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A preliminary experimental investigation of peer influence on risk-taking among adolescent smokers and non-smokers

Eleonora Cavalca[1], **Grace Kong**[1], **Thomas Liss**[1], **Elizabeth K. Reynolds**[3], **Ty S. Schepis**[4], **C. W. Lejuez**[2], and **Suchitra Krishnan-Sarin**[1]

[1]Department of Psychiatry, Yale University School of Medicine, 34 Park Street, New Haven, CT 06519, USA

[2]Center for Addictions, Personality, and Emotion Research, Department of Psychology, University of Maryland College Park, 2103 Cole Field House, College Park, MD 20742, USA

[3]Department of Psychiatry and Behavioral Sciences, Johns Hopkins School of Medicine, 600 N. Wolfe St., Baltimore, MD 21287, USA

[4]Department of Psychology, Texas State University, 601 University Drive, San Marcos, TX 78666, USA

Abstract

BACKGROUND—Epidemiological evidence suggests that peer influence plays a significant role in a variety of adolescent risk-taking behaviors, including tobacco use. We attempted to establish this relationship in a controlled laboratory setting.

METHOD—We modified the Balloon Analogue Risk Task (BART) task to include a peer component to investigate whether peer influences alter risk-taking behaviors. Thirty-nine adolescents (22 smokers, 17 non-smokers) completed one experimental session during which the standard and peer BART were presented in counterbalanced order, with the dependent measures being adjusted pumps and explosions. We also examined the relationship of changes in the BART (standard-peer) to personality measures of impulsivity (BIS-11) and resistance to peer influence (RPI).

RESULTS—A significant interaction of BART type and smoking status was present ($p = .05$); specifically smokers had a greater increase in the number of explosions by 2.27 ($SD = 3.12$) compared to an increase of .29 ($SD = 2.87$) by non-smokers. BIS-11 scores were related to peer-influenced BART changes: those who were more impulsive experienced greater changes in risk-taking, but no similar relationships were observed for the RPI.

Corresponding Author: Suchitra Krishnan-Sarin, Department of Psychiatry, bS208, 34 Park Street, Yale University School of Medicine, New Haven, CT 0651. suchitra.krishnan-sarin@yale.edu; Telephone: 203-974-7595; Fax: 203-974-7606.

Contributors

Eleonora Cavalca and Suchitra Krishnan-Sarin designed the study. C. W. Lejuez provided the behavioral paradigm –the BART and designed the Peer BART. Drs. Krishnan-Sarin, Lejuez, Mr. Liss, and Ms. Cavalca modified the study procedure. Ms. Cavalca managed the literature searches and summaries of previous related work, and wrote the first draft of the manuscript. Grace Kong conducted the statistical analysis and drafted the results section.
All authors contributed to and approved the final manuscript.

Conflict of Interest

All authors declare that they have no conflicts of interest.

CONCLUSIONS—These results suggest that peer influences enhance risk-taking among adolescents, and that smokers may be more susceptible to these influences.

Keywords

Tobacco; Adolescents; Risk Taking; Peer Pressure; Balloon Analogue Risk Task; nicotine dependence

1. INTRODUCTION

Adolescence is associated with the increased vulnerability to a variety of risk-taking behaviors (Steinberg, 2008). While some risk-taking during adolescence is considered healthy, adolescents who are greater risk-takers appear to engage in more behaviors with the potential for negative consequences including dangerous driving, high-risk sex, use of cigarettes and other substances (Shedler and Block, 1990). Understanding of the correlates of adolescent risk-taking is essential to the development of effective interventions.

Existing evidence suggests that risk-taking during adolescence is related to individual differences in the development of brain networks targeting socioemotional and cognitive control processes (Drevets and Raichle, 1998). A key developmentally related moderator of adolescent psychosocial functioning is the influence of peers (Igra and Irwin, 1996). Epidemiological evidence suggests that peers may influence a variety of risky behaviors in adolescence, including substance abuse (Ali and Dwyer, 2009; Chassin et al., 2009). More recent work has focused on understanding the mechanisms underlying individual differences in the influence of peers on risk-taking using either questionnaires (Steinberg and Monahan, 2007) or experimental performance-based measures (Cohen and Prinstein, 2006; Gardner and Steinberg, 2005; Nawa et al., 2008, Perrine and Aloise-Young, 2004; Prinstein et al., 2011). However, to date, there have been no experimental examinations of peer influences on risk-taking in adolescents who are already engaging in risky behaviors like substance use. If peer influence is indeed related to uptake of risk-taking behaviors then we would predict that adolescents who are already using substances should evidence greater risk-taking in the presence of peers.

Our goal was to conduct an experimental examination of the relationship between peer influence and risk-taking among adolescents, who were either cigarette smokers or non-smokers. We chose to study cigarette smokers because peer relationships play a crucial role in initiation and maintenance of adolescent smoking behaviors (Flay et al., 1998). We used the Balloon Analogue Risk Task (BART), an experimental measure of risk-taking and adapted it to include a peer pressure component. We hypothesized that adolescents would take more risks in the presence of peer influences, and that smokers would be more susceptible to these changes. We also explored the influences of constructs such as impulsivity and resistance to peer influence, as they are linked to greater risk-taking among adolescents (Donohew et al., 2000); we predicted that increases in risk taking in response to the peer, compared with standard BART would be positively related to high impulsivity and negatively related to resistance to peer influence (Monahan et al., 2009).

2. METHODS

2.1 Participants

Thirty-nine adolescents were recruited from high schools in Connecticut. Smokers were recruited to participate in a larger smoking cessation trial and had to report using 5 or more cigarettes per day over the past 30 days with urine cotinine levels > 500 ng/ml; the current investigation was conducted prior to initiation of the smoking cessation program. Non-

smokers were recruited from schools during lunch periods using similar recruitment techniques and had to report never smoking a cigarette in their lifetime.

2.2 Procedures

For the smokers, passive parental permission method was used; specifically, information about the cessation program was mailed to the parents and parents were told to inform the school if they did not want their child to participate. Active parental permission was obtained for the non-smokers. In addition, informed assent (less than 18 years old) or consent (greater than or equal to 18 years old) was obtained from all participants. All the methods were approved by the Yale University School of Medicine Human Investigations Committee.

2.3 Measures

Smoking status was assessed using self-reported quantity and frequency of cigarette use over the past 30 days using the Timeline Follow-Back Interview (Sobell and Sobell, 1992).

Urine cotinine levels were determined using the NicAlert Semi-quantitative Cotinine Immunoassay Strips (Craig Medical; Vista, CA), a reliable and valid measure of recent smoking in adolescents (Schepis et al., 2008).

Nicotine dependence was determined using the valid and reliable 7-item modified Fagerström Tolerance Questionnaire for adolescents (mFTQ; Prokhorov et al., 1996).

Resistance to Peer Influence (RPI; Steinberg and Monahan, 2007)measured the degree to which adolescents act autonomously in interactions with their peers. Adolescents were presented with conflicting scenarios in ten pairs of sentences and were asked to select the statement which is more like them and assess the strength of their endorsement (sort of true for me or really true for me). Higher scores indicate less susceptibility to peer influence. This measure has shown to be reliable and valid (Steinberg and Monahan, 2007).

Impulsivity was assessed with the Barratt Impulsiveness Scale-11 (BIS-11; Patton, et al., 1995). The BIS-11is a 30-item self-report measure of impulsivity consisting of three subscales (cognitive, non-planning and motor impulsiveness). It is a valid and reliable measure of impulsivity (Keilp et al., 2005) and has been used with adolescents (Krishnan-Sarin et al., 2007). The total impulsivity score combined scores for all three subscales.

Risk-taking behavior was assessed using the standard Balloon Analogue Risk Task (BART; Lejuez et al., 2002) and the peer BART. The two versions of the BART were administered in a counterbalanced manner.

The *standard BART* is a computerized behavioral paradigm designed to measure risk-taking behavior that has been used with adolescents and adults (Lejuez et al., 2002; MacPherson et al., 2010) and has sound psychometric properties (Harrison et al., 2005). The task includes 30 balloons with each balloon set to a breakpoint between 1 and 128 pumps, with the average breakpoint across balloons equal to 64. Each pump was worth 1 cent and was accrued in a temporary bank. The earning could be moved to a permanent bank leading to the next balloon, but if the balloon popped first all temporary money was lost. Once the tasks were completed participants were paid with the amount of money that was accumulated in the temporary bank for both versions of the BART. As described in Lejuez et al., (2002), the primary dependent measures are the number of balloon explosions (EXP) and the number of balloon pumps adjusted (PUMP) to include only the balloons that did not explode.

The *peer BART* was identical to the standard BART except for the computer simulated peer component. For this component, participants were told that an interactive version of the BART had been developed, and were shown a Google page with a link to the BART, followed by a screen with task instructions. Participants were told that their performance on the task would be observed online by another adolescent who was familiar with the task, and who would provide suggestions regarding pumping strategies with a single statement in a chat room style text box. It was made explicit that following peers' instructions would not affect whether they got paid or not.

In order to make this manipulation more believable, the BART screen displayed a picture of an adolescent who matched the participants' gender and race (Caucasian, African-American, Asian or Hispanic). As a manipulation check, we asked participants about their perception of the virtual peer. Two independent coders coded participants' responses as positive, negative, and neutral. An example of a positive response is: "I really liked it because she told me how much air I needed and did not let the balloon pop every time I put air in it." An example of a negative response is: "I did not listen to them because they were wrong most of the time." An example of a neutral response is: "[the peer] didn't bother me."

During the peer BART, automated feedback was provided in a message box at the bottom of the screen, and the participant was told that these messages were being sent by the adolescent, whose picture was shown on the BART screen. If the participant pumped below the average breakpoint of 64 and the balloon did not pop, they were given the feedback "pump more." If the participant pumped at or above the average breakpoint of 64 and the balloon did not pop, they were given the feedback "just right." If the balloon popped, no feedback was given regardless of how many pumps made.

At the end of the experimental session, participants were paid with the sum of money earned during the standard and peer BART, which ranged from $7.02 to $19.93, with an average of $13.74.

2.4 Data Analyses

Two repeated measures analysis of variance (ANOVA) with smoking status as a between-subjects factor, and outcomes from the standard and peer BART as within-subjects factors were conducted; these analyses were conducted separately for each of the outcome variables, EXP and PUMPS (Lejuez et al., 2002). Paired-sample t-tests were conducted in the presence of a significant interaction to evaluate the difference in the mean number of PUMPS or EXP between peer and standard BART conditions within each of the two smoking groups.

Pearson correlation analysis was conducted to examine the relationships between EXP, PUMPS and changes in BART outcomes (standard-peer) and the BIS-11 and RPI scores (those with missing impulsivity and peer influence measures were excluded; see Table 1).

3. RESULTS

The sample consisted of 22 smokers and 17 non-smokers (51.3% boys), with a mean age of 16.2 (SD = 1.5). Boys were slightly older than girls in this sample (t (39) = 2.19 p = .04) but there was no gender (χ^2 (1, 39) = 3.08, p = .11) and age (t (1, 36) = −.10, p = .92) differences in BART outcome scores. Among smokers, the average number of years smoked was 2.7 (SD = 1.18), the average number of cigarettes smoked per day in the past 30 days was 15.1 (SD = 4.9), and the total mFTQ score was 5.6 (SD = 1.8), indicating moderate to high level of nicotine dependence.

Smoking groups did not differ by gender and age (p's > .08), but smokers had greater impulsivity (t (29.60) = 5.64, p < .01), and less resistance to peer influences, (t (33.97) = 2.63, p = .01).

A repeated-measures ANOVA showed a significant interaction of BART type by smoking status on EXP (F (1, 39) = 4.14, p = .05, ηp^2 = .10; See Figure 1). The paired-samples t-tests showed that smokers had a greater increase in the number of explosions by 2.27 (SD = 3.12; t (21) = −3.52, p < .01), compared to an increase of .29 (SD= 2.87) by non -smokers, t (17) = 1.18, p = .68.

For the analyses with PUMPS as the dependent variable, there was neither a significant main effect of BART type (F (1, 39) = 2.40, p= .13, ηp^2 = .06), smoking group (F (1, 37) = 2.33, p = .14, ηp^2 = .06), nor a significant interaction between BART type and smoking group (F (1, 39) = 1.90, p = .18, ηp^2 = .05). On average, smokers obtained 44.74 (SD = 16.20) number of PUMPS on the peer BART and 39.44 (SD = 14.50) on the standard BART; non-smokers obtained 35.33 (SD = 13.55) on the peer BART and 35.02 (SD = 15.89) on the standard BART.

Bivariate correlation analysis indicated that the total BIS score (p = .011), non-planning impulsivity (p = .022), and cognitive (p = 0.01) were correlated with the changes in EXP from standard to peer BART, and the total BIS score (p = .035) and non-planning impulsivity (p = .003) were also positively correlated with EXP in the peer BART condition (Table 1).

When asked about perceptions regarding their virtual peers, 45% of the participants provided a positive response, 40% provided a negative response and 16% provided a neutral response.

4. DISCUSSION

We observed more risk-taking in the peer BART than in the standard BART among adolescent smokers. These results substantiate existing evidence that peer influences are involved in risk-taking among adolescents (Chassin et al., 2009). Adolescents' sensitivity to peer influences peaks at about age 14 and then fades from late adolescence to young adulthood (Berndt, 1979; Steinberg and Monahan, 2007; Steinberg and Silverberg, 1986). This change in peer influence during the stages of adolescence may differ among certain subgroups. For instance, smokers might be one of such subgroups, as they are more influenced by their peers. Our results suggest that smokers were more likely to take more risks when pressured by peers. These findings support existing epidemiological evidence of the importance of peers in smoking behaviors (Ali and Dwyer, 2009).

Existing literature has shown that adult smokers take more risks on the standard BART in comparison to non-smokers (e.g., Lejuez et al., 2003). However this was not found in this specific examination. The rationale underlying this difference among studies is not clear, but it might be related to the specific sample used for this study.

Contrary to expectations, we did not identify a relationship between self-reported resistance to peer pressure and BART outcomes. However, we observed positive relationships between impulsivity and peer-influenced changes in risk-taking. Impulsive behaviors are known to be early predictors of risk-taking during adolescence (Caspi and Silva, 1995; Caspi et al., 1996; Romer, 2010), are related to being a smoker (De Wit, 2009), and are barriers to achieving abstinence from smoking (Krishnan-Sarin et al., 2007). Our results suggest that adolescents who are high on non-planning impulsivity (or low attention to details and future planning) may be more prone to be distracted by peers into taking risks. The processes by which

impulsivity leads to enhanced risk-taking remain to be determined; it is possible that the relationship between smoking status and risk-taking on the peer BART may be explained by impulsivity given the higher impulsivity among smokers.

Although this current study yielded significant results, these need to be replicated in a larger sample of adolescents. Furthermore, in future studies it is important to assess smokers' response to a virtual peer in comparison to either a computerized neutral or authority figure, or the presence of an actual peer. It is possible that these other social factors might influence risk-taking behavior in a similar way. However, based on the responses adolescents provided at the end of the manipulation in our experiment, we believe that participants thought that the peer giving them suggestion was a real one.

Additionally, it would be important to determine if these findings generalize to a population of smokers who are not seeking treatment or adolescents who engage in other risky behaviors. Future studies also need to assess the presence of other conditions like Conduct Disorder or Attention Deficit Hyperactivity Disorder, which are associated with risk taking, smoking behaviors, and impulsivity (Feldstein and Miller, 2006).

In summary, this study investigates the impact of peer influence on risk-taking among smoking and non-smoking adolescents, with the use of a behavioral paradigm incorporating a peer pressure component. The results suggest that adolescents, especially smokers, are prone to more risk-taking in the presence of peers and provide further support for targeting peer influences in smoking cessation interventions.

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References

Ali MM, Dwyer DS. Estimating peer effects in adolescent smoking behavior: a longitudinal analysis. J Adolesc Health. 2009; 45:402–408. [PubMed: 19766946]

Berndt TJ. Developmental changes in conformity to peers and parents. Dev Psychol. 1979; 15:608–616.

Caspi A, Moffitt TE, Newman DL, Silva PA. Behavioral observations at age 3 predict adult psychiatric disorders. Longitudinal evidence from a birth cohort. Arch Gen Psychiatry. 1996; 53:1033–1039. [PubMed: 8911226]

Caspi A, Silva PA. Temperamental qualities at age three predict personality traits in young adulthood: longitudinal evidence from a birth cohort. Child Dev. 1995; 66:486–498. [PubMed: 7750379]

Chassin, L.; Hussong, A.; Beltran, I. Adolescent substance use. In: Lerner, R.; Steinberg, L., editors. Handbook of Adolescent Psychology: Individual Bases of Adolescent Development. Wiley & Sons; Hoboken: 2009. p. 723-763.

Cohen GL, Prinstein MJ. Peer contagion of aggression and health risk behavior among adolescent males: an experimental investigation of effects on public conduct and private attitudes. Child Dev. 2006; 77:967–983. [PubMed: 16942500]

De Wit H. Impulsivity as a consequence and determinant of drug use: a review of underlying processes. Addict Biol. 2009; 14:22–31. [PubMed: 18855805]

Drevets WC, Raichle ME. Reciprocal suppression of regional cerebral blood flow during emotional versus higher cognitive processes: implications for interactions between emotion and cognition. Cogn Emot. 1998; 12:353–386.

Donohew L, Zimmerman R, Cupp PS, Novak S, Colon S, Abell R. Sensation seeking, impulsive decision-making, and risky-sex: implications for risk-taking and design of interventions. Pers Individ Dif. 2000; 28:1079–1091.

Feldstein SW, Miller WR. Substance use and risk-taking among adolescents. J Ment Health. 2006; 15:633–643.

Flay BR, Phil D, Hu FB, Richardson J. Psychosocial predictors of different stages of cigarette smoking among high-school students. Prev Med. 1998; 27:A9–A18. [PubMed: 9808813]

Gardner M, Steinberg L. Peer influence on risk-taking, risk preference, and risky decision making in adolescence and adulthood: an experimental study. Dev Psychol. 2005; 41:625–635. [PubMed: 16060809]

Harrison JD, Young JM, Butow P, Salkeld G, Solomon MJ. Is it worth the risk? A systematic review of instruments that measure risk propensity for use in the health setting. Soc Sci Med. 2005; 60:1385–1396. [PubMed: 15626532]

Igra, V.; Irwin, CE, Jr. Theories of adolescent risk-taking behavior. In: DiClemente, RJ.; Hansen, WB.; Ponton, LE., editors. Handbook of Adolescent Health Risk Behavior. Plenum Press; New York: 1996. p. 35-48.

Keilp KG, Sackeim HA, Mann JJ. Correlates of trait impulsiveness in performance measures and neuropsychological tests. Psychiatry Res. 2005; 135:191–201. [PubMed: 15996748]

Krishnan-Sarin S, Reynolds B, Duhig AM, Smith A, Liss T, McFetridge A, Cavallo DA, Carroll KM, Potenza MN. Behavioral impulsivity predicts treatment outcome in a smoking cessation program for adolescent smokers. Drug Alcohol Depend. 2007; 88:79–82. [PubMed: 17049754]

Lejuez CW, Aklin WM, Jones HA, Richards JB, Strong JR, Kahler CW, Read JP. The Balloon Analogue Risk Task (BART) differentiates smokers and nonsmokers. Exp Clin Psychopharmacol. 2003; 11:26–33. [PubMed: 12622341]

Lejuez CW, Read JP, Kahler CW, Richards JB, Ramsey SE, Stuart GL, Strong DR, Richard AB. Evaluation of a behavioral measure of risk-taking: the Balloon Analogue Risk-Task (BART). J Exp Psychol. 2002; 8:75–84.

MacPherson L, Magidson JF, Reynolds EK, Kahler CW, Lejuez CW. Changes in sensation seeking and risk-taking propensity predict increases in alcohol use among early adolescents. Alcohol Clin Exp Res. 2010; 34:1400–1408. [PubMed: 20491737]

Monahan KC, Steinberg L, Cauffman E. Affiliation with antisocial peers, susceptibility to peer influence, and antisocial behavior during the transition to adulthood. Dev Psychol. 2009; 45:1520–1530. [PubMed: 19899911]

Nawa NE, Nelson EE, Pine DS, Ernst M. Do you make a difference? Social context in a betting task. Soc Cogn Affect Neurosci. 2008; 3:367–376. [PubMed: 19015081]

Patton JH, Stanford MS, Barratt ES. Factor structure of the Barratt Impulsiveness Scale. J Clin Psychol. 1995; 51:768–774. [PubMed: 8778124]

Perrine NE, Aloise-Young PA. The role of self-monitoring in adolescents' susceptibility to passive peer pressure. Pers Individ Dif. 2004; 8:1701–1716.

Prinstein MJ, Brechwald WA, Cohen GL. Susceptibility to peer influence: using a performance-based measure to identify adolescent males at heightened risk for deviant peer socialization. Dev Psychol. 2011; 47:1167–72. [PubMed: 21463036]

Prokhorov AV, Pallonen UE, Fava JL, Niaura R. Measuring nicotine dependence among high-risk adolescent smokers. Addict Behav. 1996; 21:117–127. [PubMed: 8729713]

Romer D. Adolescent risk taking, impulsivity, and brain development: implications for prevention. Dev Psychobiol. 2010; 52:263–276. [PubMed: 20175097]

Schepis TS, Duhig AM, Liss T, McFertridge A, Wu R, Cavallo DA, Dahl T, Jatlow P, Krishnan-Sarin S. Contingency management for smoking cessation: enhancing feasibility through use of immunoassay test strips measuring nicotine. Nicotine Tob Res. 2008; 10:1495–1501. [PubMed: 19023841]

Shedler J, Block J. Adolescent drug use and psychological health: a longitudinal inquiry. Am Psychol. 1990; 45:612–630. [PubMed: 2350080]

Sobell, LC.; Sobell, MB. Timeline follow-back. A technique for assessing self-reported alcohol consumption. In: Litten, RZ.; Allen, JP., editors. Measuring Alcohol Consumption: Psychosocial and Biochemical Methods. The Humana Press Inc; Totowa: 1992. p. 41-72.

Steinberg L. A social neuroscience perspective on adolescent risk-taking. Dev Rev. 2008; 28:78–106. [PubMed: 18509515]

Steinberg L, Monahan KC. Age differences in resistance to peer influence. Dev Psychol. 2007; 43:1531–1543. [PubMed: 18020830]

Steinberg L, Silverberg SB. The vicissitudes of autonomy in early adolescence. Child Dev. 1986; 57:841–851. [PubMed: 3757604]

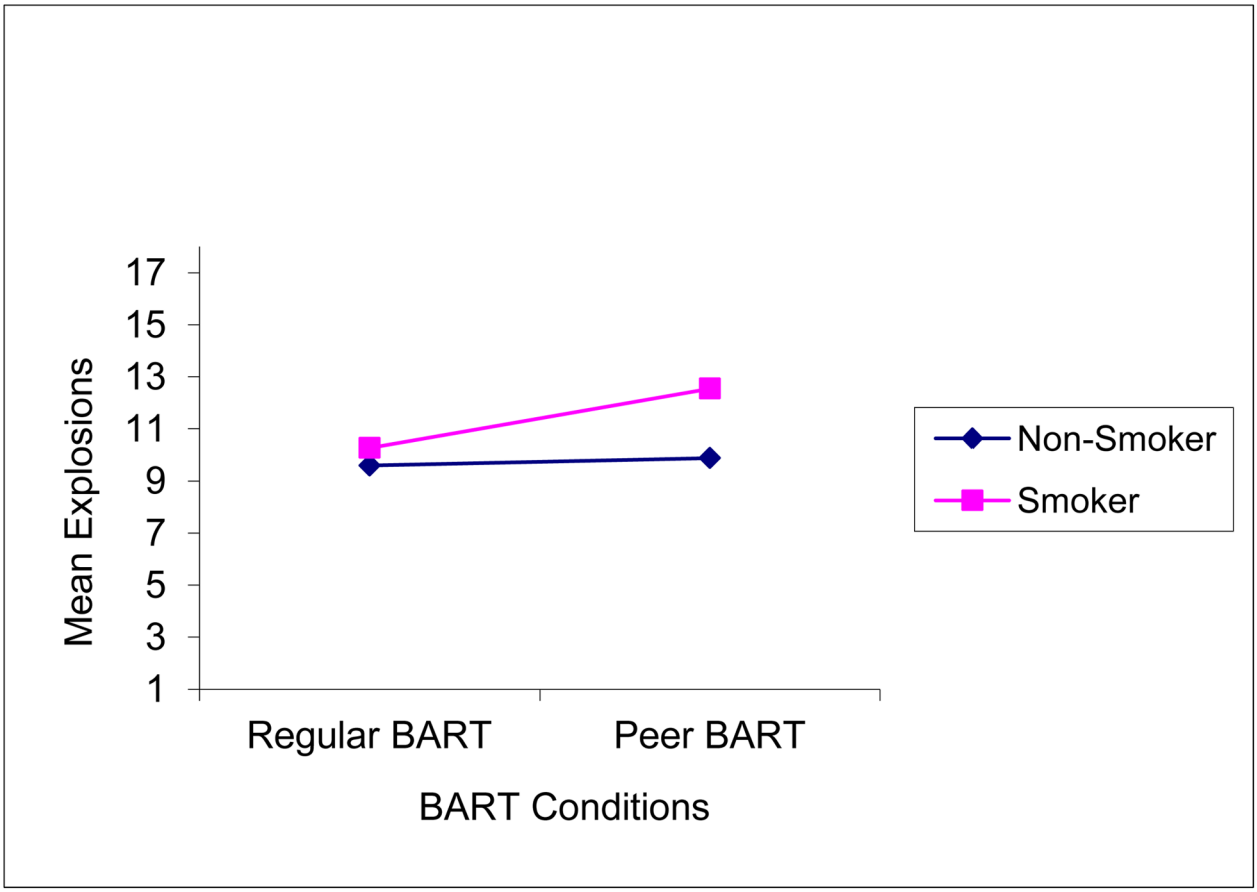

Figure 1.
Mean Explosions by smoking status (22 smokers, 17 non-smokers) and BART conditions (Standard, Peer).

Table 1

Intercorrelations among changes in BART outcomes (adjusted pumps and explosions) in peer BART and standard BART and measures of personality measures of impulsivity (BIS-11) and resistance to peer influences (RPI).

	1	2	3	4	5	6	7	8	9	10	11
1. Adj Pumps Standard BART	--										
2. Adj Pumps Peer BART	.73**	--									
3. Explosions Standard BART	.87**	.64**	--								
4. Explosions Peer BART	.73**	.90**	.72**	--							
5. Change score: BART Adj Pumps	−.33*	.41**	−.27	.26	--						
6. Change score: BART Explosions	−.24	.28	−.43**	.31	.71**	--					
7. Total BIS	.16	.31	.00	.35**	.21	.42*	--				
8. BIS Non-planning	.28	.41*	.15	.48**	.18	.38*	.92**	--			
9. BIS Motor	.05	.20	−.04	.20	.20	.30	.87**	.74**	--		
10. BIS Cognitive	.09	.20	−.10	.25	.16	.42*	.86**	.68**	.57**	--	
11. RPI	.05	.10	.16	.18	.07	.02	.55**	.47**	−.57**	−.41*	--

Note. BART = Balloon Analogue Risk Task; Adj pumps = Adjusted pumps; BIS = Barratt Impulsiveness Scale; RPI = Resistance to Peer Influence; BART $n = 39$, Impulsivity measures and RPI $n = 34$;

* $p < .05$.

** $p < 01$.