Higgins, G. E., Jennings, W. G., Marcum, C. D., Ricketts, M. L., & Mahoney, M. (2011). Developmental trajectories of nonsocial reinforcement and delinquency in adolescence: An exploratory study of an understudied part of social learning theory. ***Journal of Criminal Justice,*** 39(1): 60-66. Published by Elsevier (ISSN: 0047-2352). http://0-dx.doi.org.wncln.wncln.org/10.1016/j.bbr.2011.03.031

Developmental trajectories of nonsocial reinforcement and offending in adolescence and young adulthood: An exploratory study of an understudied part of social learning theory

George E. Higgins, Wesley G. Jennings, Catherine D. Marcum, Melissa L. Ricketts, Margaret Mahoney

ABSTRACT

Purpose

Within social learning theory, nonsocial reinforcement has been hypothesized to have a link with offending. The purpose of the present study was to address two questions: (1) Does nonsocial reinforcement change or remain stable over time? And (2) does nonsocial reinforcement have a reciprocal link with offending, as Wood et al. (1997) would expect?

Methods

We used a subsample (N = 413) of the National Longitudinal Survey of Youth (NLSY) data and semi-parametric group-based modeling (SPGM).

Results and Conclusions

The SPGM suggested three distinct groups of nonsocial reinforcement (one trajectory group appeared to have a low but stable rate of nonsocial reinforcement, one trajectory appeared to be higher but stable, another trajectory higher but also stable). A cross-tabulation of the nonsocial reinforcement trajectories and offending trajectories indicated that offending increased as nonsocial reinforcement became greater. Study limitations and implications are also discussed.

INTRODUCTION

Lately, criminologists have focused on the intrinsic pleasure and rewards (i.e., nonsocial reinforcement) of juvenile delinquency. Researchers have shown that participation in drug use and delinquency is associated with positive sensations that include risk-taking (Agnew, 1990 and Arnett, 1995; Brezina and Piquero, 2003, Higgins et al., 2009, Katz, 1988, May, 2003, Wood et al., 1994, Wood et al., 1995 and Wood et al., 1997). With this evidence, nonsocial reinforcement may be used to enrich a number of criminological theories (Akers, 1998, Katz, 1988, Wood et al., 1995 and Wood et al., 1997).

One theory in particular is social learning theory. Wood et al., 1995 and Wood et al., 1997 argued that the development of nonsocial reinforcement within the social learning theory context would provide a theoretical advancement. According to Akers (1998), nonsocial reinforcement is included in the theory, but he argued that the focus should remain on the social portions of reinforcement rather than on nonsocial reinforcement. In contrast, Wood et al., 1995 and Wood et al., 1997 argued that nonsocial reinforcement might provide a stronger impetus for delinquency and drug use than social reinforcement. The prevailing evidence points toward the idea that nonsocial reinforcement is important for the development of social learning theory.

Another theory or set of theories that nonsocial reinforcement may enrich are the developmental theories (i.e., Moffitt, 1993 and Moffitt, 2003). Briefly, Moffitt (1993) argued that two types of offenders are observable. One offender type would begin committing crime early and continue committing crime throughout life (i.e., life course persistent), and the other offender type would commit crime early and end their criminal behavior during adolescence (i.e., adolescent limited). Moffitt (2003) argued that a third group that consistently committed small amounts of crime was also possible (i.e., low-level chronics). Comparatively, Wood et al. (1995) suggested that individuals might vary in the amount that they are susceptible to nonsocial reinforcement for drug use and delinquency. Thus, it is possible that life course persistent offenders are high nonsocial reinforcers, while adolescent limited offenders and low-level chronics are not high nonsocial reinforcers. Supporting this view also provides evidence of a reciprocal link between nonsocial reinforcement and delinquency.

While enriching these theories is important, it is equally important to understand the biological etiology of nonsocial reinforcement. The biological assumptions and evidence of nonsocial reinforcement come from the sensation-seeking literature. To clarify, one of the main parts of nonsocial reinforcement is risk-taking. In criminology, risk-taking is part of the larger low self-control individual propensity for criminal behavior (Gottfredson & Hirschi, 1990). However, in psychology, risk-taking is part of the larger sensation-seeking concept (Zuckerman, 2002).

Given these discussions, we further consider the role of nonsocial reinforcement in social learning theory (Akers, 1998) and Moffitt, 1993 and Moffitt, 2003 taxonomy. This study has several purposes. First, the present study is to provide an understanding of the reciprocal nature of the relationship between nonsocial reinforcement and delinquency. Second, the present study provides some understanding of the role of nonsocial reinforcement in Moffitt's taxonomy. Third, this study highlights the biological underpinnings of nonsocial reinforcement. This study is important because it is the first to assess the reciprocal nature of nonsocial reinforcement using

a nationally representative longitudinal dataset. The study is also important because it provides researchers with more information about the etiology of nonsocial reinforcement and its developmental contributions.

To achieve these purposes, we first begin by reviewing nonsocial reinforcement from the Wood et al., 1995 and Wood et al., 1997 perspectives. Second, we provide an understanding of the biological etiology of nonsocial reinforcement. This is followed by Akers' (1998) arguments about nonsocial reinforcement. Next, we present Moffitt, 1993 and Moffitt, 2003 developmental taxonomy where nonsocial reinforcement is highlighted. This is followed by the methods, analysis plan, results, and discussion.

NONSOCIAL REINFORCEMENT

Wood et al., 1995 and Wood et al., 1997 presented nonsocial reinforcement as a series of factors that influence the initiation of criminal and delinquent behavior, including socialization, present situation, and personality traits that will guide an individual into a criminal or delinquent lifestyle. However, individuals that continue to offend do so because they are being reinforced in different ways. On one hand, an individual can be reinforced through a reward schedule that occurs externally (i.e., from others). On the other hand, an individual can be reinforced internally through a series of psychological and physiological reinforcers. Wood et al., 1995 and Wood et al., 1997 argued that these internal reinforcers operate independently but could operate in conjunction with external reinforcers. Furthermore, Wood et al., 1995 and Wood et al., 1997 proposed that psychological internal reinforcers include self-worth, the development of a criminal or delinquent identity, and the meaning that an individual attaches to acts themselves. These forms of reinforcement may occur during the commission of an act and may linger after the commission of an act. The internal reinforcers that are physiological by nature are restricted to the time surrounding the criminal or delinquent act and include pleasurable sensations such as the risk or thrill of committing a criminal or delinquent act.

The nonsocial reinforcement model that Wood et al., 1995 and Wood et al., 1997 presented is complex, and a complete explanation of the linkages are beyond the scope of the present study given that we are interested in the reciprocal nature of physiological reinforcers. Having said this, the model contains a structure with direct and reciprocal effects. For instance, physiological reinforcers (i.e., risk-taking) have a direct link with beginning criminal and delinquent behavior. Further, Wood et al., 1995 and Wood et al., 1997 also hypothesized that physiological reinforces have a reciprocal effect with offending encouraging the continuation of crime and delinquency.

Researchers in the empirical literature have shown that nonsocial reinforcement is related to drug use, crime, and delinquency. In addition, researchers have cast nonsocial reinforcement in a couple of theoretical directions. For instance, Wood et al. (1995) argued that nonsocial reinforcement was part of the larger sensation-seeking concept, which they postulated as an integral portion of social learning theory. Subsequently, Wood et al. (1995) tested these

assertions using 1,600 high school students, and their results demonstrated that nonsocial reinforcement provided intrinsic rewards that promoted and reinforced substance use.

In a second study, Wood et al. (1997) then provided the main theoretical development of nonsocial reinforcement by arguing that it was a missing part of social learning theory. In addition, they argued that the development of nonsocial reinforcement would expand social learning theory. Wood et al. (1997) tested their assumptions and showed that nonsocial reinforcement via thrill seeking and immediate gratification had strong associations with illegal drug and alcohol use among adolescents. Similarly, Arnett (1995) argued that several important concepts interacted to arrive at recklessness. For instance, reckless behavior is heightened by sensation, egocentrism, and aggressiveness. The key is that sensation seeking is part of this nexus supporting the idea that nonsocial reinforcement is part of the drive for reckless behavior.

In a more recent study, May (2003) compared three theories--control theory, differential association, and nonsocial reinforcement--to determine the theory that explained violent delinquency the best. Using data from 743 adolescents, May showed that the three theories adequately predicted violence, but nonsocial reinforcement had the strongest influence. In addition, Higgins et al. (2009) empirically tested social learning and self-control theory to understand the nonmedical use of prescription drugs. Their use of social learning theory included the development of nonsocial reinforcement. Using a national dataset, they showed that nonsocial reinforcement had an inconsistent connection with the nonmedical use of prescription drugs. Furthermore, Higgins et al. (2009) showed that nonsocial reinforcement had a link with the nonmedical amphetamine and tranquilizer use, but not with the nonmedical use of sedatives.

Overall, the evidence from the nonsocial reinforcement literature supports its use and further development. The studies of nonsocial reinforcement from the Wood et al., 1995 and Wood et al., 1997 perspective provided a modest start to understanding this concept, but more work is necessary. Specifically, the biological assumptions of nonsocial reinforcement are important to delineate and need to be made much more explicit.

BIOLOGICAL ASSUMPTIONS OF NONSOCIAL REINFORCEMENT

The biological assumptions of nonsocial reinforcement begin where the concept seems to have originated—sensation seeking. Wood et al., 1995 and Wood et al., 1997 began their discussion of nonsocial reinforcement by presenting it as a portion of sensation seeking. However, they are not the only researchers to present nonsocial reinforcement as part of sensation seeking or to see sensation seeking as an important piece of crime development. While the importance of sensation seeking as a biological function has not been unnoticed by criminologists, it has been better developed by psychologists. For instance, Katz (1988) argued criminologists should focus on the pleasures (i.e., what it feels, sounds, or tastes like) associated with different forms of criminal and delinquent behavior. The pleasures of a crime tend to draw individuals into crime and provide motivation for criminal behavior. Overall, Katz (1988) cogently argued that criminologists should focus on the sensory features of crime and delinquency commission.

Specifically, Gove and Wilmoth (1990) argued that risky behaviors such as crime and delinquency activated a dopamine-dependent reward process that results in a ‘high’. This is a view that was shared by Wilson and Hernstein (1985) as well.1

Furthermore, criminologists are not the only researchers that have argued for a link with nonsocial reinforcement and biology. Psychologists have not only argued for a link between nonsocial reinforcement and biology, but they have found a connection. The connection is predicated on nonsocial reinforcement being part of the sensation-seeking concept. For example, Zuckerman (2002) showed that the enzyme monamine oxidase (MAO0 and sensation seeking had a replicable correlation. To probe this correlation, Zuckerman (2002) argued that high sensation seeking individuals had low platelet MAO Type B (MAO-B) levels, and found support in the empirical literature that MAO-B was low among individuals that were criminal and delinquent (Belfrage et al., 1992, Lidberg et al., 1985 and Stalenheim, 2004). Additionally, af Klinteberg, von Knorring, and Oreland (2004) argued because no connection between platelet MAO and brain MAO have been found yet, it is possible that platelet MAO is merely a genetic marker for the capacity of some central nervous system neurotransmitter, for instance serotonin.

Therefore, the connection between MAO, sensation seeking, and violent crime results in the question about the type of monoamine neurotransmitters that MAO regulates or that it is correlated with at the genetic level. The most attention has been given to the serotonin levels. For instance, Zuckerman (2002) argued that reactions to serotonin are typically low among high sensation seekers, and this finding suggests a lack of inhibition. Furthermore, researchers have shown that the metabolite (5-HIAA) is reduced among impulsive individuals (Zalsman & Apter, 2002). This presentation shows that the sensation seeking extension by Wood et al. (1995) with regard to nonsocial reinforcement has a biological base this means that it may influence the decision making process consciously and unconsciously. The differences in biology indicate that some individuals may be high on nonsocial reinforcement while others may be low on nonsocial reinforcement. That is, the decision for thrilling behavior may take place consciously or unconsciously to feed nonsocial reinforcement. This is a point that we revisit later, but for now, we explore the social learning perspective of nonsocial reinforcement that provides an opposing view of the concept.

SOCIAL LEARNING THEORY AND NONSOCIAL REINFORCEMENT

Akers (1998) posits that differential association, definitions, imitation, and reinforcement are the four individual-level concepts that are all part of the social learning process. Differential association is the individual's exposure to crime and delinquency through association with others that are criminal and delinquent. Definitions represent an individual's attitude/s toward a behavior as favorable or unfavorable. For Akers (1998), criminal and delinquent behavior arises from the belief that these behaviors are positive and beneficial. Imitation is when an individual patterns his or her behavior after the performance of others. Reinforcement has properties for the beginning and the continuation of criminal and delinquent behavior. Reinforcements may be positive or negative. Positive reinforcements are real or imagined rewards for performing a behavior, whereas negative reinforcement is the avoidance of or escape from an unpleasant

situation (Akers, 1998). Reinforcement may occur in two ways--social and nonsocial. In social reinforcement, others (i.e., friends, family, and other close individuals) provide positive and negative reinforcement. Akers (1998) does acknowledge the possible role of nonsocial reinforcement, but he states that its role is tied to social reinforcement. Akers (1998) only seems to provide this possibility because he assumes that an individual must learn to interpret the sensations or pleasures that they are experiencing. Thus, the process of nonsocial reinforcement is linked with social reinforcements.

The empirical research on social learning theory is extensive (for review, see Akers, 1998 and Akers and Sellers, 2009). However, the social learning literature does not focus on all types of reinforcement, as most of the literature does not provide an examination of nonsocial reinforcement. This could be because Akers, 1985 and Akers, 1998 has promoted social reinforcement as more important than nonsocial reinforcement. Having said this, Brezina and Piquero (2003) have provided a test of nonsocial reinforcement. The purpose of their study was to determine if nonsocial reinforcement was distinct from social reinforcement as Akers (1998) describes it in social learning theory. Using data from adolescents, Brezina and Piquero (2003) showed that nonsocial reinforcement was not independent from social reinforcement. In other words, the processes are related to one another, thus supporting Akers' (1998) assumption. The one limitation with this study was that Brezina and Piquero (2003) did not provide a test of the theory that included the possible reciprocal effects that nonsocial reinforcement may provide. In addition, Akers' (1998) view does not take into account the possibility that nonsocial reinforcement may vary across individuals; thus, making it distinct from social reinforcement. To clarify, we concede that individuals learn to name the sensations or pleasures that they feel, but after this learning has occurred, research has shown that a biological difference exists that allow these sensations or pleasures to vary across individuals. This is consistent with Wood et al.'s (1997) assumption that nonsocial reinforcement may be influenced by external reinforcers. With variance in nonsocial reinforcement, some individuals may be more attractive or driven to crime than others regardless of social reinforcement.2

MOFFITT'S DEVELOPMENTAL TAXONOMY AND NONSOCIAL REINFORCEMENT

Moffitt's (1993) dual taxonomy is one of the many developmental perspectives of crime and delinquency (see Gottfredson and Hirschi, 1990, Patterson and Yoerger, 1993, Sampson and Laub, 1993 and Thornberry, 1987). Specifically, Moffitt (1993) has argued that two types of developmental crime trajectories are observable. The first offending trajectory is the adolescent-limited type of offender. This type of offender starts committing crime in adolescence and ends in young adulthood. The source of this type of offender's behavior is the maturity gap. The maturity gap reflects the disjuncture between the individual's physical stature and their social maturity. For instance, a 13 year old may look and sound like an adult because of puberty, but they do not have the ability to legally drive a car or vote. The adolescent-limited offender may turn to delinquent behavior to demonstrate autonomy from parents and gain respect and status from peers. Once the biological maturity gap and the social maturity gap have closed and

legitimate means of autonomy are viable options, delinquency and crime are less likely to become options for this offender type.

The second offending trajectory is the life-course persistent type of offender. This type of offender begins committing crime and delinquency early in life and continues throughout the life course. According to Moffitt (1993), the life-course persistent offender is someone that is the product of inherited or acquired neuropsychological variation (i.e., biological variation) that influences cognitive ability or temperament. The biological variation of the life-course persistent offender makes them susceptible to problems with parents, weakened social bonds, or poverty. Because of the biological variation, as the life-course persistent offender ages the environment makes them susceptible to problems with teachers and peers. The continued negative experiences with the environment exacerbate the biological variation making the life-course persistent offender more susceptible to crime, victimization of intimate partners, and children.

Moffitt's (1993) taxonomy has been one of the most widely test developmental theories in criminology and psychology. She provided a lengthy review of the literature that supported these two crime trajectories (see Moffitt, 2003 for a review of this literature). The resulting support of the taxonomy is the ability to effectively classify individuals and provide an understanding of the predictors of these crime trajectories. It is important to note that additional research has reported other offender groups such as low level chronic offenders that are not entirely consistent with Moffitt's early expectations (see Moffitt, 2003).

To date, to our knowledge, no research has been produced that specifically links Moffitt, 1993 and Moffitt, 2003 taxonomy to nonsocial reinforcement. Because nonsocial reinforcement may vary for many individuals, we believe that nonsocial reinforcement may influence some offender groups more than others. For instance, life-course persistent offenders and low level chronic offenders may be more susceptible to nonsocial reinforcement because they may have a stronger biological tendency toward the behavior. This is consistent with Wood et al.'s (1997) view that nonsocial reinforcement will have a reciprocal effect that pushes some to continue to commit crime. In contrast, adolescent-limited offenders will be less susceptible to nonsocial reinforcement given that their criminal and delinquent behavior is contingent on the demonstration of social autonomy.

When researchers are attempting to address issues of change and stability, they often become interested in how individuals' behavior changes or remains stable over time or age. The interest in the within group change is important to the present study to determine if there are changes or stability in homogeneous groups for nonsocial reinforcement and offending. Moffitt (2003) argued that this type of logic in examining groups is commonplace in criminology. For this understanding, researchers typically use the following specialized statistical techniques: latent growth curve modeling (LGCM) and semi-parametric group-based mixture modeling (SPGM) (Nagin, 2005). LGCM is a technique that estimates an individual's average rate of change. The individual rate of change is compared to the entire sample's rate of change. LGCM is also able to provide researchers with an opportunity to capture why individuals start, and LGCMs allow researchers to account for the deviation from the rate of change by allowing for covariates to be used to explain the deviation.

The SPGM approach is similar to LGCM, but it has an additional feature not present in LGCM (Nagin, 2005). SPGM accounts for the possibility that different clusters or groupings are present in the data that may have different interactions with other measures. Applied to the present study, SPGM would allow for the examination of whether nonsocial reinforcement and offending has different clusters. A recent methodological advance by Jones and Nagin (2007) is the use of joint trajectory analysis. This form of analysis allows researchers to examine whether developmental trajectories from two measures interact or have a reciprocal association. For the present study, this would mean that nonsocial reinforcement trajectories may have a reciprocal association with offending trajectories.

THE PRESENT STUDY

The purpose of the present study is to address the following two research questions: (1) Does nonsocial reinforcement change or remain stable? and (2) Does nonsocial reinforcement have a reciprocal link with offending, as social learning theory and Moffitt, 1993 and Moffitt, 2003 would expect? We seek to address these questions using measures of nonsocial reinforcement and offending from individuals measured from adolescence to young adulthood. The results from this study will uniquely contribute to both the nonsocial reinforcement and the developmental trajectory literatures. This study informs the nonsocial reinforcement literature by providing an understanding of the trajectories of nonsocial reinforcement. The developmental trajectory literature is uniquely informed by examining the reciprocal nature between nonsocial reinforcement and offending across two developmental periods of the life-course, e.g., adolescence and young adulthood.

METHODS

The methods for the present study include the sampling and analytic procedures. In addition, the measures that were used are presented, as well as their psychometric properties.

Sampling and Procedures

The data for the present study come from the National Longitudinal Survey of Youth (NLSY). The NLSY79 survey is sponsored and directed by the Bureau of Labor Statistics and conducted by the Center for Human Resource Research at The Ohio State University. Interviews are conducted by the National Opinion Research Center at the University of Chicago. The researchers annually interviewed the respondents in 1979 from various economic, social, and personal experiences. In 1986, the respondents addressed questions about the development of children. In 1994, children that were 15 years and older were no longer assessed by their mothers and completed individual personal interviews that focused on their young adult attitudes and behaviors. The data are extensive enough to capture criminal behaviors and

nonsocial reinforcement tendencies from ages 15 to 16 in 1994, 17 to 18 in 1996; and 19 to 20 in 1998. Using these ages, for these years, the total sample size is 413 individuals.3

Measures

The measures for the present study include nonsocial reinforcement and offending.

Nonsocial Reinforcement

Keeping with the suggestions of Wood et al., 1997 and May, 2003, we used a measure of risk-taking to serve as a proxy for physiological nonsocial reinforcement. That is, we are capturing this portion of nonsocial reinforcement using a measure of risk-taking and not a stimulus-driven measure that would come from a laboratory experiment. However, we are consistent with those that examined this part of reinforcement in the criminological literature. The measure of risk-taking that was measured at all three times (1994, 1996, and 1998). This measure consisted of five items. The items were: planning takes the fun out of things, often does things without thinking, enjoys taking risk, enjoys new and exciting experiences, and feels life without danger is dull. The individuals used a 4-point Likert-type scale to record their responses, where (1) represented strongly disagree and (4) represented strongly agree. Higher scores on this measure indicated that the individuals were more likely to be risk-takers. The internal consistency, via Cronbach's alpha, of these measures from 1994 (.63), 1996 (.64), and 1998 (.64) was acceptable.

Offending

Following Hindelang, Hirschi, and Weis (1981), we used fourteen items to measure offending. The respondents addressed the following items: damaged property of others, got into a fight at school or work, stole from a store, stole something under 50 dollars, stole something over 50 dollars, used force to get money or things, hit or threatened to hit, attacked to seriously hurt, stole a vehicle, broke into a building, sold or held stolen goods, helped with gambling operations, hurt someone bad enough to need a doctor, and lied about something important. At each age, the respondents indicated their participation in these activities by 0 equals no participation and 1 for participation. Summing the items resulted in a participation index that ranged from 0 to 14 with higher scores indicating a greater variety of offending. The measures had relatively strong internal consistency for each year: Cronbach's alpha = .74 (1994), .81 (1996), and .86 (1998).

DATA ANALYSIS

Descriptive statistics were calculated using bivariate correlation analysis for nonsocial reinforcement and offending at different ages and for the shared variance between nonsocial reinforcement and offending. The trajectories for nonsocial reinforcement and offending were estimated using the semi-parametric group-based mixture modeling (SPGM) approach (Jones et al., 2001 and Nagin, 2005). This method allows for three possibilities: (1) identify distinct subgroups among the sample; (2) estimate the proportion of the study sample following each group-based trajectory; and (3) assign individuals to a trajectory group where their individual

trajectory most closely resembles that of a group-based trajectory with a high degree of probability.

SPGM was operationalized using a SAS-based procedure (i.e., Proc Traj) (Jones et al., 2001). In the present study, the data are composite scales that have a minimum and a maximum. Thus, the trajectory estimation relied on the censored normal (CNORM) model in Proc Traj (Nagin, 1999 and Nagin, 2005).

The determination of the optimal number of groups and trajectory shapes was guided by the Bayesian Information criterion (BIC) which was calculated as: BIC = log(L)-.05Xlog(n) x (k). For the BIC, L is the model's maximized likelihood, n is the sample size, and k is the number of model parameters. In the SPGM process, the model with the maximized BIC is selected. The trajectories within SPGM can be of different shapes (i.e., polynomials): a third-order trajectory is based on a cubic equation; a second-order trajectory is based on a quadratic equation; a first-order trajectory is based on a linear equation; a zero-order trajectory is indicated by a flat line where all the slopes and betas are equal to zero (Nagin, 2005). Although the maximized BIC is used to determine the number of groups and trajectory shapes, the BIC tends to favor selecting models that are more parsimonious (i.e., fewer groups and lower-order trajectories). Thus, the individuals are assigned to a specific group trajectory that represents their observed behavior based on the maximum posterior probability of group membership. Posterior probabilities are estimates of the likelihood that an individual's trajectory can be classified to a particular group-based trajectory with a high degree of precision (Nagin & Tremblay, 2001). Therefore, posterior probabilities can be used to assign individuals to groups that best describe his or her behavior and can be used to evaluate model precision. When posterior probabilities are above the .70 cutoff as provided by Nagin (2005), then this provides an indication that there is relatively little ambiguity in the model when making these assignments.

The association between nonsocial reinforcement and offending was assessed using a cross-tabulation. Cross-tabulations allow for the inspection of how the groups relate to one another. Further, we use the chi-square statistic to determine statistical significance.

RESULTS

Table 1 presents the descriptive statistics for nonsocial reinforcement and offending. The mean levels of nonsocial reinforcement show that it is decreasing over time. Table 1 also shows that offending is decreasing over time. This is consistent with Moffitt, 1993 and Moffitt, 2003 views that offending will decrease for most individuals over time particularly upon entering adulthood.

Table 1
Descriptive and pearson's product-moment correlations among nonsocial reinforcement and offending at ages 15 to 21

Measure	1.	2.	3.	4.	5.	6.
1. Nonsocial (15-17) Reinforcement	1.00					
2. Nonsocial (17-19) Reinforcement	0.42**	1.00				
3. Nonsocial (19-21) Reinforcement	0.41**	0.50**	1.00			
4. Offending (15-17)	0.32**	0.18*	0.09	1.00		
5. Offending (17-19)	0.22**	0.26**	0.16**	0.49**	1.00	
6. Offending (19-21)	0.27**	0.28**	0.26**	0.27**	0.52**	1.00
Mean	12.38	12.11	11.73	1.91	1.65	1.38
SD	2.62	2.63	2.60	2.44	2.45	2.47

Note ***p<.001; **p<.01; *p<.05.

Table 1 also presents the bivariate correlations for nonsocial reinforcement and offending. The correlations between the nonsocial reinforcement measures show strong test-retest reliability. The correlations between the offending measures show strong test-retest reliability as well. Finally, the correlations between nonsocial reinforcement and offending show that a significant link exists albeit moderate to weak.

Fig. 1 presents the trajectory analysis for nonsocial reinforcement and offending. Based on the BIC and satisfactory posterior probabilities (i.e., >.70), three trajectory groups were determined for nonsocial reinforcement. All of the trajectory groups indicate stable levels of nonsocial reinforcement. The differences between G1, G2, and G3 are their levels. The G1 trajectory group follows the lowest trajectory of nonsocial reinforcement and contains over 37 percent of the sample. The nonsocial reinforcement G2 group follows the second highest trajectory and contains 53.50 percent of the individuals. The G3 nonsocial reinforcement group follows the highest trajectory but contains 8.69 percent of the individuals.

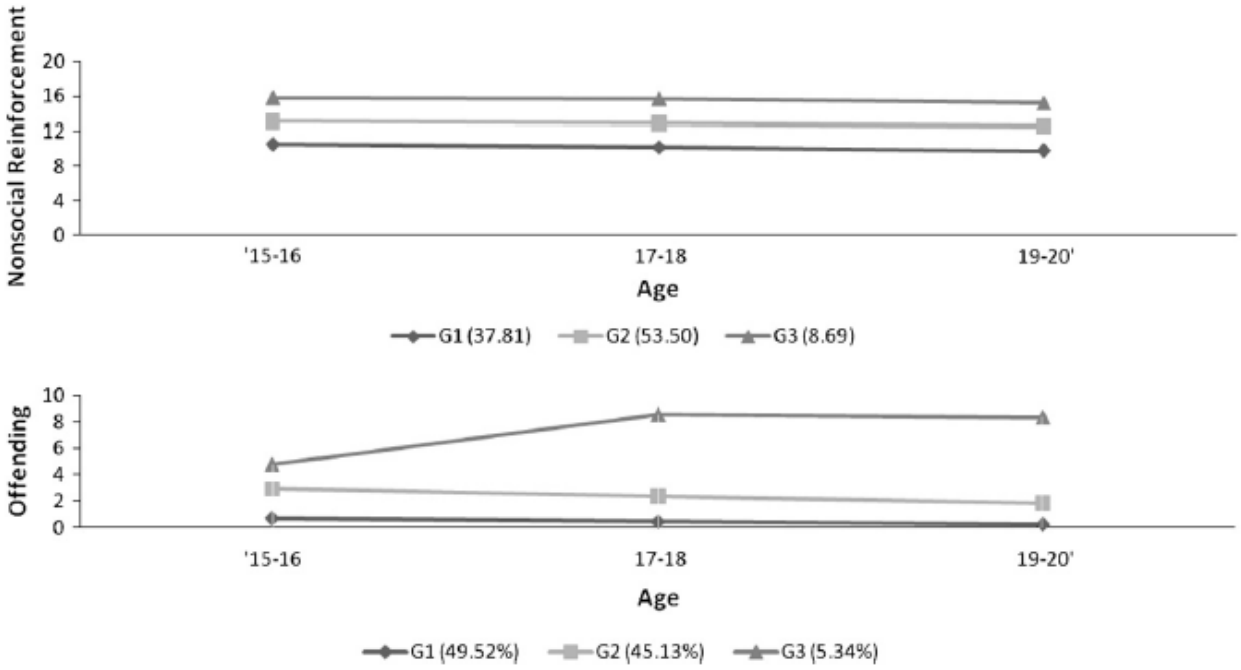

Fig. 1. Nonsocial reinforcement and offending trajectories from age 15 to 21 years.

Based on the BIC and satisfactory posterior probability (i.e., >.70), three trajectory groups were found for offending. Offending trajectory group G1 follows a low and desisting path over time and contains 49.52 percent of the sample. Offending trajectory group G2 follows a low but stable path and consists of 45.13 percent of the sample. Offending trajectory group G3 follows a high and increasing path and consists of the lowest percentage of individuals 5.34 percent. This is consistent with Moffitt's (2003) assumptions that a desisting (adolescent limited group) and a life course persistent are present in these data.

Table 2 presents the cross-tabulation of the nonsocial reinforcement and offending trajectory groups. The cross-tabulations show that 66.7 percent of the individuals that are classified into the nonsocial reinforcement group G1 are also classified in the offending trajectory group G1. Importantly, 71.4 percent of the individuals that are classified in the nonsocial reinforcement trajectory group G3 are also classified in the offending trajectory group G3.

Table 2
Cross-Tabulation of Trajectory Groups

	Nonsocial Reinforcement Trajectory Groups			
Offending Trajectory Groups	1	2	3	
1	66.7% (102)	47.4% (110)	28.6% (8)	53.3% (220)
2	32.0% (49)	47.0% (109)	50.0% (14)	41.6% (172)
3	1.3% (2)	5.6% (13)	21.4%(6)	5.1% (21)
Total	100.0%(153)	100.0%(232)	100.0%(28)	100%(413)
Chi-square	34.44*			

Note: *p<.05.

DISCUSSION

Nonsocial reinforcement theory indicates that physiological reinforcers (i.e., risk-taking) have a link with offending (Akers, 1985, Akers, 1998, Wood et al., 1997 and May, 2003) because they provide an internal reward for performing the behavior. Wood et al. (1997) argued that nonsocial reinforcement would have a link with offending at its beginning and at its continuation. The continuation of offending due to nonsocial reinforcement would be due to a reciprocal link. This view is consistent with Moffitt's (1993) taxonomy. That is, the greater the intrinsic reward that comes from offending the more apt the individual is to continue to perform the behavior, an assertion that is consistent with Akers's (1998) theory. In this study, we sought to build on the existing offending and nonsocial reinforcement literature by examining them as dynamic trajectories. This analysis results in a more nuanced understanding of the developmental link between nonsocial reinforcement and offending. Knowledge of this link could help in further developing nonsocial reinforcement theory to understand offending.

The present study used a semi-parametric group-based mixture modeling (SPGM) to study nonsocial reinforcement and offending using longitudinal data rather than static measures from cross-sectional data. This format resulted in capturing developmental changes in nonsocial reinforcement and offending over a multiple-year span of time. We were then able to assess how changes in nonsocial reinforcement link to changes in offending in a reciprocal manner.

Three offending groups were examined during the same period as nonsocial reinforcement: G1 (49.52%), G2 (45.13%), and G3 (5.34%). Nearly 50 percent of the individuals were reducing their criminal activity by the time that they were 20 years old. Approximately, 45 percent of the individuals were engaging in offending or only committing one act by the age of 20 (i.e., offending group G2). Only 5 percent of the individuals were increasing their criminal activity. This is encouraging that nearly 95 percent of the individuals were offending at a low level or desisting from offending upon entering adulthood.

Three trajectories of nonsocial reinforcement were examined during adolescence (age 15-20): G1 (37.81%), G2 (53.50%), and G3 (8.69%). The nonsocial reinforcement trajectories were stable for all three groups over time. By the age of 20, over a third (37.81%) of the individuals'

trajectories could be considered as G1, and nearly half were slightly higher (G2, 53.50%). Finally, the third group G3 was slightly higher than G1 and G2 (8.69%). These results would be expected by social learning theory and Wood et al. (1997). Specifically, these results indicate that nonsocial reinforcement is not a major issue or even an issue at all for a large percentage of the sample. On the other hand, over half of the sample indicates that nonsocial reinforcement is a dynamic process that can be reduced. While Wood et al. (1997) do not make any particular provision in their theory that nonsocial reinforcement has to remain stable for it to have a link with offending. In fact, this consistent with their view that nonsocial reinforcement will have a reciprocal effect with crime and delinquency. In our view, this finding is supportive of Akers, 1985 and Akers, 1998 assumption that reinforcement, both social and nonsocial, change over time. This suggests that individuals do learn the content that is necessary to interpret the nonsocial reinforcing feels that they experience. Nevertheless, these results expand our understanding by showing that some individuals have no or low levels of nonsocial reinforcement and some have levels that change over time.

In addition, an examination of the cross-tabulation for nonsocial reinforcement and offending revealed, as expected, that a low level of nonsocial reinforcement was associated with a low level of offending. In contrast, the increases in nonsocial reinforcement were also associated with increases in offending. The nonsocial reinforcement groups G1 and G2 were associated with G1 from the offending groups (i.e., low to no offending). The nonsocial reinforcement groups G2 and G3 were mostly associated with the increasing offending group (i.e., G2). Being assigned to the nonsocial reinforcement group G3 was mostly associated with those in G3 where the individuals were in offending trajectory groups G1 and G2. This is supportive of Wood et al.'s (1997) assertion that nonsocial reinforcement will have a reciprocal link with offending, and it is supportive of the view that as behavior changes so does reinforcement from social learning theory. Thus, it appears that this form of nonsocial reinforcement provides individuals with enough of a physiological intrinsic reward to continue to perform more delinquent acts, as expected from social learning theory and Wood et al. (1997).

The results are also consistent with Moffitt's (1993) assertions that the more severe offenders (i.e., life-course persistent) would not be sensitive to reinforcement issues. However, our measure captures a physiological version of nonsocial reinforcement that is part of the larger sensation seeking concept. Thus, some may view the results as being supportive of Moffitt's (1993) assertion that personality traits will influence the role of continued offending for the more severe offenders. On the other hand, some may see the results as offending declining due to age. We believe that this indicates that nonsocial reinforcement is important for the continuation of offending regardless of the number of criminal/delinquent acts, even when they are reducing, and is supportive of Moffitt's (1993) taxonomy and Wood et al.'s (1997) extensions and Akers' (1998) social learning theory.

Nevertheless, there are some limitations to the present study. First, this study focused only on the risk-taking portion of nonsocial reinforcement theory. Future research needs to examine the changes in other known measures of nonsocial reinforcement as they relate to trajectories of offending. Further, the study does not take into account the differences across genders, race, and socioeconomic factors that may contribute to offending and nonsocial reinforcement. Thus,

future research is encouraged to examine alternative hypotheses to better understand the relative importance and combined effects of physiological nonsocial reinforcement (i.e., risk-taking) alongside other predictors of offending within other samples.

Despite these limitations, the results of the present study are encouraging for this part of social learning theory and Wood et al.'s (1997) extensions of nonsocial reinforcement. Future studies that use different measures and samples that are more diverse will be helpful in advancing our understanding of nonsocial reinforcement. In the end, our study shows support for the assumption that nonsocial reinforcement has a reciprocal link with offending. Further, our study shows that nonsocial reinforcement exhibits distinct trajectories in adolescence and into young adulthood.

NOTES

1 We recognize that some research has shown that self-control has a biological foundation (Beaver, Ratchfor and Ferguson, 2009, Beaver, Shutt, et al., 2009 and Beaver et al., 2008). Our perspective is that nonsocial reinforcement has pieces that belong to self-control, but they are not the same things. For an argument of this perspective, we send the interested reader to Wood et al. (1995).

2 An astute reviewer argued that nonsocial reinforcement may be part of Stafford and Warr's (1993) re-conceptualization of deterrence. We agree that this may have importance for this particular focus and that future researchers should focus on this idea. We believed that focusing on this is outside the purview of our study.

3 These methods resulted in 430 cases but 17 cases had missing data. These 17 cases were eliminated. The 413 cases that remain are complete cases for nonsocial reinforcement and crime.

REFERENCES

af Klinteberg, B., von Knorring, L., & Oreland, L. (2004). On the psychobiology of personality. In R. M. (Ed.), On the psychobiology of personality: Essays in honor of Marvin Zuckerman (pp. 429−451). Amsterdam: Elsevier.

Agnew, R. (1990). The origins of delinquent events: An examination of offender accounts. Journal of Research in Crime and Delinquency, 27, 267−294.

Akers, R. (1985). Deviant behavior: A social learning approach. Belmont, CA: Wadsworth.
Akers, R. (1998). Social learning and social structure: A general theory of crime and deviance. Boston, MA: Northeastern University Press.

Akers, R., & Sellers, C. (2009). Criminological theories: Introduction, evaluation, and application (Fifth edition). New York: Oxford University Press.

Arnett, J. (1995). The young and the reckless: Adolescent reckless behavior. Current Directions in Psychological Science, 4, 67−71.

Beaver, K. M., Ratchfor, M., & Ferguson, C. J. (2009). Evidence of genetic and environmental effects on the development of self-control. Criminal Justice and Behavior, 36, 1158−1172.

Beaver, K. M., Shutt, J. E., Boutwell, B., Ratchford, M., Roberts, K., & Barnes, J. C. (2009). Genetic and environmental influences on levels of self-control and delinquent peer association. Criminal Justice and Behavior, 36, 41−60.

Beaver, K. M., Wright, J. P., DeLisi, M., & Vaughn, M. G. (2008). Genetic influences on the stability of low self-control: Results from a longitudinal sample of twins. Journal of Criminal Justice, 36, 478−485.

Belfrage, H., Lidberg, L., & Oreland, L. (1992). Platelet monoamine oxidase activity in mentally disordered violent offenders. Acta Psychiatrica Scandinavica, 85, 218−221.

Brezina, T., & Piquero, A. R. (2003). Exploring the relationship between social and nonsocial reinforcement in the context of social learning theory. In Social Learning Theory and the Explanation of Crime: A Guide for the New Century (pp.265–288).

Ronald L. Akers & Gary F. Jensen (eds). New Brunswick, NJ: Transaction Books.
Gottfredson, M. R., & Hirschi, T. (1990). A general theory of crime. Stanford, CA: Stanford University Press.

Gove, W. R., & Wilmoth, C. (1990). Risk, crime, and neurphysiologic highs: A consideration of brain processes that may reinforce delinquent and criminal behavior. In L. Ellis & H. Hoffman (Eds.), Crime in biological social and moral contexts. New York, NY: Praeger.

Higgins, G. E., Mahoney, M., & Ricketts, M. L. (2009). Nonsocial reinforcement of the nonmedical use of prescription drugs: A partial test of social learning and selfcontrol theories. Journal of Drug Issues, 39, 949−964.

Hindelang, M. J., Hirschi, T., & Weis, J. G. (1981). Measuring Delinquency. Beverly Hills, CA: Sage.
Jones, B. L., & Nagin, D. S. (2007). Advances in group-based trajectory modeling and a SAS procedure for estimating them. Sociological Methods and Research, 35, 542−572.

Jones, B. L., Nagin, D. S., & Roeder, K. (2001). A SAS procedure based on mixture models for estimating developmental trajectories. Sociological Methods and Research, 29, 374−393.

Katz, J. (1988). Seductions of crime. New York: Basic Books.

Lidberg, L., Modin, I., Oreland, L., Tuck, J. R., & Gillner, A. (1985). Platelet monoamine oxidase and psychpathy. Psychiatry Research, 16, 339−343.

May, D. C. (2003). Nonsocial reinforcement and violence: Can juvenile justice policies be effective against intrinsic gratification received from violent activity among youth? Journal for Juvenile Justice and Detention Services, 18, 1−18.

Moffitt, T. E. (1993). “Life-course persistent” and “adolescent-limited” anti-social behavior: A Developmental taxonomy. Psychological Review, 100, 674−701.

Moffitt, T. E. (2003). Life-Course-Persistent and Adolescence-Limited Antisocial Behavior: A 10-Year Research Review and a Research Agenda. Causes of conduct disorder and juvenile delinquency (pp. 49−75).

Nagin, D. S. (1999). Analyzing group-based trajectories: A semi-parametric, groupbased approach. Psychological Methods, 4, 139−177.

Nagin, D. S. (2005). Group-based modeling of development. Cambridge, MA: Harvard University.

Nagin, D. S., & Tremblay, R. E. (2001). Analyzing developmental trajectories of distinct but related behaviors: A group-based method. Psychological Methods, 6, 18−34.

Patterson, G. R., & Yoerger, K. (1993). Developmental models for delinquent behavior. In Mental disorder and crime. Hodgins, S. (ed.) (pp. 140–172), Newbury Park, CA: Sage.

Sampson, R. J., & Laub, J. H. (1993). Crime in the making: Pathways and turning points through life. Cambridge, MA: Harvard University Press.

Stafford, M. C., & Warr, M. (1993). A reconceptualization of general and specific deterrence. Journal of Criminal Justice, 30, 123−135.

Stalenheim, E. G. (2004). Long-term validity of biological markers of psychopathy and criminal recidivism: Follow-up 6-8 years after forensic psychiatric investigation. Psychiatry Research, 121, 281−291.

Thornberry, T. P. (1987). Toward an interactional theory of delinquency. Criminology, 25, 863−891.

Wilson, J. Q., & Hernstein, R. (1985). Crime and human nature. New York, NY: Simon and Schuster.

Wood, P. B., Cochran, J. K., Pfefferbaum, & Arneklev, B. J. (1995). Sensation-seeking and delinquent substance use: An extension of learning theory. Journal of Drug Issues, 25, 173−193.

Wood, P. B., Gove, W. R., & Cochran, J. K. (1994). Motivations for violent crime among incarcerated adults: A consideration of reinforcement processes. Journal of the Oklahoma Criminal Justice Research Consortium, 1, 75−93.

Wood, P. B., Gove, W. R., Wilson, J. A., & Cochran, J. K. (1997). A Nonsocial reinforcement and habitual criminal conduct: An extension of learning theory. Criminology, 35, 335−366.

Zalsman, G., & Apter, A. (2002). Serotongeric metabolism and violence/aggression. In J. Glickshohn (Ed.), Neurobiology of criminal behavior (pp. 231−250). Boston, MA: Kluwer Academic.

Zuckerman, M. (2002). Sensation seeking and risky behavior. Washington, DC: American Psychological Association.