THE DYNAMICS OF DELINQUENT PEERS AND DELINQUENT BEHAVIOR*

ROSS L. MATSUEDA

KATHLEEN ANDERSON
University of Iowa

This analysis examines the dynamic reciprocal relationship between delinquent peer associations and delinquent behavior. It tests the hypothesis, derived from learning and interactional theories, that delinquent peers and delinquent behavior are reciprocally related—delinquent peer associations foster future delinquency, and delinquency increases the likelihood of associating with delinquent peers. It also tests the competing hypothesis, derived from control theories, that delinquent peers do not cause delinquency, but instead, the relationship is (1) spurious due to individual criminal propensity, (2) a result of the effects of delinquent behavior on future associations with delinquent peers, or (3) an artifact of problems of measuring delinquent peers. To test these propositions, we use data from the National Youth Survey and estimate a cross-lagged panel model that corrects for measurement error in indicators of delinquent peers and delinquent behavior. The model specifies a covariance structure model for ordinal measures. Parameters are estimated by (1) estimating a threshold model relating ordinal measures to continuous latent variables; (2) estimating a matrix of polychoric correlations relating observed variables, and (3) using an asymptotic distribution-free estimator to estimate structural parameters. The results suggest that delinquent peer associations and delinquent behavior are reciprocally related, but the effect of delinquency on peer associations is larger than that of peer associations on delinquency.

One of the strongest and most consistent findings in criminology is that delinquent behavior is correlated with delinquency of one's peers. Decades of research have found that youths who have more delinquent friends are themselves more likely to be delinquent. As early as 1950, the Gluecks found that 98% of 500 delinquents had delinquent friends, whereas only 8% of 500 nondelinquents had delinquent friends (Glueck and Glueck, 1950). Shortly thereafter, several researchers, seeking to test differential association theory, found a strong correlation between reports of association with delinquents and self-reports of delinquent behavior (Short, 1957, 1958; Voss, 1964). These findings have been replicated in more-recent research using better measures and broader samples (Akers et al., 1979; Elliott et al., 1985; Gold, 1970; Hindelang, 1973; Hirschi, 1969; Krohn et al., 1996; Warr 1993a, 1993b; Warr and Stafford, 1991). Related research has found that delinquent acts occur largely in groups of two or more peers (Erickson and Jensen, 1997; Gold, 1970; Shaw and McKay, 1969; Warr, 1996).

These results have been so well-established that delinquent peer associations continue to be placed at the core of many causal explanations of criminal behavior. Theories such as differential association, cultural transmission, social learning, and group process differ not in *whether* delinquent peers cause delinquency, but rather in *how* delinquent peers cause delinquency. In contrast, theories from a control or individual-propensity perspective maintain that the correlation between delinquent peers and delinquency does not reflect a causal relationship, but rather reflects the effect of delinquent behavior on delinquent peers, a spurious relationship resulting from some omitted set of causal variables, or a measurement artifact in the way that delinquent peers are measured. Unfortunately, nearly all previous research has relied on cross-sectional research designs, which are unable to distinguish between the spurious versus causal hypotheses, and on analytic methods that cannot rule out measurement artifacts.

This analysis examines the relationship between delinquent peers and delinquent behavior using a methodological strategy that can address these hypotheses. Using a cross-lagged panel design, it tests the hypothesis that delinquency is caused by delinquent peers, as well as the hypothesis that associations with delinquent peers are caused by prior delinquent behavior. Using a covariance structure model of correlated response errors in measures of delinquent peers and delinquent behavior, it tests and statistically controls for the hypothesis that the correlation is due to a measurement artifact.

RELATIONSHIP OF DELINQUENT PEERS AND DELINQUENT BEHAVIOR: IMPLICATIONS · FOR CRIMINOLOGICAL THEORY

Generally speaking, criminological theories have taken three views on the relationship between delinquent peer association and delinquent behavior. Control and propensity theories have claimed that delinquent peers do not cause delinquency and have explained the relationship in terms of spuriousness, social selection, and response effects in measurement. Learning and group process theories have emphasized the causal efficacy of delinquent peers in transmitting delinquency to members, while also allowing for social selection. Finally, integrated theories have explicitly emphasized both social selection and causality hypotheses that unfold in a developmental process.

CONTROL THEORIES: DELINQUENT PEER ASSOCIATION IS SPURIOUSLY ASSOCIATED WITH DELINQUENCY

Control and propensity theories argue that delinquent peers do not cause delinquent behavior. Here, the correlation between delinquent peers and delinquent behavior is said to be spurious, due to social selection (reverse causality), individual heterogeneity (attributes of individuals that select for both peers and behavior), or measurement error in reports of delinquent peers and delinquent behavior. This was first stated by Sheldon and Eleanor Glueck (1950, 1952), who argued that gang members were largely maladjusted and delinquent before selecting into gangs, and therefore, social selection of delinquent peer groups was a "more fundamental fact in any analysis of the causes of juvenile crime" than differential association (1952:88–89). They concluded that "birds of a feather flock together" (Glueck and Glueck, 1950).

Robins (1974) argued that if the correlation reflects a causal relation rather than a social selection effect, one should find high correlations between delinquency of siblings as well. Her reasoning is that a youth cannot select his or her siblings, so that the correlation of delinquency between siblings reflects a causal effect, rather than a social selection effect (see also Lauritsen, 1993). She finds that the correlation between delinquency of siblings is substantially smaller than the correlation between delinquency of peers and, therefore, concludes that the latter correlation is largely a result of social selection (see also Sampson and Laub, 1993). This assumes, however, that siblings and peers have the same influence on each other. Research finds that peers spend much more time with each other and develop much more influential relationships. Therefore, if the causal interpretation is correct, one still would not expect siblings to resemble each other as closely in delinquency. Consistent with this are the

findings of Rowe and Gulley (1992) that the warmth of the relationship among siblings and mutual friends conditions behavioral resemblance among siblings in substance use and delinquency and those of Rodgers and Rowe (1990) that the behavior of siblings and best friends is more predictive than that of "other" friends.

In his empirical examination of control theory, Hirschi (1969) found a strong correlation between number of friends picked up by the police and self-reported delinquent behavior. He attempted to account for this relationship in two ways. First, he hypothesized that it could result from a selection effect, following the Gluecks' (1950) proverb, "birds of a feather flock together." Delinquents engage in delinquent behavior and then seek out companions who have also engaged in delinquency.[1] As Hirschi and Selvin (1967) pointed out, a proper test of this hypothesis requires longitudinal or panel data (see also Liska, 1969). Second, Hirschi suggested that the correlation could be spurious, a result of a third causal variable that determines both delinquent behavior and delinquent peer associations.[2] For Hirschi (1969), the relevant variable is social control theory's well-known concept of weak bonds to conventional society. This concept consists of attachments to others, commitments to conventional lines of action, involvement in conventional activities, and belief in morality. For control theory, delinquency is not learned from significant others, but rather the motivation or propensity for deviance exists in equal amounts for each member of society. Strong bonds to conventional society dissuade individuals from acting on their natural deviant dispositions, and also dissuades them from associating with delinquent companions (see also Kornhauser, 1978). In his empirical analyses, however, Hirschi statistically controlled for various measures of social bonding, and found that the effect of delinquent peers was reduced, but still remained substantial.

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1. To justify this selection effect from the standpoint of control theories, Hirschi (1969:137) cites Briar and Piliavin (1965:40), who argue that high-stakes boys avoid low-stakes boys to stay away from "trouble" and low-stakes boys avoid high-stakes boys because they avoid those who are "chicken." Briar and Piliavin (1965) further argue that low-stakes boys motivate each other to delinquency by presenting "situationally induced motives." Hirschi (1969) further argues that, on average, low-stakes boys are less able to form close stable relationships and, consequently, will be less attached and more free to deviate.

2. Actually, as Hirschi and Selvin (1967) point out, the spuriousness argument may have been suggested by the Gluecks (1950). However, Hirschi and Selvin (1967:70) also conclude that, "given the magnitude of the relations between delinquency and delinquent companions in the Gluecks' study, however, it is unlikely that they could show this relation to be spurious." This conclusion was shown to be true by subsequent research (e.g., Hirschi, 1969), which suggests that spuriousness alone cannot rule out causality. Something else is needed.

Hirschi (1969:230) concluded that his social control theory "underestimated the importance of delinquent friends" (see also Matsueda, 1982; Matsueda and Heimer, 1987; Warr, 1996).

Gottfredson and Hirschi's (1990) more-recent version of control theory, emphasizing the stable individual trait of low self-control, provides another interpretation of the causal structure underlying delinquent peers and delinquent behavior. Seeking to explain the stability of delinquency over time and the lack of specialization in offenses, Gottfredson and Hirschi (1990) conclude that delinquency is the result of low self-control. This stable individual trait can be characterized by the characteristics of crime: impulsive, risk-seeking, unskilled, immediately gratifying, absence of planning, no regard for the pain of others, and meager long-term rewards. Low self-control explains all acts of crime—self-interested acts of force or fraud—as well as other acts that resemble crime, such as illicit sex, smoking, drinking, unwanted pregnancy, and divorce. Moreover, low self-control originates in early socialization when parents fail to punish undesirable, impulsive, self-interested behaviors. Thus, neglecting, uncaring, unattached parents who fail to notice such behaviors, or fail to punish them if detected, will fail to socialize their child to delay gratification, consider the pain of others, and maintain control over their impulses and emotions—in short to exercise high self-control.

Armed with this theoretical explanation, Gottfredson and Hirschi (1987, 1990) posit three possible explanations for the correlation between delinquent peers and delinquent behavior. The first two were noted above: the birds of a feather hypothesis and the spuriousness hypothesis, in which the relevant antecedent causal variable is low self-control. Combined, these hypotheses imply that "people acquire the propensity to delinquency, find delinquent friends, and then commit delinquent acts, including 'serious criminal' acts" (Gottfredson and Hirschi, 1987:597). A third explanation argues that the correlation between delinquency and delinquent peers is a methodological artifact of invalidity in the self-report measure of delinquent peers. Focusing on Elliott et al.'s (1985) analysis of the National Youth Survey (NYS), Gottfredson and Hirschi (1987) argue that the finding that delinquent peer bonding strongly predicts delinquency is an artifact of measurement. They note that the measure of delinquent peer bonding asks respondents how often their friends have committed various delinquent acts, while the dependent variable asks them how often they themselves have committed the identical acts. The causal relationship between the two variables may be suspect because of a response effect. When the respondent is asked how many delinquent acts his or her friends have committed, he or she may be giving reports of his or her own delinquency, rather than that of his or her friends. According to Gottfredson

and Hirschi (1990:157; see also Gottfredson and Hirschi 1987:598), this response effect could take one of several forms:

> (1) the respondent may have been at the scene, himself engaging in the activity; (2) the respondent may impute his own qualities to his friends; (3) the respondent may impute friendship to people like himself; (4) the respondent's friends may have told him about delinquencies he did not himself witness; or (5) the respondent may have heard about his friend's delinquencies from people who witnessed or heard about them.

Recently Warr (1993a:37) has argued that these claims are unlikely to be valid for the NYS data. He presents four points. First, the accuracy of respondents' reports of peer delinquency might actually be increased rather than decreased by witnesses or participants to a delinquent episode. Second, respondents should not feel the need to impute their own behavior to their peers, particularly given that self-reports occur much later in the interview than reports on peers. Third, respondents are unlikely to give "frivolous or cavalier responses" to questions about their closest friends, whom they have identified by name. Fourth, reports about peers should be as reliable as reports about teachers and parents, which are routinely used to assess control theories. Warr's points are well-taken, although whether there are response effects or not is ultimately an empirical question.

Gottfredson and Hirschi's claims about response effects have empirical implications for a structural model of delinquent peers and delinquent behavior. Each implies that respondents' reports of delinquency of peers may be contaminated by random or systematic measurement errors. The last two claims—that respondents learn of peer delinquency from friends, witnesses, or hearsay—implies random measurement error in respondents' reports of peer delinquency, since this information is unlikely to be perfectly reliable.[3]

Gottfredson and Hirschi's first three claims suggest that respondents' reports of peer delinquency reflect not only the true delinquency of their true peers, but also may be contaminated by the respondents' true (or self-perceived) delinquent behavior. The first claim, that measures of delinquent peers may in part reflect coparticipation in delinquency, could reflect two distinct processes. It could reflect group processes, in which peers within a situation induce each other to commit group forms of delinquency (Briar and Piliavin, 1965; Short and Strodtbeck, 1965; Warr, 1996). This is a causal effect of delinquent peers on delinquency. Conversely, it

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3. Although such response errors could be nonrandom if the information on friends' delinquency were systematically distributed according to other variables in the model, such effects are likely to be trivially small.

could reflect a spurious relationship, in which respondents' delinquency is caused solely by low self-control, peers' delinquency is caused solely by low self-control, and peer homophily is based on low self-control. This implies that, controlling for low self-control of respondent and peers, the correlation between respondents' delinquency and peers' delinquency is zero. For Gottfredson and Hirschi (1990), the best measure of low self-control is prior delinquency; therefore, the spuriousness hypothesis reduces to Figure 1.

Figure 1. Coparticipation in Delinquency Causing Spuriousness in Association Between Delinquent Peers and Delinquency
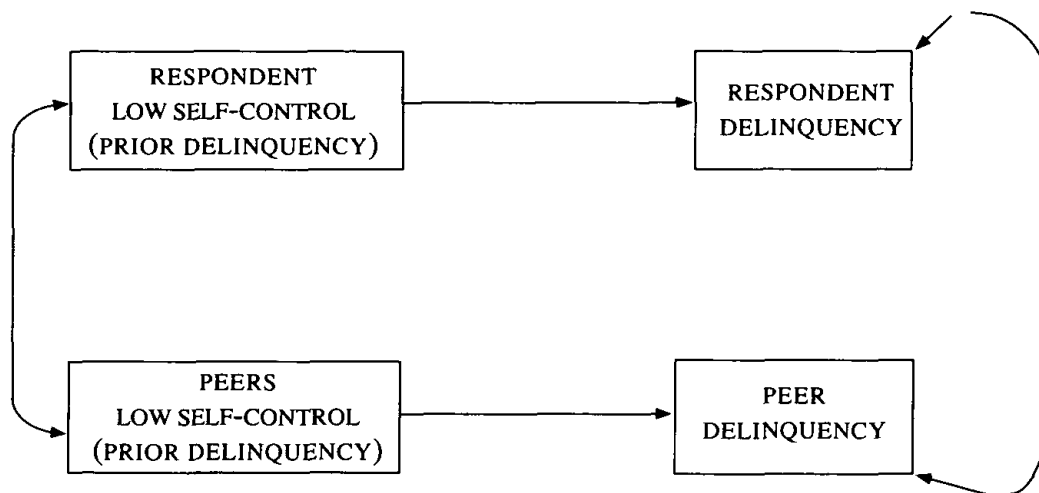
The second and third claims—that respondents impute their own qualities to friends or impute friendships to people like themselves—implies response errors that are correlated with the qualities (delinquency) of the respondent. Here, there are two empirical possibilities. The respondents' reports of peer delinquency could be a reflection of respondents' *perceived* delinquency, as revealed in their self-reports. This contamination would imply a correlation between measurement errors of self-reported delinquency and reports of friends' delinquency (see Figure 2). Alternatively, the respondents' reports of peer delinquency could be a reflection of respondents' *true* delinquency, as revealed (approximately) in self-reports purged of measurement errors. This contamination would imply a correlation between the *latent* variable underlying respondents' self-reported delinquent behavior and the *manifest* variable of respondents' reports of peer delinquency (Figure 3). In our structural models, we attempt to examine and control for these measurement artifacts.

Figure 2. Correlations Between Measurement Errors of
Self-Reported Delinquency and Reported
Delinquency of Peers
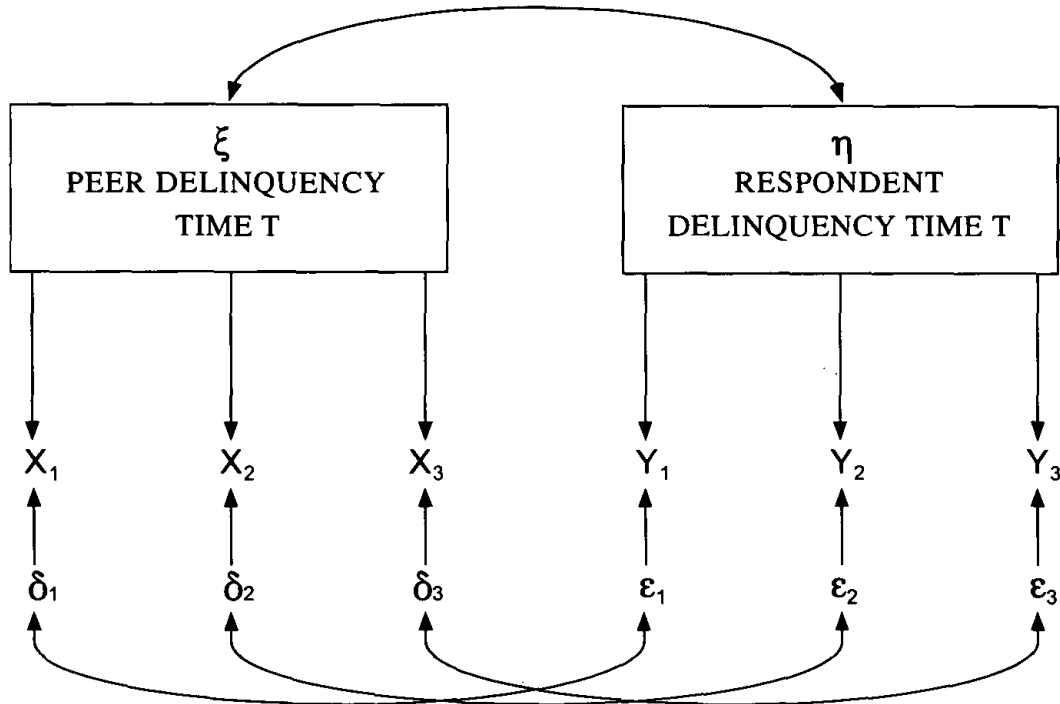
LEARNING THEORIES: DELINQUENT PEER ASSOCIATION INCREASES DELINQUENT BEHAVIOR

In contrast to control and propensity theories, learning and group process theories argue that association with delinquent peers is causally related to delinquent behavior. If this hypothesis were found to be false, the theories themselves would be drawn into question. While these theories all presume that delinquent peer association is causally related to delinquency, they differ on the specific mechanism explaining this relation. For example, the theory most often identified with peer effects—Sutherland's (1947) differential association theory—posits that delinquency results from learning an excess of definitions favorable to crime over ones unfavorable to crime, which is likely to occur in association with delinquent groups and isolation from conventional groups. On this issue, most research finds that delinquent peers operate directly on delinquency and indirectly through definitions of delinquency (Matsueda and Heimer, 1987; Warr and Stafford, 1991; but see also Matsueda, 1982).

Similarily, Akers' extension of differential association—social learning

Figure 3. Model of Differential Bias: Direct Effects of
Latent Delinquency Construct on Indicators of
Peer Delinquency
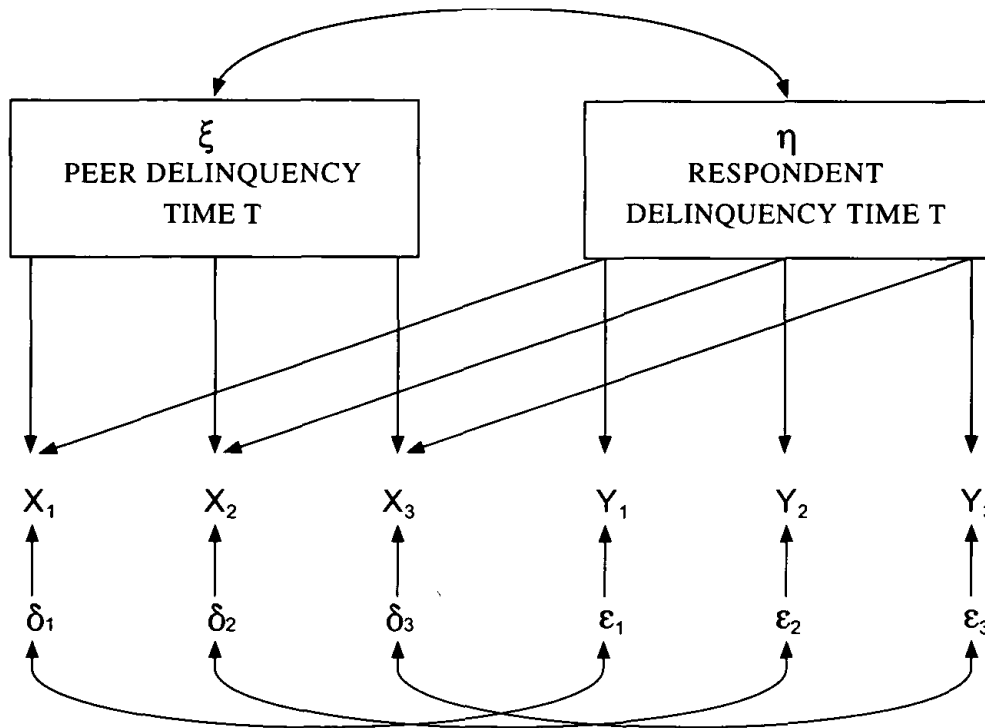
theory—argues that delinquent peers influence delinquency through differential reinforcement (the relative frequency and magnitude of rewards and punishments that follow delinquent and nondelinquent behavior) as well as observational learning or modeling though vicarious reinforcement (reinforcement of behavior resulting from observing another's behavior being reinforced). Because peer groups hold the most important reinforcers for adolescents, they will have important effects on behavior. Moreover, delinquent peers are more likely than conforming peers to be role models for delinquency, to reward to delinquency, and to punish conformity. Therefore, association with delinquent peers should increase the likelihood of delinquent behavior, both directly through modeling and indirectly by reinforcing delinquency (Akers et al., 1979).

Shaw and McKay's (1969) theory of social disorganization and cultural transmission argues that delinquency rates in inner-city neighborhoods remain high over time, despite a complete turnover of the ethic composition of the area. This is because the disorganized communities have weak institutional controls, which leads to unsupervised adolescent groups that

transmit delinquent traditions to younger peers through a process of cultural transmission. Similarily, group process theories argue that delinquent peers can have direct effects on delinquent behavior by providing situationally induced motives, pressures, and value-added collective acts (Briar and Piliavin, 1965; Short and Strodtbeck, 1965). Finally, symbolic interactionist theories, such as differential social control, argue that delinquent peers can have direct and indirect effects on delinquent behavior (Heimer and Matsueda, 1994; Matsueda, 1992). Indirectly, delinquent peers affect delinquency by influencing the self as a (delinquent) object from the standpoint of others, delinquent attitudes, and anticipated reactions to delinquency. Directly, delinquent peers affect delinquency by providing delinquent solutions to problematic situations.

The important point is that, regardless of intervening causal mechanism, each of these theories posits a *total effect* of delinquent peers on delinquency. If such an effect were not found, the theories would have to be radically altered or wholly rejected. A hypothesis of social selection is also consistent with these theories: Adolescents will change their peer group affiliations to be consistent with their behavior. Those who engage in delinquency are likely to be attracted to delinquent groups in which their behavior will be rewarded, approved, and defined positively. Conversely, those who refrain from delinquency are more likely to seek out conforming groups, which will share their disdain for delinquent behavior. Sutherland (1947:146) discussed social selection into gangs: "It is not possible to determine the extent to which the gang produces criminality. Many gangs are merely organizations of persons, who are, as separate persons, criminalistically inclined" (see Matsueda, 1997). Akers (1994:99–100) also noted the possibility of reciprocal effects in social learning theory, but argues that causation will occur more frequently than selection.

Combining the causality hypothesis (delinquent peers increase the likelihood of delinquency) with the social selection hypothesis (delinquency increases the likelihood of associating with delinquent peers), learning theories imply that delinquent peer associations and delinquent behavior should be reciprocally related in a dynamic process: Delinquent peer associations increase the likelihood of future delinquency, which in turn, increases the likelihood of future associations with delinquent peers. Moreover, this process does not occur in a vacuum, but rather is structured by larger social organization. Thus, one's location in the broader social structure should affect the likelihood of coming into contact with delinquent peers and engaging in delinquent behavior (e.g., Akers, 1985, 1994; Heimer and Matsueda, 1994; Matsueda, 1988).

INTERACTIONAL THEORIES: RECIPROCAL EFFECTS BETWEEN DELINQUENT PEERS AND DELINQUENCY

Thornberry (1987) specified an integrated theory of delinquency—"interactional theory"— that combined the causality hypothesis with the social selection hypothesis. Thus, unlike other theories that integrate concepts from control and learning theories (e.g., Elliott et al., 1979, 1985; Johnson, 1979), interactional theory explicitly emphasizes reciprocal effects between explanatory concepts. Thornberry (1987) argued that attachments to parents, conventional beliefs, commitment to school, delinquent peers, delinquent values, and delinquent behavior were all reciprocally related. Moreover, he suggested that delinquent peers and delinquent behavior were strongly related throughout adolescence, but that the relationships between other concepts and delinquent peers and behavior varied across adolescence due to developmental processes. Delinquency and delinquent peers are driven by attachment to parents and school commitment in early adolescence, by delinquent values and school commitment in middle adolescence, and by delinquent values and other conventional commitments (marriage, military, college, and employment) in later adolescence. With respect to the relationship between delinquent peers and delinquent behavior, however, Thornberry specified strong direct reciprocal effects of approximately equal magnitude throughout adolescence.[4] This implies that the effects of attachment, commitment, and values vary across adolescence, but the reciprocal effects between delinquency and delinquent peers remain relatively invariant. In their empirical test of peers' drug use, respondents' beliefs, and respondents' drug use, Krohn et al. (1996) found that peer drug use and respondent drug use were reciprocally related, the effect of respondent drug use on peer drug use was stronger than peer drug use on respondent drug use, and the effects stayed relatively stable over time. They also found that the effect of peer drug use on respondents' beliefs increased across five waves of data.

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4. Thornberry (1987) does, however, specify age-varying effects of other variables on delinquency and delinquent peers, which could result in differences in total reciprocal effects between delinquency and delinquent peers. However, close inspection of these values (specified as strong, weak, or absent) reveals that the number of strong effects by other variables on delinquency and delinquent peers remains about the same. What varies is the specific variables exerting this effect (e.g., attachment in early adolescence, delinquent values in later adolescence). Algebraically, using algorithms of path analysis, this implies that the total reciprocal effects between delinquent peers and delinquency remain relatively similar across adolescence.

A STRUCTURAL MODEL OF DELINQUENT PEER ASSOCIATIONS AND DELINQUENCY

An empirical test of the propositions outlined above requires longitudinal data to examine the dynamic reciprocal relationship between delinquent peer associations and delinquent behavior. Most previous research has relied on cross-sectional designs and has found that delinquent peer associations have substantial and significant effects on delinquency (Akers et al., 1979; Elliott and Voss, 1974; Hirschi, 1969; Johnson et al., 1987; Matsueda, 1982; Matsueda and Heimer, 1987; Short, 1957). These studies cannot rule out the opposite causal ordering, because both delinquency and delinquent peers refer to previous behavior, nor can they rule out Gottfredson and Hirschi's (1987) hypothesis that the correlation reflects a measurement artifact.

Elliott et al.'s (1985) analysis of longitudinal data from the National Youth Survey, which found that bonding to delinquent peers increased delinquency, also cannot rule out the opposite causal ordering, since delinquency and delinquent peers were measured at the same time period (Gottfredson and Hirschi, 1987; Hirschi, 1987). The same can be said for three other longitudinal studies, which found substantial contemporaneous effects of delinquent peers on delinquency (Burkett and Warren, 1987; Meier et al., 1984; Menard and Huizinga, 1994).

Recent research has used longitudinal data to examine the effects of delinquent peers. Elliott and Menard (1992) reanalyzed the NYS data to identify the temporal and developmental patterns of delinquent friends and delinquency. They grouped the members of their sample into categories of delinquent behavior and delinquent friends, and then examined transition matrices of change among the categories. Overall, they found that the onset of delinquent behavior tended to follow rather than precede onset of delinquent peer association, which supports the explanation of learning theory over that of control theory. In examining shifts after onset, learning and control perspectives were supported: A reciprocal effect resulted in which changes in delinquency preceded changes in delinquent peers, as well as vice versa. Elliott and Menard's (1992) findings about the temporal ordering are important: Causality could run in either or both directions. Their results, however, do not establish whether delinquency causes delinquent peers or vice versa, or whether the relationship is spurious due to some omitted explanatory variable.

Other studies have used panel models to examine the causality issue. Kandel (1978) used longitudinal data on adolescent friendship pairs and found that processes of both socialization and selection accounted for similarity in marijuana use and that both processes were of equal importance (also see Kandel, 1996, for a discussion of the impact on confounding

socialization and selection effects in a consideration of peer influence). In a series of papers, Warr has reanalyzed the NYS data using regression models for panel data. He finds that delinquent peers exert a large effect on delinquency, even net of attitudes about delinquency (Warr and Stafford, 1991), delinquent peers mediate most of the effect of age on crime (Warr, 1993a), and delinquent peers mediate the effects of parental attachments on crime (Warr, 1993b). Thornberry et al. (1994) used data from the Rochester Youth Development Study and structural equation modeling and found a reciprocal effect wherein associating with delinquent peers increases the likelihood of delinquency and engaging in delinquent behavior increases the likelihood of associating with delinquent peers. They concluded that interactional theory was supported. Similarly, Krohn et al. (1996) examined drug use and also found reciprocal effects: the effect of respondent's drug use on drug-using peers was slightly stronger than the effect of drug-using peers on respondent's drug use. Simons et al. (1994) examined the relationship between inept parenting, delinquent peer association, and delinquency and concluded that for "late starters" the peer influence perspective is supported. For "early starters" the control perspective is supported; inept parenting accounts for both association with delinquent peers and delinquency. Paternoster and Brame (1997), however, used a negative binomial random effects model that controlled for unobserved heterogeneity; they found no evidence that delinquent peers and prior delinquency exert different effects for early starters compared to late starters.

These studies shed important light on the causality issue. Nevertheless, the results of these studies could be misleading if recent claims are true and the relationship between delinquent peers and delinquency is not causal, in part because of spuriousness, social selection, and measurement artifacts. Our analysis takes a different approach to the problem, attempting to test more explicitly the recent claims of control theorists versus learning and interactional theorists. Using covariance structure analysis to analyze a three-wave panel model, we specify a conventional cross-lagged panel model of the reciprocal relationship between delinquent peer association and delinquent behavior over time.

Our structural model is diagramed in Figures 4 and 5. The model contains four features. First, it includes a measurement model of the relationships among observed indicators and latent constructs representing delinquency and delinquent peers. Given that survey measures of both constructs are likely to be plagued with measurement errors, the model attempts to correct for such errors by specifying that each indicator of delinquency (delinquent peers) at time t is a function of the construct of delinquency (delinquent peers) at time t plus a random measurement error. Measurement errors for each specific measure of delinquent peer

Figure 4. Path Model of a Reciprocal Causal Relationship
          of Property Delinquent Peers and Property
          Delinquency
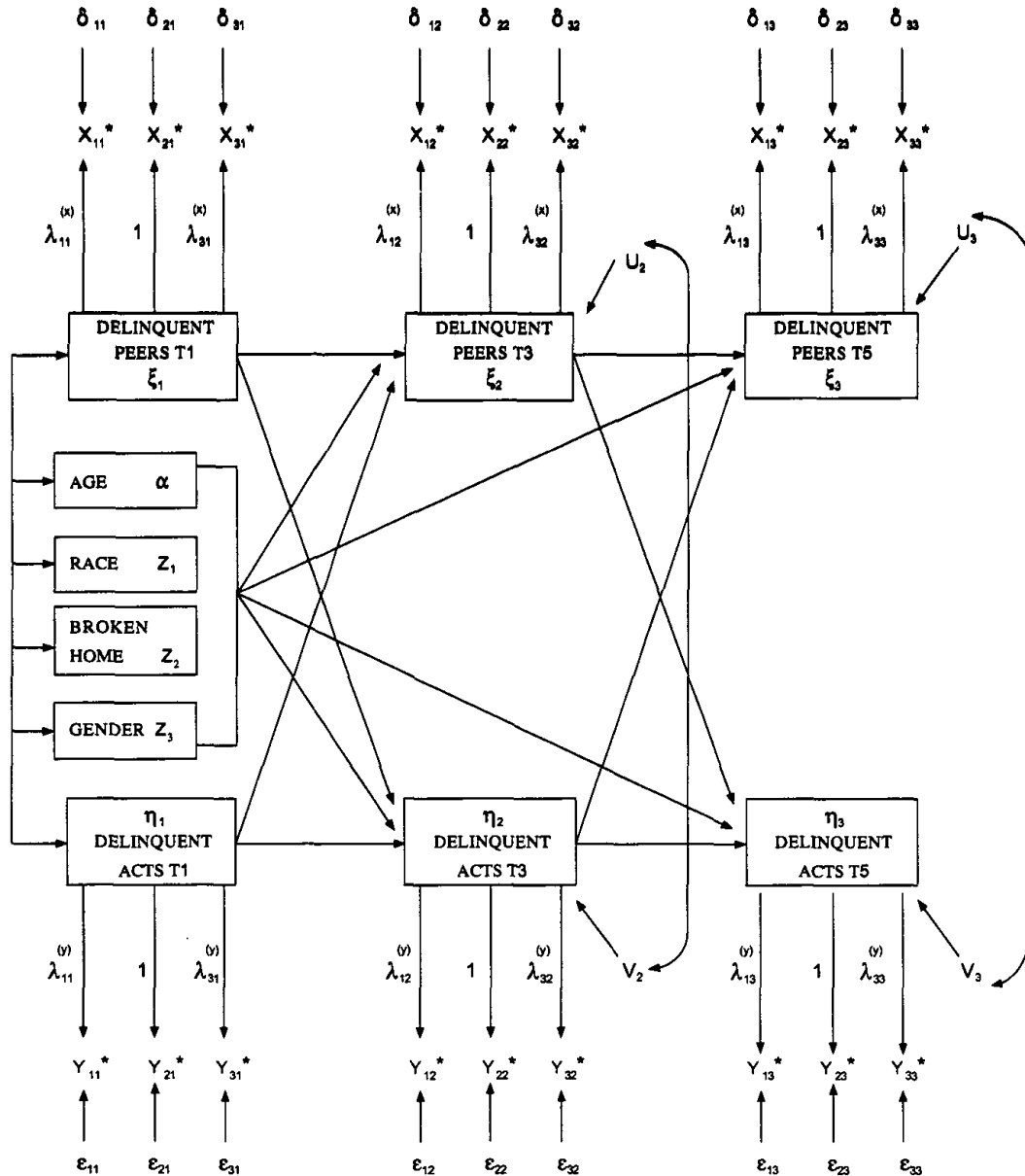
association are allowed to be contemporaneously correlated with the cor-
responding measure of delinquent behavior. Response errors for an indi-
cator at time t are allowed to be autocorrelated with errors at time $t + 1$,
since random errors are likely to be similar over time (Figure 5). Thus, the
model allows us to test Gottfredson and Hirschi's (1987, 1990) hypothesis

that indicators of delinquent friends contain substantial errors of measurement, as well as their (1987) hypothesis that response errors of indicators of delinquent peers correlate with those of delinquent behavior.

Figure 5. Measurement Model of Property Delinquent Peers and Property Delinquency
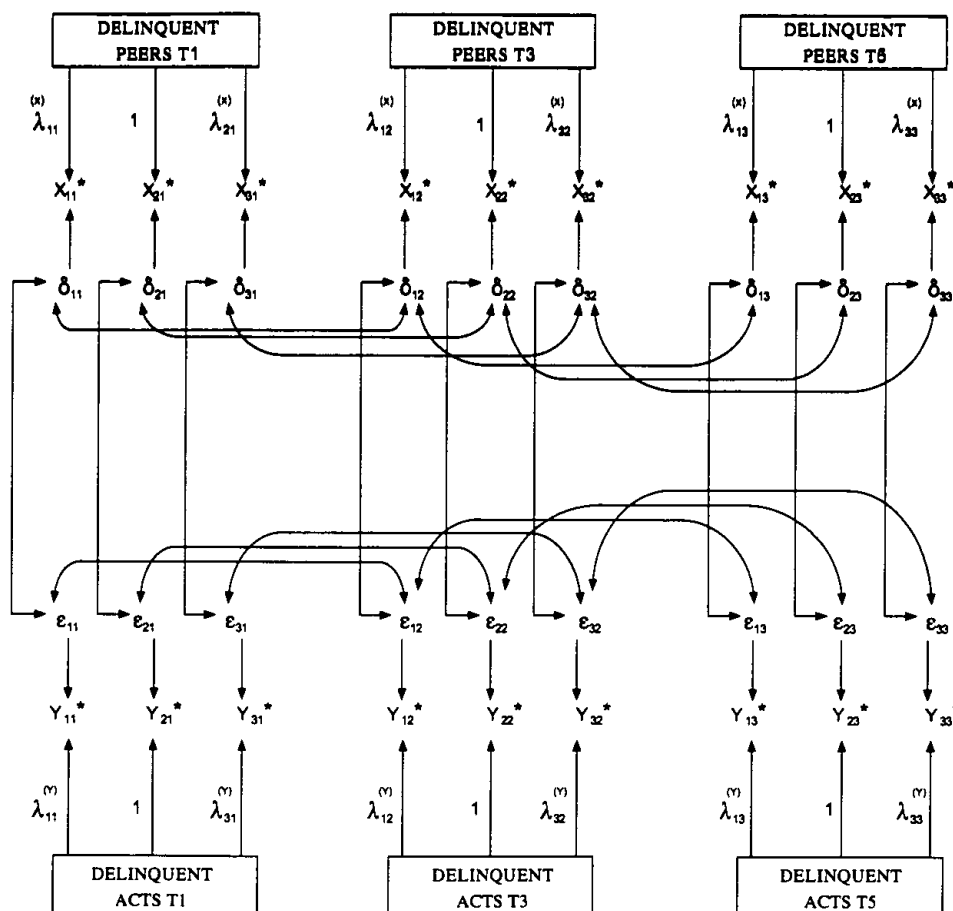
Hypothesis 1: Reports of delinquency of one's friends reflect either random measurement error or nonrandom measurement error in which errors in reports of peer delinquency are contaminated by respondent's delinquency.

Second, the model specifies first-order cross-lagged effects between delinquent peers and delinquent behavior, thereby positing a causal order between the two variables that is consistent with the timing of their measurement.[5] This allows us to test the causal hypothesis:

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5. We are constraining the second-and higher-order lagged effects to be zero because the effects are difficult, if not impossible, to justify substantively. We are also leaving the contemporaneous covariance between delinquent peers and delinquent

Hypothesis 2: Delinquent peer association increases the likelihood of future delinquent behavior.

It also allows us to test the social selection hypothesis, in which prior delinquency leads to selection into delinquent peer groups. This is consistent with Akers' (1985:60, 115–116) discussion of feedback effects, Thornberry's (1987) discussion of reciprocal effects, and Gottfredson and Hirschi's (1990) discussion of selection due to low self-control. Here, we are following Gottfredson and Hirschi (1990) in operationalizing low self-control using prior delinquent behavior. Although this operationalization leaves the theory vulnerable to charges of tautology (see Akers, 1991), it provides a strong test of the low self-control specification of social selection and spuriousness.[6]

Hypothesis 3: Delinquent behavior increases the likelihood of future delinquent peer associations.

We can test the hypothesis that the two effects are equal (as suggest by Thornberry, 1987), versus the competing hypotheses that delinquent peers have larger effects on delinquent behavior (as suggested by Akers, 1994), and vice versa.

Hypothesis 4: The reciprocal effects between delinquent peer association and delinquent behavior are equal.

Third, the model includes a vector of background variables capturing

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behavior unanalyzed by specifying the disturbances to be correlated. Some research parameterizes the contemporaneous relationship as a simultaneous causal relationship. We are not pursuing this strategy, for three reasons. First, the lack of clarity between *contemporaneous* measures of delinquency and delinquent peers makes attempts to disentangle simultaneous relationships ambiguous (effects could be due to measurement artifacts and not causal effects). Second, such models are difficult to identify in the population; they require very strong assumptions about identifying restrictions when only weak assumptions are warranted. Third, given the data typically collected, such models are even more difficult to identify empirically, which results in imprecise parameter estimates and ambiguous conclusions (see Bielby and Matsueda, 1991). Given these difficulties, the problem of disentangling simultaneous contemporaneous effects between delinquent peers and delinquent behavior is virtually intractable.

6. Some recent studies have used psychological measures of impulsivity, risk taking, self-centeredness, and temperament to operationalize low self-control (see Arneklev et al., 1993; Polakowski, 1994). Gottfredson and Hirschi (1990), however, have maintained that the best measure of low self-control is prior delinquent behavior. Because prior delinquency is likely to have stronger effects on delinquency than psychological measures of low self-control, we provide a strong test of Gottfredson and Hirschi's specification. Nevertheless, there remains the possibility that the stability in self-reported delinquency could be overestimated due to memory or other response effects we cannot fully control. Paternoster and Brame (1997) used both behavioral and attitudinal measures of low self-control and found that results were not affected by the choice of either behavioral or attitudinal measures.

exogenous characteristics of individuals that may, in part, account for individual differences in criminal propensity. These include background variables commonly found to affect delinquency: age, race, gender, and broken homes. To control for individual heterogeneity (individual characteristics that may affect both commission of delinquent acts and selection of delinquent peers) and test for the hypothesis of spuriousness, we examine the effect of delinquent peer associations on delinquent behavior while controlling for background characteristics (age, race, gender, and broken homes) and prior delinquency. Controlling for prior delinquency (stability in delinquency) also helps to control for other individual characteristics that we have not measured directly (unobserved heterogeneity). The following is the hypothesis of causality:

Hypothesis 5: Net of background characteristics and prior delinquency, delinquent peer associations affect future delinquent behavior.

The alternative hypothesis of spuriousness, based on low self-control (prior delinquency) and individual heterogeneity measured by background variables and prior delinquency, is:

Hypothesis 6: Net of individual propensities, delinquent peer associations have no effect on future delinquent behavior.

Fourth, the model specifies a three-wave panel model of the stability of delinquency and delinquent peers (using lagged variables), as well as the cross-lagged reciprocal effects between delinquent peers and delinquent behavior. The three waves allow us to estimate two sets of stability parameters (lagged effects) and two sets of cross-lagged parameters. It also allows us to test whether the two stability parameters and the two cross-lagged parameters change over time.[7]

Hypothesis 7: Cross-lagged effects and stability in delinquency and delinquent peers (lagged effects) vary over time.

Our three-wave model specifies equally spaced two-year intervals between waves. In principle, decisions on the length of lagged effects should be based on theoretical grounds. Unfortunately, virtually no social science theory is capable of specifying the precise duration between cause and effect variables. One could resort to speculation about the possible length of lagged effects—for example, perhaps the fluidity of peer groups

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7. The hypothesis of invariant stability and cross-lagged parameters over time does not correspond directly to a hypothesis about developmental (life-course) processes. This is because our model pools seven age cohorts, and therefore, some wave 1–2 parameters (e.g., for 15-year-olds at wave 1) capture the same developmental effects as the wave 2–3 parameters (e.g., for 15-year-olds at wave 2). Thus, even in the presence of strong developmental processes, our effects may remain stable over time. Disaggregating cohorts and testing explicitly developmental hypotheses is beyond the scope of this analysis (and given data constraints, possibly beyond the scope of our modeling strategy).

suggests that peers should affect delinquency immediately, while a labeling mechanism might suggest that the effects of delinquent behavior on delinquent peers should take longer, assuming that labeling effects are of longer duration (e.g., Krohn et al., 1996; Warr, 1993a; Warr, 1996). We explore this possibility below. Speculation aside, the actual formal principles of the criminological theories we investigate do not specify precise time lags of causal variables. Therefore, so as not to bias the results one way or another, we emphasize models with identical lags between delinquent peers and between delinquent behavior. Our use of two-year lags ensures sufficient change in delinquent peers and delinquent behavior—even after correcting for attenuation due to unreliability—while remaining sufficiently sensitive to capture cross-lagged effects. We also estimated models with one-year lags and found that, after correcting for attenuation due to unreliability, there was insufficient change in delinquency and delinquent peers, multicollinearity among explanatory constructs, and resulting unstable and inadmissable estimates. Therefore, given the structure of our models, we are unable to examine whether shorter lags would yield different substantive results.[8]

DATA AND METHODS

THE NATIONAL YOUTH SURVEY

A test of these propositions requires longitudinal data on a representative sample of a heterogeneous population of adolescents. Data that meet these requirements were collected by Delbert S. Elliott and his colleagues as part of the National Youth Survey, a longitudinal study of delinquency and drug use (Elliott et al., 1985, 1989). Employing a multistage cluster sampling frame, the National Youth Survey obtained a national probability sample of households in the United States in 1976. After several stages of sampling geographic units, 7,998 households were randomly selected, and all 2,360 eligible youths living in the households were included. Seventy-three percent of those youths (1,725) agreed to participate, signed consent forms, and along with one of their parents, completed first-wave interviews in 1977.[9] As a result, the participating youth are reasonably representative of 11–17 year-olds in the United States. Our analyses focus on three waves of data equally spaced two years apart: 1977,

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8. We should note that if the true process is a cross-lagged panel model, as we have assumed, our two-year lagged effects give the *total* effects of a model with shorter intervals between waves.

9. Elliott et al. (1981) investigated possible systematic sources of nonparticipation. The 649 nonparticipants failed to participate because of (1) parental refusal, (2) youth refusal, or (3) youth ineligibility (e.g., severely mentally retarded). Subsequent analyses found that the age, sex, and racial composition of the participating youths was proportional to that of the nonparticipating eligible youths. Moreover, data from the

1979, and 1981. Attrition over the three waves was fairly low: 6% of the youths were lost in 1979, and an additional 7% in 1981. Thus, a total of 1,494 respondents (about 87% of the original sample) participated through five years of data collection.[10] A comparison of stayers and leavers revealed that attrition did not influence the distributions of age, sex, ethnicity, class, residence, or reported delinquency (Elliott et al., 1981).

To elicit self-reports of delinquent behavior and reports of the delinquent behavior of peers, the National Youth Survey used personal interviews conducted in the respondent's home. The measure of delinquent behavior asked respondents, on a nine-point scale, how often they had committed a property crime in the past year. The measure of delinquent peer associations asked respondents, on a five-point scale, how many of their friends had committed a property crime in the past year. We use three measures of property crimes—minor theft (of less than $5), major theft (of more than $50), and burglary (breaking and entering a building or vehicle with intent to steal)—because they were asked about both respondents and their friends, they constitute an important core of what is meant by delinquency, and because empirically they cluster into a single dimension. Other measures, including drug use, cheating, and violence show a similar pattern of results. Nevertheless, we must be cautious in generalizing our results to other kinds of delinquent behaviors. The National Youth Survey also obtained information about exogenous characteristics of respondents, including their age, race, gender, and family structure.

ESTIMATION PROCEDURES

Our structural model is designed to (1) model the substantive reciprocal causal relationships between delinquent peers and delinquent behavior over time, (2) disentangle measurement errors from substantive relationships, and (3) test and control for correlated measurement errors between measures of delinquent peers and measures of delinquent behavior. We begin with a measurement model. Because the measures of delinquent peer associations and delinquent behavior are measured on ordinal scales, we specify a threshold model that relates the observed ordinal variable y

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U.S. Bureau of the Census reveal that the participating youths are representative of the total 11–17 year-old population of the United States.

10. The analyses that follow use listwise deletion of missing values, which leads to an additional 270 (18%) missing cases. Most of these cases are missing because of missing values on the delinquent peer items, principally because respondents with no friends were coded as missing on delinquent peer items. We also estimated models in which such respondents were coded as zero on delinquent peer items and obtained identical results.

(with c ordinal categories) to an underlying continuous latent variable Y^*. For the ith individual, the jth measure, and the tth time period:

$$Y_{ijt} = 1 \quad if \quad\quad\quad Y_{ijt}^* \leq \alpha_1$$
$$Y_{ijt} = 2 \quad if \quad \alpha_1 < Y_{ijt}^* \leq \alpha_2$$

$$\cdot \quad\quad\quad \cdot \quad\quad\quad\quad \cdot$$
$$\cdot \quad\quad\quad \cdot \quad\quad\quad\quad \cdot$$
$$\cdot \quad\quad\quad \cdot \quad\quad\quad\quad \cdot$$

$$Y_{ijt} = r{-}1 \quad if \quad \alpha_5 < Y_{ijt}^* \leq \alpha_6$$
$$Y_{ijt} = r \quad if \quad \alpha_6 < Y_{ijt}^* .$$

To estimate the thresholds, we must specify a distribution of Y^*. If we assume that Y^* is a normally distributed continuous variable, we can estimate the thresholds as follows:

$$\alpha_l = \Phi^{-1} \left(\sum_{k=1}^{l} n_k/N \right) ,$$

where $1 = 1, 2, \ldots, r - 1$ (and r is the number of categories of the measure); Φ^{-1} is the inverse of the standard normal distribution function; and n_k is the sample size of the kth category, where $N = n_1 + n_2 + \ldots + n_r$. Consider a second ordinal variable x (with s ordinal categories), which is similarly related to a continuous normally distributed variable X^* with thresholds

$$\beta_m = \Phi^{-1} \left(\sum_{k=1}^{m} n_k/N \right) .$$

Once the thresholds are estimated, we can estimate a polychoric correlation ρ, which is the scale-appropriate correlation between ordinal variables (assuming the underlying variable is continuous and normal). Olsson (1979) shows that if π_{lm} is the probability that an observation falls into cell (l,m), the log likelihood function of the sample is:

$$\log L \left(n_{lm} \mid \pi_{lm} \right) = C \sum_{l=1}^{r} \sum_{m=1}^{s} n_{lm} \log \pi_{lm} ,$$

where $\pi_{lm} = \Phi_2 \left(\alpha_l, \beta_m \right) - \Phi_2 \left(\alpha_{l-1}, \beta_m \right) - \Phi_2 \left(\alpha_l, \beta_{m-1} \right) - \Phi_2 \left(\alpha_{l-1}, \beta_{m-1} \right)$ and Φ_2 is the bivariate cumulative normal distribution function with population correlation ρ, and C is a constant. Then differentiating $\log L$ with respect to ρ, setting the result to zero and solving for ρ will give the maximum likelihood estimate of ρ. The covariance matrix of the estimates can be estimated by taking the expected value of the negative of the inverted matrix of second-order partial derivatives of $\log L$ with respect to ρ. This can be generalized to the multivariate case of p variables, and the $\frac{1}{2}p^2$ polychoric correlations (ρs) can be placed in a matrix R, with population covariance matrix of estimated ρs, $\Sigma\hat{\rho}\hat{\rho}$, which is of order $\frac{1}{2}p^2 \times \frac{1}{2}p^2$. The covariance matrix of $\hat{\rho}$ estimated from sample data is $S\hat{\rho}\hat{\rho}$ (Jöreskog, 1994; Poon and

Lee, 1987). We used Jöreskog and Sörbom's (1988) PRELIS 2 program to obtain maximum likelihood estimates of R and $S\hat{\rho}\hat{\rho}$.

Our structural model specifies the above continuous, normally distributed measures indexing propensity to associate with delinquent peers X_{ijt}^* and propensity to commit delinquent property crimes Y_{ijt}^* to be linearly determined in a measurement model. For the ith individual, the jth measure, and tth time point:

$$X_{ijt}^* = \lambda_j^x \xi_{it} + \delta_{ijt}$$

$$Y_{ijt}^* = \lambda_j^y \eta_{it} + \varepsilon_{ijt},$$

where λ_j^x and λ_j^y are regression coefficients, ξ_{it} and η_{it} are latent variables capturing association with delinquent peers and commission of delinquent acts (purged of measurement errors), and δ_{ijt} and ε_{ijt} are random measurement errors. We assume that the measurement slopes vary across indicators but not over time. Also, to set a metric for the latent variable we normalize by setting $\lambda_2^x = \lambda_2^y = 1$, which is the slope for minor theft measure. We test and control for Gottfredson and Hirschi's (1990) hypothesis that similar contemporaneous measures of delinquent peers and delinquent behavior will be correlated, $E(\delta_{jt}\varepsilon_{jt}) \neq 0$. We also allow for first-order autocorrelated measurement errors for each construct, $E(\delta_{ijt} \delta_{ijt+1})$ and $E(\varepsilon_{ijt} \varepsilon_{ijt+1}) \neq 0$.

To test our substantive hypotheses we specify a structural model of the latent constructs representing endogenous delinquent peers ξ_{it+1} and delinquent behavior η_{it+1} for the ith observation and the tth time point for T time points:

$$\xi_{it+1} = \Gamma_v z_v + \lambda_{t+1}\alpha + \sum_{t=1}^{T-1} \alpha\ \xi_{it} + \sum_{t=1}^{T-1} \beta\ \eta_{it} + u_{it+1}$$

$$\eta_{it+1} = \Theta_v z_v + \phi_{t+1}\alpha + \sum_{t=1}^{T-1} \Delta\ \eta_{it} + \sum_{t=1}^{T-1} \gamma\ \xi_{it} + v_{it+1},$$

where z_v represents s background variables (race, gender, and broken home), Γ_v and Θ_v are coefficients, a represents age of respondent, λ_t and ϕ_t are time-varying parameters, α and Δ represent stability coefficients for delinquent peers (ξ_{it}) and delinquent behavior (η_{it}, respectively, β and γ are the cross-lagged effects of delinquent behavior on delinquent peers and vice versa, and u_{it+1} and v_{it+1} are structural disturbances. We allow contemporaneous disturbances to be correlated across constructs, $E(u_t v_t) \neq 0$, but constrain to zero autocorrelated disturbances across and within constructs, $E(u_t v_{t+1}) = E(u_t u_{t+1}) = E(v_t v_{t+1}) = 0$ (this autocorrelation will largely be picked up by the measurement error autocorrelations). Finally, to obtain more stable and precise estimates, and in the interests of parsimony, we constrain corresponding parameters (stabilities, cross-lags, and

effects of exogenous variables) to be equal across the two time periods. We also test these constraints using a likelihood-ratio test. The one exception is the coefficients for age, which, given the well-documented non-linear age distribution of crime, we assume vary over time.

To estimate the model, we use Browne's (1984) asymptotic distribution-free estimator, which minimizes the following fit function:

$$F = [\hat{\rho} - \sigma(\theta)]' S\hat{\rho}\hat{\rho}^{-1} [\hat{\rho} - \sigma(\theta)],$$

where $\hat{\rho}$ is a vector of maximum likelihood estimates of the polychoric correlations, $S\hat{\rho}\hat{\rho}$ is the asymptotic covariance matrix of the estimated polychoric correlation (from above) and $\sigma(\theta)$ is a vector of structural parameters to be estimated. Using $S\hat{\rho}\hat{\rho}$ as the weight matrix yields a best asymptotic normal estimator. Also, minimizing F with respect to the parameter vector yields a chi-square variate—$(n - 1)F \sim$ chi-square with d degrees of freedom—equal to the number of polychoric correlations minus the number of parameters to be estimated. This can be used to test the overall fit of the model—that is, the extent to which the model's overidentifying restrictions hold in the population. We also use Steiger's (1990) root mean square error of approximation (RMSEA), which assesses relative fit per degree of freedom:

$$RMSEA = [\max\{(F/d - 1/n{-}1), 0\}]^{\frac{1}{2}},$$

where F is the minimized value of the fit function, d is degrees of freedom, n is the sample size, and the statistic has a lower bound of zero. However, in large samples, even the best models will be formally rejected; therefore, Browne and Cudeck (1993) propose using a RMSEA of .05 as the criterion for an approximately fitting model, and testing whether the model fits at least that well. We follow their recommendation. The asymptotic covariance matrix of the parameter vector $\sigma(\theta)$ is ACOV $(\theta) = 1/n \{[\partial\sigma(\theta)/\partial\theta] S\hat{\rho}\hat{\rho}^{-1} [\partial\sigma(\theta) \partial\theta]'\}^{-1}$. Using our estimates of $\hat{\rho}$ and $S\hat{\rho}\hat{\rho}$ obtained earlier, we then use Jöreskog and Söbom's (1993) LISREL 8 program to estimate the model's parameters, using what they term "weighted least squares," which uses the above fitting function.

RESULTS

MEASUREMENT MODEL

We estimate the measurement and substantive models jointly as a single system. The measurement portion of the model, depicted in Figure 4, specifies delinquent peer associations and delinquent behavior as latent variables, each of which generates three indicators. Thus, each measure of delinquent peers (delinquent behavior), referring to minor theft, major theft, or burglary, at time t is a linear function of the latent variable of delinquent peers (delinquent behavior) plus random measurement error. The baseline model (model 1 of Table 1) has a marginal fit to the data (chi-

square = 648.75; d.f. = 190; $p < .001$). The RMSEA is .044, suggesting a reasonable fit, and the hypothesis of an approximately fitting model (H_0:RMSEA < .05) is not rejected ($p = 1.0$). We expected the response errors of each item to be correlated over time, due to memory effects, random response errors that persist over time, or unique variance in the item that remains stable (Figure 5). A formal test of this hypothesis is retained: Adding all six pairs of first-order autocorrelations to the model (model 2 of Table 1) significantly reduces the chi-square test statistic to 611.55 with 184 degrees of freedom (the difference in chi-square = 37.20; d.f. = 6; $p < .001$). Further, the RMSEA = .044 and H_0:RMSEA < .05 is again not rejected ($p = 1.0$). Among the individual autocorrelations (Table 2) expressed in unstandardized form (covariances), the coefficients for friend's minor theft (.03) and major theft (.02) are positive and statistically significant. The coefficients for friend's burglary (–.04) and respondent's major theft (–.06) are anomalously negative; they are part of the null hypothesis, given that we specified the direction of the alternative hypothesis as positive and used a one-tailed test.

We tested the hypothesis that measures of delinquent peers and delinquent behavior are contaminated due to (1) respondents' imputing their own behavior to that of their friends, (2) respondents' imputing friendship to those who share their delinquency, and (3) respondents reporting hearsay or rumors that are correlated with their own delinquent status (Gottfredson and Hirschi, 1990). Each of these mechanisms implies that measurement errors for a specific measure of delinquent peers (e.g., peers' breaking and entering) should be contemporaneously correlated with the corresponding measure of delinquent behavior (e.g., respondents' breaking and entering) (see Figure 5). Our statistical test supports this hypothesis (chi-square = 184.32; d.f. = 9; $p < .001$). Of the individual cross-construct measurement error covariances, those for minor theft are statistically significant at all three time periods (.15, .15, and .18), those for major theft are significant at the second and third time periods (.07 and .06), and those for burglary are not significant at any time period (Table 2). Thus, we find some support for Gottfredson and Hirschi's (1990) speculation that measures of specific self-reported offenses and reports of similar offenses of one's peers are contaminated. This finding implies that contemporaneous (cross-sectional) correlations between delinquent peer associations and delinquent behavior would be overestimated due to correlations among response errors. Moreover, regressions of delinquency on contemporaneous measures of delinquent peers, typically used in cross-sectional analysis, may overestimate the coefficients. Therefore, in examining the reciprocal relationships between delinquent peers and delinquent behavior, it is important to control for this contamination. The overall fit for this model is quite good (model 3 of Table 1): chi-square = 427.23; d.f.

Table 1.   Chi-square and RMSEA Test Statistics for Testing
           Overall Fit and Selected Hypotheses (N = 1,224)

| Overall Fit: | Chi-Square | | | RMSEA | | |
Model	Chi-Square	D.F.	P Value	RMSEA	P Value	Description
1	648.75	190	<.001	.044	1.00	Equal measurement slopes over time Equal stabilities over time Equal cross-lags over time and equal exog effects over time
2	611.55	184	<.001	.044	1.00	Adds 6 pairs of equal 1st-order serial autocorr. to model 2
3	427.23	175	<.001	.034	1.00	Adds 9 contemporaneous correlations to model 2
4	427.48	175	<.001	.034	1.00	Adds 9 contemporaneous effects of differential bias to model 2
5	431.57	176	<.001	.034	1.00	Adds equal reciprocal effects to model 3
6	426.87	173	<.001	.035	1.00	Drops equal stabilities over time from model 3
7	426.00	173	<.001	.035	1.00	Drops equal cross-lags over time from model 3

Selected Hypotheses: Test	Chi-Square	D.F.	P Value	Description
1	37.20	6	<.001	6 pairs of equal first-order serial autocorrelations
2	184.32	9	<.001	9 contemporaneous correlations
3	184.07	9	<.001	9 contemporaneous effects of differential bias
4	4.34	1	<.05	2 equal reciprocal effects
5	.36	2	>.75	No equality constraints on the stability effects
6	1.23	2	>.5	No equality constraints on the cross-lagged effects

= 175; p < .001). The RMSEA = .034 and H_0:RMSEA < .05 is not rejected (p = 1.0), suggesting a good fit.

A slightly different hypothesis of contamination between delinquency and delinquent peers is that respondents' reports of delinquent peers is a function of respondents' own true delinquency (not reported delinquency)

Table 2. Covariances Among Measurement Errors
(N = 1,224)

Autocovariances[a]		Contemporaneous Covariances			
			Wave 1	Wave 2	Wave 3
Delinquent Peers Associations		Delinquent Peer Associations with Property Delinquency			
Major Theft ($50)	.02[b]				
Minor Theft ($5)	.03[b]				
Burglary	−.04[b]				
		Major Theft ($50)	.0002	.07[b]	.06[b]
		Minor Theft ($5)	.15[b]	.15[b]	.18[b]
		Burglary	−.01	.03	−.03
Property Delinquency					
Major Theft ($50)	−.06[b]				
Minor Theft ($5)	.02				
Burglary	−.03				

[a] Autocovariances are constrained to be equal over time.
[b] Coefficient is at least twice its standard error.

(see Figure 3).[11] This implies the following equation for measures of peer delinquency:

$$X_{ijt}{}^* = \lambda_j\,\eta_{it} + \lambda_j{}^x\,\xi_{it} + \delta_{ijt}\,,$$

where λ_j is a regression coefficient for each of j measures of X, and η_{it} is respondents' true delinquency a time t. Long ago, Costner (1969) termed this form of indicator contamination "differential bias" and noted that it offered a different parameterization of relaxing the same tetrad-difference constraints parameterized by measurement error correlations across constructs. This model, however, is not identified without additional information. Therefore, to identify the model, we added the constraint, $\lambda_j = c\lambda_j{}^y$ where $\lambda_j{}^y$ is the measurement slope from the delinquent behavior equation defined earlier and c is a constant. Substantively, this constraint specifies that, in the regression of reports of peer delinquency $X_{ijt}{}^*$ on true peer delinquency ξ_{it} and true respondent delinquency η_{it}, the coefficient for true respondent delinquency λ_j is a function of the coefficient $\lambda_j{}^y$ from the measurement regression of self-reported delinquency $Y_{ijt}{}^*$ on true respondent delinquency η_{it}. But c is not identified, and therefore, we performed a sensitivity analysis, varying c from 0 to .5 by increments of .1. Because reports of peer delinquency should correspond much closer to true peer delinquency than true respondent delinquency, we expect c to be a small fraction ranging from extremes of 0 to .5. The overall fits for these models are virtually identical to the model that includes contemporaneous measurement error correlations across constructs. For example, in a

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11. Gottfredson and Hirschi (1987, 1990) do not distinguish between contamination between observed measures of delinquency and delinquent peers and contamination between unobserved delinquency and observed measures of delinquent peers.

model with $c = .3$ (model 4 of Table 1), chi-square = 427.48; d.f. = 175; $p <$ .001; RMSEA = .034; and H_0:RMSEA < .05 is not rejected ($p = 1.0$). This is not surprising, since this model simply provides a different parameterization of the same moments involved when relaxing the tetrad-difference overidentifying restrictions across constructs. The two models are not nested and therefore cannot be tested against each other. The important point, however, is not the relative merits of the two models, but rather that either could be true in the population, and either could affect the relationship between delinquent peers and delinquency. Therefore, while we believe model 3 to be more plausible substantively, we consider below whether this second parameterization of measurement error contamination substantially alters the estimates of reciprocal effects between delinquency and delinquent peers.

Table 3 presents parameter estimates of the measurement model for model 3. This model assumes that the metrics of the latent variable and the relative metrics of the observed measures remain constant over time, but it allows the measurement error variances to vary over time. The validity coefficients suggest that the three measures of self-reported property crime and reports of peer property crime are relatively reliable. In general, major theft and burglary are highly reliable (validities range from .90 to .96), while minor theft is moderately reliable (validities range from .75 to .80).

SUBSTANTIVE MODEL

Table 4 presents estimates of parameters of the substantive portion of model 3. Among the background variables, age has a significant negative effect on delinquency at wave 3 but not wave 2. This makes sense, given that at wave 2 respondents were aged 13–19, when the age distribution of crime levels off, whereas at wave 3 the respondents were aged 15–22, about when the age curve for minor crimes begins to decline. We also find that gender exerts significant positive direct effects on delinquency: Net of prior delinquency and delinquent peers, males report more property crimes than their female counterparts. We also find that race exerts significant negative direct effects: Net of prior delinquency and delinquent peers, blacks report more delinquency among their friends than do nonblacks.

The most important parameters of the model are the cross-lagged effects of delinquent peers on delinquency and vice versa. The effect of delinquent peers on delinquency is statistically significant, although modest in size (standardized coefficient of .11). We fail to support the hypothesis that the effect of delinquent peers on delinquency is spurious, even when controlling for possible measurement artifacts, such as response effects that artificially inflate the contemporaneous correlation between

Table 3. Parameter Estimates of the Measurement Model ($N = 1,224$)

Observed Indicators	Metric Slope			Validity Coefficient			Error Variance		
	Wave 1	Wave 2	Wave 3	Wave 1	Wave 2	Wave 3	Wave 1	Wave 2	Wave 3
Delinquent Peers									
Major Theft ($50)	1.22	1.22	1.22	.92	.94	.96	.16	.11	.09
Minor Theft ($5)	1.00	1.00	1.00	.75	.77	.78	.44	.41	.39
Burglary	1.21	1.21	1.21	.91	.94	.95	.17	.12	.10
Property Delinquency									
Major Theft ($50)	1.18	1.18	1.18	.95	.94	.93	.09	.12	.14
Minor Theft ($5)	1.00	1.00	1.00	.80	.80	.78	.35	.37	.39
Burglary	1.15	1.15	1.15	.93	.92	.90	.14	.16	.19

NOTE: All coefficients are at least twice their standard error.

Table 4. Unstandardized and Standardized Parameter
Estimates of the Substantive Model—Three Wave
Model ($N = 1,224$)

Predictor Variables	Endogenous Variables			
	Delinq. Peer2	Delinq. Peer3	Delinquency2	Delinquency3
Age	.002	-.020	-.000	-.073*
	(.020)	(.020)	(.019)	(.020)
	.002	-.025	.000	-.094
Race (Nonblack)	-.078*	-.078*	.039	.039
	(.027)	(.027)	(.030)	(.030)
	-.102	-.100	.049	.050
Broken Home	-.040	-.040	.023	.023
	(.026)	(.026)	(.029)	(.029)
	-.052	-.051	.028	.029
Gender (Male)	.016	.016	.051*	.051*
	(.022)	(.022)	(.022)	(.022)
	.020	.020	.065	.066
Delinquent Peer1	.620*	—	.113*	—
	(.049)		(.039)	
	.605		.107	
Delinquent Peer2	—	.620*	—	.113*
		(.049)		(.039)
		.611		.111
Delinquency1	.254*	—	.708*	—
	(.052)		(.048)	
	.266		.716	
Delinquency2	—	.254*	—	.708*
		(.052)		(.048)
		.259		.720
R^2	.677	.668	.719	.707

NOTE: Standard errors appear in parentheses. Standardized parameter estimates appear in italics.
* Coefficient is at least twice its standard error.

constructs. Moreover, the effect of delinquent peers on delinquent behavior persists even after controlling for prior delinquency, the best measure of the trait of low self-control. Thus, contrary to low self-control theory, the association between delinquent peers and subsequent delinquency is not spurious due to the trait of low self-control.

Nevertheless, we do find much support for the "birds of a feather flock together" hypothesis: The effect is relatively large (.26) and substantially and significantly larger than the effect of delinquent peers on delinquency. A formal test of the null hypothesis that the cross-lagged effects are equal in the population (model 5 in Table 1) rejects the null hypothesis (chi-

square = 4.34; d.f. = 1; $p < .05$). Thus, at the .05 significance level, we are able to reject the hypothesis that the cross-lagged effects are identical.

We also reject the hypotheses that stability coefficients for delinquency and delinquent peers vary across waves (chi-square = 0.36; d.f. = 2; $p > .75$) and that the cross-lagged effects between delinquency and delinquent peers vary across waves (chi-square = 1.23; d.f. = 2; $p > .50$). Both delinquent peer associations and delinquent behavior are highly stable across the three waves: The two bivariate correlations among the latent variables for delinquent peers are each .80; for delinquent behavior, they are .84 and .83. Some of this stability is accounted for by the model. The standardized stability coefficients (first-order lagged direct effects) for delinquent peers are .60 and .61; whereas for delinquent behavior they are each .72. Thus, the model accounts for slightly more of the stability of delinquent behavior than of delinquent peers.

We can determine how well the model accounts for the contemporaneous correlations between delinquent peers and delinquent behavior. The bivariate correlations between these two latent variables are very high for each of three waves: .80, .76, and .77, respectively. The model treats the correlation at wave 1 as unanalyzed, but accounts for the correlation for waves 2 and 3 in terms of stability and cross-lagged effects. The disturbance correlations represent the contemporaneous correlation between delinquent peers and delinquency after partialling out the cross-lagged and stability effects. If these correlations are substantially smaller than the bivariate correlations, we can conclude that the model accounts for much of the correlations. This appears to be the case: the remaining correlations among disturbances are .11 and .16, for waves 2 and 3, respectively. These correlations are statistically distinguishable from zero, but small in size, particularly relative to the corresponding correlations between latent variables. If we express the amount of covariance explained as the proportion of explained covariance divided by the total covariance, $[1 - E(u_{t+1}v_{t+1})/E(\xi_{t+1}\eta_{t+1})]$, we obtain .86 explained for wave 2 and .79 explained for wave 3. Thus, the model does very well in explaining the contemporaneous covariation between delinquent peers and delinquent behavior.

Finally, these general results are consistent across models that parameterize measurement contamination as an effect of true delinquency on indicators of reports of peer delinquency. In models of the form of model 4, varying c between 0 and .5 yields similar substantive results. Thus, our reciprocal effects are not a measurement artifact of either correlated measurement errors between similar measures of delinquency and delinquent peers or direct effects of true delinquency on measures of delinquent peers.

These results assume uniform two-year, cross-lagged effects between delinquent peers and delinquency. As noted above, behavioral theories

are not stated with sufficient precision to specify a particular duration between causal effects, and duration is often determined empirically by estimating different lag structures. Other research has used shorter lags, such as six months or one year and yielded roughly similar substantive results (Krohn et al., 1996; Thornberry et al., 1994; Warr, 1993a). We tried to replicate our findings on a shorter lag structure—one year for both delinquency and delinquent peers—but found that insufficient change in delinquency and delinquent peers caused unstable and inadmissable estimates. Even though we cannot disentangle these shorter lags, our two-year lag estimates can be interpreted as total effects of a cross-lagged panel model with shorter lags.

Nevertheless, if the true causal lag for peer effects differs from that for behavior effects, our results could be biased. Some researchers suggest that the effect of delinquency on delinquent peers may be of a long duration (because labeling and selection effects take time) but that the effect of delinquent peers on delinquency is of a very short duration (e.g., Krohn et al., 1996; Warr, 1993a; Warr, 1996). The limit of shorter durations would be an instantaneous effect, which would include the effects of both short-term learning and group processes. To explore this possibility we estimated a model that specified a contemporaneous effect of delinquent peers on delinquency and a two-year lagged effect of delinquency on delinquent peers. With one exception, this model yielded results similar to our uniform two-year lagged models. Delinquency and delinquent peers are highly stable and the effect of delinquency on delinquent peers is virtually unchanged (standardized coefficient of .27 compared to .25). The effect of delinquent peers on delinquency, however, is substantially larger (standardized coefficient of .18 compared to .11). Moreover, our test of equal reciprocal coefficients no longer rejects the null hypothesis of equal effects in the population (chi-square = 1.00; d.f. = 1; $p > .25$). Therefore, our results supporting the social selection ("birds of a feather") and causality hypotheses are robust, but our result that selection effects are larger than causality effects is not robust to different lagged structures.

CONCLUSIONS

Our analyses lead to three major conclusions. First, there is evidence supporting Gottfredson and Hirschi's (1987) speculation that the strong correlation between delinquent peer associations and delinquent behavior, derived from cross-sectional data, may have an ambiguous interpretation. The contemporaneous correlation is, in part, due to correlated measurement errors, or alternatively, to "differential bias," in which true delinquency exerts direct effects on individual measures of delinquent peers. The precise meaning of these response sets, however, is not clear. We are

unable to adjudicate among the many speculations offered by Gottfredson and Hirschi, and we are unable to rule out a simple alternative hypothesis that the error correlations are due to similar wording of delinquent peer and self-reported delinquency measures. To distinguish this effect and the various hypotheses offered by Gottfredson and Hirschi (e.g., coparticipation, imputing one's own qualities to friends, or imputing friendship to people like oneself) requires a different research design. One would need survey data on self-reported delinquency, reports of peer delinquency, self-reports of delinquency by the respondent's peers, and detailed data on whether the behavior was committed in isolation or with specific peers. Nevertheless, our results suggest that Warr's (1993a) arguments against Gottfredson and Hirschi's (1990) claims must be at least tempered, and that failing to consider response effects in cross-sectional analyses could lead to misleading results.

Second, consistent with control theories and the Gluecks' (1950) claim that birds of a feather flock together, we find that delinquent behavior exerts a large effect on delinquent peer associations. Moreover, the effect of delinquency on delinquent peers is larger than the effect of delinquent peers on delinquency. This difference is statistically significant in our models that specify uniform two-year lagged effects, but not in models that specify instantaneous effects of delinquent peers on delinquency and two-year lags for effects of delinquent behavior. Third, contrary to control theories, and consistent with learning theories, we find that delinquent peer associations exert a nontrivial effect on delinquent behavior. This finding is consistent with some previous research, but we have found that it also persists after controlling for measurement error correlations, background characteristics, and prior levels of delinquency (and thus, low self-control). Nevertheless, the magnitude of this effect, when compared to the cross-sectional correlation between delinquency and delinquent peers, and when compared to the reverse effect of delinquency on delinquent peers, is not as large as past research has implied.

Our models found substantial stability effects (first-order lags) in both delinquency and delinquent peers. To provide a strong test of Gottfredson and Hirschi's (1990) propensity view, we attributed the stability in delinquency to low self-control (which follows their recommendation of using prior delinquency to measure low self-control). Recent research, however, has correctly distinguished between the effects of stable individual differences resulting from a stable trait, like criminal propensity, and effects of prior states of the dependent variable, like delinquency. Nagin and his colleagues have conceptualized this problem as state dependence (prior state of delinquency) and unobserved heterogeneity (stable trait) (Nagin and Farrington, 1992; Nagin and Paternoster, 1991). Most relevant to our analyses, Paternoster and Brame (1997) find that the dynamic variables,

prior delinquency and delinquent peers, exert strong effects even when unobserved heterogeneity is controlled. Our models have not decomposed the effects of prior delinquency (and delinquent peers) into state dependence and heterogeneity; instead, we have attributed the entire effect to low self-control. Thus, in giving low self-control theory the benefit of the doubt, we may have exaggerated the effect of stability in delinquency and delinquent peers.[12]

We should emphasize that our results are specific to our measures of delinquency. Because we are modeling the possible response contamination across individual measures of delinquency, our models use three measures of property delinquency, rather than the usual broad index of delinquent acts. It is conceivable that our results would vary given different forms of delinquency. For example, some would argue that drug use is carried out in groups and requires peers to supply drugs, provide motivation, and define the experience, and therefore, peer effects might dominate drug-using effects. Krohn et al. (1996), however, examine a panel model of drug use and drug-using peers and find results that parallel ours.

While these analyses shed important light on the dynamics of delinquent peer associations and delinquent behavior, they do not address the specific question of whether *initiation* into delinquent behavior requires delinquent peer associations. The preceding analyses assume that onset and continuation of delinquency are generated by similar mechanisms. Additional analyses (not reported here) of the model that break the sample into age cohorts revealed no clear age trends in the dynamics between delinquent peer associations and delinquent behavior. (One might presume that the process works differently for 11-year-olds, most of whom have yet to engage in delinquency, and 17-year-olds, most of whom will have engaged in delinquency if they ever will.) A definitive examination of whether the relationships between associating with delinquent peers and committing delinquent acts differs for onset versus continuation of delinquency would require richer data. Clearly, data on youth very early in life would be needed to measure onset of delinquency and onset of delinquent peer association. Then, a hazard model could control for censoring (onset would occur at different times for different individuals) and individual differences in propensity, and estimate the effects of time-varying covariates of delinquency and delinquent peer associations.[13] We have

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12. In principle, our models could disentangle unobserved heterogeneity from state dependence within a covariance structure framework (e.g., Matsueda, 1986), but our data will not allow us to simultaneously model cross-construct measurement error correlations.

13. On this issue, Elliott and Menard (1992) analyzed the National Youth Survey and found that delinquent peer associations preceded delinquent behavior for more respondents than delinquent behavior preceded association with delinquent friends.

shown here that covariance structure methods are also needed to control statistically for the consequences of random and nonrandom measurement errors. Until such data and methods are brought to bear on these issues, we conclude that the relationship between delinquent peer association and delinquent behavior is reciprocal, that the effect of delinquency on delinquent peers is larger than the effect of delinquent peers on delinquency, and that the latter effect has likely been overestimated in previous research.

Our results suggest that delinquent peers and delinquency are reciprocally related in a dynamic process, which is consistent with Thornberry's (1987) interactional theory, which explicitly specifies reciprocal effects. Theoretically, however, what is needed is a theory of crime that is combined with a theory of peer group formation. Such a theory would embed friendship patterns within a larger social organization and explain how the structure of friendship networks operates, including selection into and out of such networks. It would also include an individual-level component that explains how individual differences between children, including early child biological and developmental differences, operate to motivate the child to select into friendship networks and cause groups to select children based on certain characteristics (Matsueda and Heimer, 1997).

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Ross L. Matsueda is Professor and Chair, Department of Sociology, University of Iowa. His current research includes sibling models of social capital, teenage childbearing, child behavior problems, switching regression models of sentencing and deterrence, and continued work on a symbolic interactionist theory of delinquency.

Kathleen Anderson is a Ph.D. candidate in the Department of Sociology, University of Iowa. Her research interests include examining a life-course model of crime and role transitions in the familial, educational, and occupational domains of life.

APPENDIX
DESCRIPTIONS OF MEASURES

Background Characteristics

AGE	Years of age of youth respondent.
RACE	Race of the youth respondent (0 = black; 1 = nonblack).
BROKEN HOME	Broken home (0 = intact; 1 = at least one parent absent).
GENDER	Gender of youth respondent (0 = female; 1 = male).

Delinquent Peer Associations

For the following measures, the respondents were asked, at each of the three waves of data collection (1977, 1979, and 1981), how many of their friends had committed a property crime in the past year. Responses were coded 1 = none of them; 2 = very few of them; 3 = some of them; 4 = most of them; and 5 = all of them.

DELINQUENT PEER1

Major theft (more than $50)	"How many of your friends have stolen something worth more than $50?"
Minor theft (less than $5)	"How many of your friends have stolen something worth less than $5?"
Burglary	"How many of your friends have broken into a vehicle?"

DELINQUENT PEER2

Major theft (more than $50)	"How many of your friends have stolen something worth more than $50?"
Minor theft (less than $5)	"How many of your friends have stolen something worth less than $5?"
Burglary	"How many of your friends have broken into a vehicle?"

DELINQUENT PEER3

Major theft (more than $50)	"How many of your friends have stolen something worth more than $50?"
Minor theft (less than $5)	"How many of your friends have stolen something worth less than $5?"
Burglary	"How many of your friends have broken into a vehicle?"

Property Delinquency

For the following measures, the respondents were asked, at each wave of data collection (1977, 1979, and 1981), how often they had committed a

property crime in the past year. Responses were coded 1 = never; 2 = once or twice; 3 = once every 2–3 months; 4 = once a month; 5 = once every 2–3 weeks; 6 = once a week; 7 = 2–3 times a week; 8 = once a day; and 9 = 2–3 times a day.

DELINQUENCY1

Major theft (more than $50)	"Stolen something worth more than $50?"
Minor theft (less than $5)	"Stolen something worth $5 or less?"
Burglary	"Broken into building?"

DELINQUENCY2

Major theft (more than $50)	"Stolen something worth more than $50?"
Minor theft (less than $5)	"Stolen something worth $5 or less?"
Burglary	"Broken into building?"

DELINQUENCY3

Major theft (more than $50)	"Stolen something worth more than $50?"
Minor theft (less than $5)	"Stolen something worth $5 or less?"
Burglary	"Broken into building?"