 3	(f8.2)	missing=999
<i>anti4:</i>	child's antisocial behavior at Time 4	(f8.2)	missing=999
<i>read1:</i>	child's reading recognition at Time 1	(f8.2)	no missing data
<i>read2:</i>	child's reading recognition at Time 2	(f8.2)	missing=999
<i>read3:</i>	child's reading recognition at Time 3	(f8.2)	missing=999
<i>read4:</i>	child's reading recognition at Time 4	(f8.2)	missing=999
<i>gen:</i>	child's gender: female=0, male=1 (f8.2)		no missing data
<i>momage:</i>	mother's age in years at Time 1	(f8.2)	no missing data
<i>kidage:</i>	child's age in years at Time 1	(f8.2)	no missing data
<i>homecog:</i>	child's cognitive stimulation at home	(f8.2)	no missing data
<i>homeemo:</i>	child's emotional support at home	(f8.2)	no missing data
<i>id:</i>	unique four-digit ID for every subject	(f6.0)	no missing data

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## **Appendix A**

SAS code for inputting, analyzing, and outputting raw data.

This SAS code is stored in ASCII format on the DOS 3.5" disk  
in file SRCDCODE.SAS and reads in the raw data file SRCDDATA.DAT



## **Appendix B**

SAS Log resulting from running SRCDCODE.SAS

with data set SRCDDATA.DAT

## **Appendix C**

SAS output resulting from running SRCDCODE.SAS

with data set SRCDDATA.DAT.

Produces descriptive analyses on N=221 (complete data) and N=405 (partially missing data) samples and reads out raw data in various forms for input in other software packages.