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The neighborhood effects of disrupted family processes on adolescent substance use

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ABSTRACT

In the current paper, we argue that the neighborhood-level of disrupted family processes (weak social ties to parents and coercive family interaction) should have a contextual effect on adolescent substance use (cigarette smoking, heavy drinking, and lifetime cannabis use), because adolescents living in neighborhoods in which disrupted family processes are prevalent should be more likely to associate with deviant (substance using) peers. We use nested data on 5491 Icelandic adolescents aged 15 and 16 years in 83 neighborhoods to examine the neighborhood-contextual effects of disrupted family processes on adolescent substance use (cigarette smoking, heavy drinking, and lifetime cannabis use), that is, whether neighborhoods in which disrupted family processes are common have more adolescent substance use, even after partialling out the individual-level effects of disrupted family processes on substance use. As predicted, we find that the neighborhood-levels of disrupted family processes have significant, contextual effects on all the indicators of substance use, and that association with substance using peers mediates a part of these contextual effects. The findings illustrate the limitation of an individual-level approach to adolescent substance use.

Disrupted family processes are primary mechanisms in many individual-level theories of child and adolescent deviant behavior. Accordingly, research on the effects of disrupted family processes on adolescent problem behavior usually focuses on the individual-level effects of family processes on adolescent behavior. Such research has found extensive evidence for the role of disrupted family processes in the origins of adolescent conduct problems. Thus, weak social ties to parents have been shown to influence adolescent delinquency and substance use (Krohn & Massey, 1980; Sampson & Laub, 1994), presumably because such ties constitute an important element of social control (Hirschi, 1969; Kornhauser, 1978). Also, coercive interaction or conflict between parents and their children has been found to influence adolescent deviance (Conger, Ge, Elder, Lorenz, & Simons, 1994; Sampson & Laub, 1994; Sigfusdottir, Farkas, & Silver, 2004), perhaps because coercive interaction reinforces antisocial behavior in young people (Patterson, DeBaryshe, & Ramsey, 1989), and perhaps because it creates strain and negative affect (Agnew, 1992).

However, there has been limited research on the potential neighborhood effects of disrupted family processes on adolescent deviance. This lack of research constitutes an important gap in the growing literature on multilevel research of neighborhood effects on child and adolescent development. Such research has usually focused on the effect of community structural disadvantage (i.e. community-levels of impoverishment, residential mobility, ethnic or racial heterogeneity, single parent households) on adolescent substance use (Chuang, Ennett, Bauman, & Foshee, 2005; Frank, Cerda, & Rendon, 2007; Henry & Slater, 2007; Xue, Zimmerman, & Caldwell, 2007). Such community characteristics are held to impact adolescent substance use because they undermine neighborhood sources of social control, including social ties among neighborhood residents, normative consensus, and informal surveillance of public space (Sampson & Groves, 1989; Sampson, Raudenbush, & Earls, 1997). In short, when neighborhood research has incorporated disrupted family processes, it has operationalized disrupted family processes as individual-level constructs only (Beyers, Bates, Pettit, & Dodge, 2003; Bowen, Bowen, & Ware, 2002; Leventhal & Brooks-Gunn, 2000; Rankin & Quane, 2002; for an exception, see Thorlindsson & Bernburg, 2004).

The current paper argues that examining disrupted family processes solely as individual-level constructs provides an incomplete account of the effects that such processes have on adolescent

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substance use. The reason is that peer associations, which are usually nested in the local neighborhood, have a large impact on adolescent deviant behavior, including substance use (Akers, 1985; Cattarello, 2000; Chuang et al., 2005; Haynie, 2001; Jessor & Jessor, 1977; Kandel & Davies, 1991; Thorlindsson & Bernburg, 2006; Thornberry & Krohn, 1997; Warr, 2002). Our point is that the prevalence of disrupted family processes in a neighborhood influences the type of peer contacts that is available and/or likely for any particular adolescent living in the neighborhood. Specifically, neighborhoods in which disrupted family processes are common should tend to have a larger pool of troubled or deviant adolescents (given the well-documented individual-level effects of disrupted family processes on deviant behavior). Therefore, adolescents living in such neighborhoods should be more likely to associate with deviant (substance using) peers, and hence should be more likely to be substance users themselves. Accordingly, adolescents that belong to neighborhoods in which disrupted family processes characterize many households should be more likely to associate with deviant peers (including substance using peers), even after partialling out the effects that their own family processes have on peer associations, and hence they should be more likely to be substance users themselves. We are not aware of any previous tests of these hypotheses.

Although the research has rarely included neighborhood measures of disrupted family processes, there is research that supports the general notion that neighborhood context influences adolescent conduct problems through its effects on peer associations. Cattarello (2000) found that community disadvantage (low socioeconomic status) was associated with adolescent marijuana use, and that peer marijuana use mediated a part of this effect. Haynie, Silver, and Teasdale (2006) found that affiliation with violent peers mediated the association between- neighborhood disadvantage and adolescent violent behavior. Similar results have been reported for alcohol use (Chuang et al., 2005). Brody et al. (2001) found that community disadvantage was associated with a greater likelihood that 10–12-year-old children will affiliate with deviant peers, net of parent–child relations. Finally, Bernburg, Thorlindsson, and Sigfusdottir (2009b) found that neighborhood household poverty influenced adolescent suicidal behavior in part through its effect on suicide suggestion (affiliation with suicidal others).

The current study moves beyond individual-level research on disrupted family processes (ties to parents and coercive interaction between parents and adolescents). Here we focus also on the neighborhood effects of aggregate levels of disrupted family processes on adolescent individual risk of cigarette smoking, heavy drinking, and lifetime cannabis use. Using nested data on 5491 adolescents and 83 school-neighborhoods in Iceland, we examine the neighborhood-contextual effects of disrupted family processes on adolescent substance use, and whether association with deviant (substance using) peers mediates these effects. Finally, we explore whether the neighborhood-level of disrupted family processes constitutes an important, albeit previously ignored, mediating mechanism in the much studied effect of neighborhood structural disadvantage on adolescent deviant behavior.

The current study

The Icelandic research setting is uniquely well-suited to examine the effect of neighborhood context on adolescent outcomes (Bernburg & Thorlindsson, 2007; Bernburg, Thorlindsson, & Sigfusdottir, 2009a, 2009b). We define neighborhood boundaries by using public schools. In Iceland public school attendance and neighborhood residence are tightly coupled during childhood and adolescence. The great majority (about 85 percent) of children and adolescents (up to age 16) attend small, neighborhood-based, public schools that are operated and funded by the county governments. Children and adolescents are selected into the schools based on neighborhood residence, regardless of their backgrounds. Hence, in contrast to many other countries, most of the adolescents in a given school live in the same local neighborhood and they comprise most of the adolescents living in the local neighborhood. Thus, the schools comprise small, local communities in which social ties among adolescents are dense. This point is important, as our approach is predicated on the assumption that social ties among adolescents are more likely to occur within, rather than between, neighborhoods (the current survey data shows that about 84 percent of adolescents indicate knowing "almost all", "most", or "a few" of the same-aged children that live in their neighborhood by their first name; 66 percent say that they know "most" or "almost all" by their first name). The research setting thus overcomes the common problem in community research of using arbitrary criteria in drawing the boundaries of community-level units (Bursik, 1988).

Duncan and Raudenbush (1999) have pointed out that schools and neighborhoods provide the most important extra-familial contexts for studying children and adolescents. Focusing on the role of peer influence, we take this point one step further and argue that neighborhood peers comprise a particularly important extra-familial context for adolescents. Below, we tackle the context of disruptive family processes among neighborhood peers by aggregating survey responses to the neighborhood-level. Our survey data contains the majority of the adolescent population in each neighborhood, and hence our measures are highly representative of the neighborhood context of disruptive family processes.

Data and measurement

The current analysis used two data sources. First, we used a national population survey of Icelandic adolescents to obtain individual-level measures as well as neighborhood-level measures of disrupted family processes. The initial sample consisted of all students born in 1990 and 1991 (15 and 16 years old), attending the compulsory ninth and tenth grade of the secondary school. Anonymous questionnaires were administered to all students present in class on 1 day in March 2006. Questionnaires were administered with sealed envelopes by teachers and research assistants. No attempts were made to reach students that were absent on the day of the survey. Valid questionnaires were obtained from 7430 respondents, about 84 percent of the population of the two cohorts. A total of 129 schools (96 percent of all the schools in Iceland) participated in the survey. We excluded from the analysis 1002 respondents who did not attend their local neighborhood school. Furthermore, schools with less than 20 respondents, all located in sparsely populated rural areas, were excluded (46 schools). There are three reasons for deleting these schools. First, the measures of neighborhood family disruption were created by aggregating survey items to the school-level (see below), and hence we wanted a sufficient number of respondents in each school-neighborhood. Second, the schools that we deleted are located in very large and extremely sparsely populated rural areas, and thus do not constitute meaningful neighborhoods. Third, we were unable to obtain registered data for most of these areas. The final analysis included 5491 respondents (51 percent female) in 83 neighborhoods. The average number of respondents in each school-neighborhood was about 71 (standard deviation = 48). The largest school had 286 respondents; the smallest had 21 respondents (eleven schools had less than 40 respondents, of which six schools had between 20 and 29 respondents).

Second, we obtained measures of neighborhood structural characteristics by using population data from Statistics Iceland (http://www.statice.is), a governmental organization that collects registered data on income (based on actual tax records) and social-demographic characteristics of all persons in Iceland by address and family type (based on the National Registry). Following the geographical boundaries of the 83 school-neighborhoods, we aggregated selected records for the year 2005 (see below).

To illustrate the size of the neighborhoods (based on registered data), the average number of households with children in the neighborhoods is 410 (median = 348). The interquartile range spans 252–517 households with children; the smallest 25 percent have between 92 and 251 households with children; and the largest 25 percent have between 517 and 1879 households with children (of which only two neighborhoods have over 1000 households). The total neighborhood populations range between 719 and 15,923 (mean = 3226; median = 2860). The urban neighborhoods have a radius between about .6 and 1.0 miles, with a few larger urban neighborhoods having a radius between 1.0 and 2.0 miles.

Substance use

Cigarette smoking was coded "1" if respondent smokes at least one cigarette on a daily basis and "0" otherwise. *Heavy drinking* was coded "1" if respondent had been drunk at least once during the past 30 days and "0" otherwise. *Lifetime cannabis use* was coded "1" if respondent had used cannabis ("hashish or marijuana") at least once in his/her lifetime and "0" otherwise. Table 1 shows that eight percent of the respondents smoked at least one cigarette each day, 18 percent had been drunk at least once during the past 30 days, and 5 percent had used cannabis sometime in their lifetime. Research has shown that self-reported measures of substance use are generally valid and reliable (Krohn, Lanza-Kaduce, & Akers, 1984).

Deviant peer association

Following a common approach in research on peer influence (e.g. Krohn et al., 1984), we measured peer substance use by the respondents' perception of their friends' involvement in deviant behavior. Following Haynie (2002), we tackled the relative (as opposed to the absolute) number of deviant friends. Thus, *peer substance* use was measured with four questions about how many of the respondent's friends smoke cigarettes, drink alcohol, get drunk at least once a month, and use cannabis. The answers ranged from 1 (none) to 5 (all of them). The scores were standardized and averaged to create a summary measure (Chronbach's alpha = .88).

However, measures that rely on the perception of friends' deviant behavior entail the risk of same-source bias, because respondents may project their own deviance on others (see Haynie, 2002). Hence, we created alternative measurement by tackling some of the mechanisms that drive peer influence. The mechanisms that presumably drive peer influence on deviant behavior include social reinforcement (Akers, 1985); for example, deviant behavior can be a form of impression management, that is, a means to defend, maintain, or assert a desired social identity (Tedeschi & Felson, 1994); modeling the behavior of others (Akers, 1985), especially when such behavior results in valued outcomes (e.g. deviant acts that result in the attention or admiration in the peer-group); and the learning of definitions that are favorable to deviance (Sutherland & Cressey, 1984). Thus, when the individual senses that substance use brings status in the peergroup, substance use may often be a form of impression management as well as resulting from modeling the behavior of others. Measuring the perception that substance use is a source of status and membership in the peergroup thus provides alternative indicators of deviant peer association. We used two indicators to tackle the respondent's perception of whether substance use is a source of status and membership in the peergroup. First, *STATUS* comprises three questions: "Do you think that it makes a difference for your respect in your group of friends to… "smoke cigarettes", "drink alcohol", and "use hassish or marihuana". The answers ranged from 1 (decreases respect very much) to 5 (increases respect very much). The scores were standardized and averaged (Chronbach's alpha = .86). Second, *MEMBERSHIP* comprises three items: "Sometimes it is necessary to… [smoke cigarettes, drink alcohol, smoke hassish or marihuana]… in order not to be an outsider in my group of friends." The answers ranged from 1 (I disagree very much) to 4 (I agree very much). The scores were standardized and averaged (Chronbach's alpha = .81).

Table 1
Descriptive statistics for neighborhood-level ($N = 83$) and individual-level variables ($N = 5491$).

	Mean	Standard deviation	Minimum value	Maximum value	Intraclass correlation (ρ)
Neighborhood-level					
Weak social ties to parents	.03	.16	−.27	.43	–
Coercive family interaction	.32	.08	.16	.55	–
Concentrated disadvantage	.00	1.00	−1.86	4.26	–
Residential mobility	−.90	.38	−1.91	.00	–
Rural location[a]	.23	.42	0	1	–
Individual-level					
Weak social ties to parents	−.01	.79	−.79	3.46	–
Coercive family interaction	.32	.50	.00	2.00	–
Household poverty	−.01	.75	−.42	4.97	–
Immigrant status[a]	.02	.12	0	1	–
Gender[a]	.52	.50	0	1	–
Moved in last 12 months[a]	.08	.27	0	1	–
Live with both parents[a]	.72	.45	0	1	–
Peer substance use	.00	.86	−.95	3.17	.07*
STATUS	−.01	.88	−1.00	2.85	.05*
MEMBERSHIP	−.01	.83	−.37	5.22	.01*
Cigarette smoking[a]	.08	.27	0	1	.07*
Heavy drinking[a]	.19	.39	0	1	.05*
Lifetime cannabis use[a]	.06	.24	0	1	.07*

* Probability that the level 2 variance component is zero is less than .05.
[a] Dichotomous variable.

Disrupted family processes

We measured two key dimensions of disrupted family processes, namely, *weak social ties to parents* and *coercive family interaction*. According to social bonding theory (Hirschi, 1969), deviant behavior is more likely when adolescents lack attachment to parents and other significant institutions of society. Studies emphasizing social support as an important precondition for the provision of effective social control have found a consistent relationship between family social support and deviant behavior (Barrera & Li, 1996; Krohn & Massey, 1980; Sampson & Laub, 1994). We measured social ties to parents with the mean score on six questions about how difficult or easy it is to receive different types of support from parents, that is, warmth and caring, conversations about private matters, advice concerning work/practical matters, help with practical matters, borrowing money, and borrowing things (Chronbach's alpha = .86). The index was reverse coded (1 = maximum social ties to parents, 4 = minimum social ties to parents).

Coercive interaction between parents and their children has been shown to influence adolescent deviant behavior (Agnew & White, 1992; Aseltine, Gore, & Gordon, 2000; Conger et al., 1994; Sampson & Laub, 1994; Sigfusdottir et al., 2004). Coercive interaction within the family setting may reinforce antisocial behavior in children and youths (Patterson et al., 1989). Also, coercive family interaction constitutes an aversive situation that can result in negative emotional reactions that can induce deviant behavior (Agnew, 1992). We combined two key dimensions of coercive family interaction, namely, verbal fighting and physical coercion (Conger et al., 1994; Patterson et al., 1989; Sigfusdottir et al., 2004). Respondents were asked whether they had been in a "serious argument" with their parents during the last 12 months (about 38 percent say that they have) and whether they had been subject to physical violence by an adult in their home during the last 12 months (about 6 percent say that they have). Coercive family interaction was coded "0" (respondent has not been in a serious argument with their parents and has not experienced physical violence in the past 12 months), "1" (respondent has experienced either a serious argument or physical violence in the past 12 months) and "2" (respondent has been in a serious argument and has experienced physical violence in the past 12 months).

Neighborhood-level measurement of family disrupted processes

We created neighborhood-level indicators of weak social ties and coercive interaction by using the school-neighborhood mean for each index.

Control variables (individual-level)

Family structure was coded "1" if respondent lives with both parents and "0" otherwise. *Residential mobility* was coded "1" if respondent had moved to a new neighborhood/community during the past 12 months, and "0" otherwise. *Immigrant status* was coded "1" if respondents indicated that both parents were not born in Iceland and "0" otherwise. Finally, *sex* was coded "1" for females and "0" for males.

Conger et al. (1994) have found that perceived economic stress fully mediates the effect of parents' economic status on adolescent problem outcomes. Accordingly, we measured *household poverty* with four items: "Your parents' financial status is bad", "Your parents cannot afford to own and operate a car", "Your parents hardly have enough money to pay for basic necessities (e.g. food, housing, phone)", and "Your parents cannot afford the type of leisure activity that you would most prefer to practice (e.g. music or sports)". The answers ranged from "1" (almost never) to "5" (almost always). The scores were standardized and averaged (Chronbach's alpha = .77). A supplementary study of measurement validity has shown a strong association between this measure of household economic deprivation and parents' reporting of household economic deprivation (Bernburg et al., 2009a). Also, we have examined the measurement validity of this subjective measure of household poverty by aggregating it to the school-neighborhood level (using school means), and correlating it with registered data on mean household income in the neighborhoods (a measure that we describe in the following section). The correlation between these items is strong ($r = -.75$ in rural areas and $-.64$ in the Reykjavik (metropolitan) area). Finally, this subjective measure of poverty has been shown to have good construct validity, influencing a wide range of adolescent behavioral and emotional outcomes, including delinquent and violent behavior, anger, normlessness, and suicidal behavior (Bernburg et al., 2009a).

Registered data on neighborhood structural characteristics

The selection of neighborhood structural characteristics follows prior research on community context and youth antisocial behavior (Bernburg & Thorlindsson, 2007; Rankin & Quane, 2002; Sampson & Groves, 1989; Sampson et al., 1997). First, based on actual tax records for the Icelandic population in year 2005, we measured the *mean household income* of households within the geographical boundary of the school-neighborhood (a household is defined as any parental unit that is registered as a caregiver of a child, 0–18 years old). The measure is positively skewed, and hence we transformed it using the natural logarithm of the original values (we note that using the median household income does not change the findings presented below). *Immigrant concentration* was defined as the neighborhood proportion of parents that are registered as foreign nationals. *Single parent households* was defined as the proportion of neighborhood households registered as single parent households. The three neighborhood indicators are highly correlated. Hence, following prior research (Rankin & Quane, 2002; Sampson et al., 1997), we used factor analysis (not shown) to create a summary index, *concentrated disadvantage*. The contribution of each item to the index was weighted by its factor loading score. The Pearson's correlations of the three items with the index are .83 (single parent households), .84 (proportion foreign parents), and $-.74$ (log of mean household income). *Residential mobility* was defined as the neighborhood proportion of parents that lived in the school-neighborhood in year 2005 but who did not live there in year 2000. As this measure was skewed to the right, we used a natural logarithm transformation. Finally, *rural location* was coded "1" for school-neighborhoods in rural areas and "0" otherwise.

Statistical analysis

Hierarchical regression is the appropriate method for nested, multilevel data (Bryk & Raudenbush, 1992). We use HLM 5 to conduct the analysis (Raudenbush, Bryk, & Cheong, 2001). Following Guo and Zhao (2000), we use logistic (Bernoulli) hierarchical regression for dichotomous dependent variables, that is, cigarette smoking, heavy drinking, and cannabis use (method of estimation: restricted PQL). Linear hierarchical regression is used for continuous dependent variables (peer substance use, STATUS, and MEMBERSHIP). The individual-level equations:

$$\text{Linear model}: \quad Y_{ij} = \beta_{0j} + \sum \beta_{kj}\left(X_{ijk} - X_{..k}\right) + r_{ij}$$

$$\text{Binary model}: \log[\Pr(Y_{ij}=1)/(1-\Pr(Y_{ij}=1)] = \beta_{0j}+\sum\beta_{kj}\left(X_{ijk}-\overline{X_{..k}}\right)$$

where Y_{ij} is a value on the dependent variable for individual i in community j; β_{0j} is the mean value of the dependent variable in community j adjusted for the differences among the j units in X_{ijk}; β_{kj} is a slope coefficient for the individual-level variable X_{ijk}; $((X_{ijk}-\overline{X_{..k}}))$ refers to individual-level variables centered at their grand means; and r_{ij} is the error term. The baseline community-level equation:

$$\beta_{0j} = \gamma_{00}+\overline{\sum\gamma_{k01}}X_{jk}+u_{0j}$$

where γ_{00} is an intercept, $\Sigma\gamma_{k01}$ are the (contextual) effects of the community-level characteristics $\overline{X_{jk}}$ on the adjusted average value of the dependent variable in community j, and u_{0j} is the error term for the community-level random effect on the intercept B_{0j}. We estimate all individual-level effects as random across communities.

Results

Focusing on a neighborhood-level explanation of substance use and association with deviant peers rests on the assumption that these constructs exhibit some between-neighborhood variation in the current setting. We estimated intercept-only models to produce significant tests for the between-neighborhood variances in these variables. We followed Guo and Zhao (2000) and estimated the intraclass correlations from intercept-only multilevel binary models by $\rho=\sigma_u^2/(\sigma_u^2+\sigma_e^2)$, where $\sigma_e^2=\pi^2/3$ (the variance of the standard logistic distribution), and where σ_u^2 is the between-neighborhood variance component. These models (not shown in table) showed that the indicators of substance use and deviant peers association all exhibit a significant between-neighborhood variance ($p<.05$), even after controlling for the baseline individual-level model (see the list of individual-level variables reported in Table 3). Thus, a significant part of the variance in these variables occurs between- neighborhoods. Moreover, the intercept-only models can be used to estimate intraclass correlations for these variables.[a] Shown in Table 1, the intraclass correlations for the substance use indicators range between .05 and .07, and the intraclass correlations for peer substance use, STATUS, and MEMBERSHIP are .07, .05, and .01, respectively. Thus, with the exception of MEMBERSHIP, the between-neighborhood variances are nontrivial, although most of the total variation in these variables is between-individuals variance—a typical finding in neighborhood research on children and adolescents (Bryk & Raudenbush, 1992).

The between-neighborhood dispersions of coercive interaction (Skewness = .52; Kurtosis = .27; $P_{\text{Shapiro Wilk}}=.17$) and weak social ties to parents (Skewness; .53; Kurtosis = .17; $P_{\text{Shapiro Wilk}}=.07$) are roughly normal in shape. Moreover, the between-neighborhood dispersion in disrupted family processes is substantial. To illustrate, the neighborhood percent of adolescents reporting any coercive interaction during the past 12 months (that is, scoring 1 or 2 on the measure for coercive interaction) ranges between 14 and 55 percent (25th quartile = 25 percent, 50th quartile = 30 percent, and 75th quartile = 36 percent). The percent of adolescents in the top quartile on weak social ties to parents ranges between 11 and 52 percent (25th quartile = 22 percent, 50th quartile = 25 percent, and 75th quartile = 31 percent).

Main analysis

The current argument implies that association with deviant peers may mediate the neighborhood effects of aggregate levels of disrupted family processes on substance use. This implies an analysis of "2 → 1 → 1" mediated effect (Krull & MacKinnon, 1999), that is, a Level 2 independent variable (neighborhood disrupted family processes) is predicted to influence a Level 1 dependent variable (substance use) through a Level 1 mediator variable (association with deviant peers). Accordingly, to establish mediated effects, we need to show that disrupted family processes have a neighborhood effect on both association with deviant peers and substance use, and that the neighborhood effect of disrupted family processes on substance use is reduced when association with deviant peers is controlled for.

We examine these hypotheses in Tables 3 and 4 (see Table 2 for zero-order correlations). Table 3 reports the regression of association with deviant peers. The findings lend some support for the neighorhood effect of disrupted family processes on deviant peer associations. In Model 1 the neighborhood measures for weak social ties to parents and coercive family interaction have significant and positive, contextual effects on peer substance use. In Model 2 the neighborhood effect of weak social ties to parents on STATUS is statistically significant, but the neighborhood effect of coercive family

Table 2
Zero-order correlations.

Neighborhood-level variables			1			2			3			4
1. Weak social ties to parents			–									
2. Coercive family interaction			.30**			–						
3. Concentrated disadvantage			.34**			.21			–			
4. Residential mobility			−.20			.01			.20			–
5. Rural location			.30**			−.02			−.07			−.69**

Individual-level variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Weak social ties to parents	–											
2. Coercive family interaction	.27**	–										
3. Household poverty	.26**	.14**	–									
4. Immigrant Status	.09**	.03**	.05**	–								
5. Gender	−.03*	.09**	.01	.01	–							
6. Moved in last 12 months	.06**	.06**	.10**	.02	.00	–						
7. Live with both parents	−.14**	−.18**	−.21**	−.04**	−.01	−.15**	–					
8. Peer substance use	.15**	.31**	.10**	.01	.09**	.07**	−.13**	–				
9. STATUS	.16**	.20**	.12**	.02	−.04**	.05**	−.09**	.47**	–			
10. MEMBERSHIP	.18**	.18**	.17**	.04**	−.07**	.11**	−.08**	.29**	.34**	–		
11. Cigarette smoking	.13**	.23**	.12**	.03	.04**	.05**	−.12**	.46**	.29**	.23**	–	
12. Heavy drinking	.10**	.24**	.09**	−.01	.03*	.05**	−.10**	.50**	.33**	.25**	.44**	–
13. Lifetime cannabis use	.12**	.15**	.10**	.04**	−.06**	.06**	−.10**	.34**	.24**	.21**	.47**	.41**

* $p<.05$; ** $p<.01$ (two-tailed).

Table 3
Hierarchical linear regression of peer substance use, STATUS, and MEMBERSHIP.

Independent variables	Dependent variables		
	Peer substance use	STATUS	MEMBERSHIP
	Model 1	Model 2	Model 3
	Coefficient	Coefficient	Coefficient
Neighborhood-level variables			
Concentrated disadvantage	.01	−.01	.01
Residential mobility	.00	.02	.06
Rural location	.07	.07	.11
Weak social ties to parents	.36*	.42*	.01
Coercive family interaction	.92**	.32	.30
Individual-level variables			
Weak social ties to parents	.05**	.08***	.09***
Coercive family interaction	.44***	.27***	.22***
Female	.12***	−.09*	−.12**
Household poverty	.03	.06**	.11***
Immigrant status	−.09	−.03	.09
Residential mobility	.13*	.08	.21**
Two-parent households	−.11**	−.06*	−.01
Model fit			
$-2 \times$ log-likelihood	13,012	13,634	12,968

Note: The table reports unstandardized coefficients from hierarchical regression models. Significant tests are based on robust standard errors.
* $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed).

interaction is insignificant. Model 3, however, finds no significant neighborhood effects of disrupted family processes on MEMBERSHIP. Furthermore, the individual-level results are mostly consistent with what would be expected. Thus, the indicators of disrupted family processes have significant, positive effects on all the indicators of deviant peer associations; adolescents that live in two-parent households are somewhat less likely to associate with deviant peers, as are those having moved to a different neighborhood recently are more likely to associate with deviant peers. Interestingly, females are somewhat more likely to report having substance using friends, but they are a little less likely to perceive substance use as a source of group status and membership.

Table 4 reports the regression of cigarette smoking, heavy drinking, and lifetime cannabis use. Consider first the neighborhood findings in Models 1, 4, and 7 that examine the baseline neighborhood effects of disrupted family processes on substance use, prior to controlling for association with deviant peers. As predicted, the neighborhood indicators of disrupted family processes have significant, contextual effects on cigarette smoking (Model 1) and heavy drinking (Model 4). In the case of lifetime cannabis use (Model 7), only one of the neighborhood indicators of disrupted family processes, namely, coercive family interaction, exhibits a significant effect.

To illustrate these effects, we have calculated odds ratios for a standard deviation change in the indicators of neighborhood disrupted family processes (not shown in table). These calculations show that for every standard deviation increase in the neighborhood-level of weak social ties to parents (that is, for every .16 unit increase), the odds of smoking are increased by 14 percent ($OR = e^{.16*.80} = 1.14$), and the odds of heavy drinking are increased by 15 percent ($OR = e^{.16*.90} = 1.15$). Likewise, for every standard deviation increase in neighborhood coercive family interaction (that is, for every .08 unit increase), the odds of smoking are increased by 24 percent ($OR = e^{.08*.2.69} = 1.24$), the odds of heavy drinking are increased by 13 percent ($OR = e^{.08*.1.58} = 1.13$), and the odds of lifetime cannabis use are increased by 19 percent ($OR = e^{.08*.2.25} = 1.19$).

The individual-level results are in line with what would be expected. Individual-level disrupted family processes have significant, positive effects on substance use with the exception of heavy drinking where weak ties to parents do not have a significant effect. Household poverty has a positive effect on cigarette smoking, and lifetime cannabis use, but not on heavy drinking. Living in a two-parent household is associated with decreased odds of substance use. Adolescents that have moved to a different neighborhood recently are more likely to smoke cigarettes and to report lifetime cannabis use, but mobility has no significant influence on heavy drinking. Immigrant status is associated with increased odds of cigarette smoking and cannabis, but decreased odds of heavy drinking. Finally, females are significantly more likely than males to report smoking, but they are less likely to report lifetimes cannabis use.

Deviant peer association is added to the equations in Models 2, 5, and 8. As predicted, deviant peer association indicators are in most cases significantly and strongly related to substance use. To illustrate, for every standard deviation increase in peer substance use ($s = .86$) the odds of smoking, heavy drinking, and lifetime cannabis use are increased by 145 percent ($OR = 2.45$), 188 percent ($OR = 2.88$), and 70 percent ($OR = 1.70$), respectively.

We have predicted that deviant peer association should mediate the neighborhood effects of disrupted family processes on substance use. A comparison of the neighborhood effects of disrupted family processes with and without deviant peer associations lends support for this argument. Thus, comparing Model 1 and Model 2, the coefficient for the neighborhood effects of weak ties to parents on cigarette smoking is reduced from .80 to .60 (by 25 percent), and the coefficient for the neighborhood effect of coercive family interaction on smoking is reduced from 2.69 to .86 (by 68 percent). In the case of heavy drinking in Model 4 and Model 5, adding association with deviant peers reduces the coefficient for the neighborhood effect of weak social ties to parents by about 50 percent, and the coefficient for the effect of coercive family interaction on heavy drinking almost reduces to zero (compare Models 4 and 5). Finally, comparing Model 7 and Model 8, adding deviant peer association produces about 70 percent reduction in the coefficient for the neighborhood effect of coercive family interaction on lifetime cannabis use.

The effects of the neighborhood structural characteristics

As discussed above, the neighborhood-level of disrupted family processes may mediate the effect of neighborhood structural disadvantage on substance use. Accordingly, we need to examine whether the effects of neighborhood disadvantage on substance use and deviant peer association are mediated by neighborhood disrupted family processes. First, we have estimated the total effects of neighborhood concentrated disadvantage, rural location, and residential mobility on deviant peer association in Models 2, 4, and 6 in Table 3, and on substance use in Models 3, 6, and 9 in Table 4. The results show that, except for STATUS, neighborhood concentrated disadvantage has a significant contextual effect on all outcomes, consistent with prior neighborhood research (Elliott et al., 1996; Sampson et al., 1997). These effects are substantial. Thus, every standard deviation increase in concentrated disadvantage ($s = 1.0$) increases the odds of smoking, heavy drinking, and lifetime cannabis use by 9 percent ($OR = 1.09$), 13 percent ($OR = 1.13$), and 16 percent ($OR = 1.16$), respectively.

Second, the effects of neighborhood concentrated disadvantage are reduced substantially when neighborhood disrupted family processes are controlled. Thus, the coefficient for the effect of concentrated disadvantage on smoking is reduced by 100 percent (from .09 to .00) when neighborhood family disrupted processes are controlled. Similarly, the effect on heavy drinking is reduced by about 67 percent (from .12 to .04). However, in the case of lifetime

Table 4
Hierarchical binomial regression of cigarette smoking, heavy drinking, and lifetime cannabis use.

Independent variables	Dependent variables								
	Smoking (0, 1)			Heavy drinking (0, 1)			Lifetime cannabis use (0, 1)		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Neighborhood–level									
Concentrated disadvantage	.00	−.02	.09*	.04	.00	.12**	.12***	.09**	.15***
Residential mobility	−.12	−.13	−.19	−.13	−.14	−.18	−.06	−.09	−.07
Rural location	−.30	−.19	−.23	.09	.01	.18	−.06	−.22	−.10
Weak social ties to parents	.80*	.60*	–	.90**	.45	–	−.12	.20	–
Coercive family interaction	2.69***	.86	–	1.58**	.04	–	2.25***	.68	–
Individual-level									
Weak social ties to parents	.10**	.01	.10**	.05	.04	.06	.22***	.05***	.17***
Coercive family interaction	.87***	.32***	.86***	.93***	.44***	.93***	.79***	.23***	.79***
Female	−.16*	.16	−.15*	.13	.02	.14*	−.53***	−.86***	−.50***
Household poverty	.17***	.14*	.16***	.07	.01	.07	.14***	.13**	.13**
Residential mobility	.54***	.34***	.46***	.19	.06	.18	.50***	.28**	.50***
Two-parent households	−.34***	−.40***	−.33***	−.35***	−.19**	−.34***	−.44***	−.28***	−.43***
Immigrant status	.22	.62***	.29*	−.66**	.04	−.64**	.48**	.25	.48***
Peer substance use	–	1.04***	–	–	1.23***	–	–	.62***	–
STATUS	–	.26***	–	–	.30***	–	–	.00	–
MEMBERSHIP	–	.18***	–	–	.20***	–	–	.14***	–
Model fit									
−2 × log-likelihood	12,984	11,897	12,729	14,454	13,460	14,315	12,756	11,879	12,612

Note: The table reports unstandardized coefficients from hierarchical binomial regression models (population average estimates). Significant tests are based on robust standard errors.
* $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed).

cannabis use the evidence of mediation is more modest. Adding neighborhood disrupted family processes produces about 20 percent reduction in the effect of concentrated disadvantage on lifetime cannabis (the effect is reduced from .15 to .12 and is still significant).

Robustness issues

Although not the focus of the current study, social ties among neighborhood residents have been shown to mediate the effect of neighborhood structure on deviant behavior (Belliar, 1997; Sampson & Groves, 1989). Weak social ties among residents may leave room for unsupervised teenage peer interaction, which in turn may increase deviant peer association and deviant behavior (Sampson & Groves, 1989). Bernburg and Thorlindsson (2007) have shown that social closure (embeddedness in a social network that links community parents and their adolescents; see Coleman, 1988) mediates a part of the effect of neighborhood structure on adolescent delinquency. Disrupted family processes may negatively influence social closure, and hence the contextual effects of disrupted family processes could reflect the effects of social closure. We have estimated the models in Table 4, controlling for a summary index (social closure) comprised of four survey questions about whether the respondents' parents know their friends and whether they know the parents of their friends (see Bernburg & Thorlindsson, 2007). This analysis (not shown) finds no significant evidence indicating that social closure mediates the neighborhood effects of disrupted family processes on substance use. Moreover, controlling for social closure does not change the substantive findings reported in Table 4.

Also, it is possible that absence from school on the day of the survey could produce a bias in our results, especially if schools in which disruptive family processes are more common have a higher attrition rate than other schools (a concern raised by an anonymous reviewer). A supplementary analysis indicates that such bias is not present. First, there is no significant association between the school attrition rate (number of registered students divided by the number of respondents used in the current analysis) and the neighborhood measures of weak social ties to parents (Pearson's $r = .02$; $N = 83$) or coercive family interaction (Pearson's $r = -.01$; $N = 83$). Second, including the school attrition rate as a Level 2 predictor in the main models in Tables 3 and 4 does not influence the results reported above.

Discussion

Our study is among the first to show that disrupted family processes influence not only the risk of substance use among adolescents that experience disruption personally; disrupted family processes increase the risk of substance use among other adolescents in the neighborhood as well. Thus, our findings show that the neighborhood-level of disrupted family processes has a contextual effect on all three indicators of substance use, net of the individual-level effects of disrupted family processes and other relevant variables, and that deviant peer association mediates a part of these contextual effects. These findings are consistent with the theoretical mechanism that we have proposed above, namely, that neighborhoods in which disrupted family processes are common tend to have a larger pool of troubled adolescents, and hence entail an increased risk of deviant peer association for adolescents that belong to such neighborhoods, regardless of whether or not they themselves live in households characterized by disrupted family processes, and hence are more likely to be substance users themselves.

Our findings have implications for research on adolescent substance use and deviant behavior. First, the findings indicate that research on the effect of disrupted family processes on adolescent substance use and deviant behavior should not be limited to individual-level analysis. Our findings indicate that such an individual-level approach may often provide an incomplete account of the effects that disrupted family processes have on children and adolescents. This point is important, especially given the central

role that disrupted family processes play in many theories of child and adolescent deviant behavior (Agnew, 1992; Hirschi, 1969; Patterson et al., 1989; Sampson & Laub, 1994). However, as previous research on this issue has been extremely limited, we urge researchers to replicate our key findings across different societal settings. Moreover, although we have focused on adolescent substance use in the current study, our model can be applied directly to other forms of child and adolescent deviant and risk-taking behavior. After all, the two focal mechanisms emphasized in our model, namely, disrupted family processes and peer influences, comprise crucial elements in many theories of youth deviance.

The findings lend support for "epidemic" theories of neighborhood effects (Jencks & Mayer, 1990), that is, theories that argue that peer influences have a role to play in creating neighborhood effects on individual outcomes. Emphasizing neighborhood disrupted family processes, our study goes beyond previous research on this point, which has focused on the neighborhood effect of structural disadvantage on the risk of affiliating with deviant peers (Bernburg et al., 2009b; Brody et al., 2001; Cattarello, 2000; Chuang et al., 2005; Haynie et al., 2006; Thorlindsson & Bernburg, 2009). Furthermore, the type of epidemic model that we have proposed in the current paper may be applied to the neighborhood concentration of other individual-level risk factors for child and adolescent substance use and deviant behavior. Indeed, we should expect the neighborhood concentration of any powerful individual- or household-level risk factor to increase the pool of troubled children and adolescents in the neighborhood, and hence to excert a contextual effect on child and adolescent deviant behavior. Future research should look into this issue.

Our study indicates that the neighborhood concentration of disrupted family processes may constitute a mediating mechanism in the well-documented influence of neighborhood structural disadvantage on youth welfare. Previous multilevel research has focused on neighborhood structural characteristics, with an emphasis on the effects of neighborhood structural disadvantage on deviant behavior and substance use (Bernburg et al., 2009b; Bursik, 1988; Sampson & Groves, 1989; Sampson et al., 1997; Smith & Jarjoura, 1989). This work has not focused on the mediating role of neighborhood disrupted family processes. Our analysis shows that the effects of neighborhood structural disadvantage (proportion of immigrants, proportion of single parents, and mean income) on substance use are reduced substantially when the neighborhood context of family disrupted processes is taken into account, which therefore suggests that neighborhood structural disadvantage influences adolescent substance use in part through the neighborhood concentration of disrupted family processes. This finding is also consistent with previous individual-level research that has shown that structural disadvantage—economic disadvantage, single parenthood, and immigrant status—has detrimental effects on family processes (e.g. Conger et al., 1994; Sampson & Laub, 1994). Thus, the neighborhood-level of disrupted family processes may in part mediate the "total" contextual effect of neighborhood structural disadvantage on youth substance use. Future research on the neighborhood effects on adolescent substance use and deviance should include disrupted family processes as a neighborhood-level construct.

The study's methodological strengths and weaknesses should be noted. The Icelandic setting provides a unique opportunity to examine neighborhood effects on adolescents, because public school attendance and neighborhood residence are tightly coupled during childhood and adolescence in Iceland. After all, our hypotheses are based on the assumption that peer association is more likely to occur within rather than between-neighborhoods. Moreover, combining population based survey data and registered data on neighborhood structural characteristics has provided an unusual degree of confidence in that the data is representative of the neighborhood context. However, there are limitations as well. The findings cannot be generalized directly to sparsely populated rural areas, as schools from such areas were deleted from the current analysis. Also, our study is not an experiment. Accordingly, although the statistical associations that we have reported are consistent with the causal pathways proposed above, we should bear in mind that they are not proof of causation. Finally, the study is based on cross-sectional data, and hence we cannot address developmental changes. For example, we have not separated in time deviant peer association and substance use, and we cannot examine neighborhood effects on stability and change in behavior (see Duncan & Raudenbush, 1999). Having longitudinal data to test such effects would allow for a more powerful test of our model. Such a test awaits future research.

Conclusion

The current paper has combined insights from three major strands of research on adolescent development, namely, research on disrupted family processes, peer influence, and neighborhood effects. As we have discussed above, our findings have implications for each of these research strands. Our multilevel approach indicates that just as it is impossible to gain sufficient understanding of adolescent substance use by focusing on individual-level risk factors, successful prevention has to take the neighborhood context into account. Our findings highlight the importance of community-based prevention work, as well as demonstrating the complex interplay of individual- and community-level factors in the social context of adolescent substance use. In recent years, community-based prevention programs directed at children and adolescent health have produced promising results (Caswell, 2000; Skutle, Iversen, & Bergan, 2002). However, this work has usually treated the community simply as a context for coordinating prevention efforts (see Arthur, Ayers, Graham, & Hawkins, 2003; Kibel & Holder, 2003). Our study suggests that we must go beyond this approach and take into account the various characteristics of the local community in order to plan effective prevention strategies.

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