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Parents, Peers, and Places: Young Urban Adolescents' Microsystems and Substance Use Involvement

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Abstract

Limited research is available that explains complex contextual and interactive effects of microsystems such as family relationships, peer networks, and place-based influences have on urban adolescent substance use. We contend that research into these complex processes is improved by integrating psychological, social, and geographic data to better understand urban adolescent substance use involvement. Accordingly, we tested a longitudinal, 3-way moderation model to determine if the direct effect of teen–parent relationships on substance use involvement is moderated by peer network characteristics, which in turn is moderated by the risk and protective attributes within urban adolescents' activity spaces, among a sample of 248 adolescents. Results revealed that peer networks moderate the effects of relations with parents on substance use involvement for those adolescents with higher levels of risk attributes within their activity space, but not for those who spend time in locations with less risk. Thus, the teen–parent relationship interacts with peer net-work characteristics, for those urban adolescents whose activity space is constituted within high-risk environments. We conclude that peer networks have important interactive effects with family relationships that influence substance use, and that this is particularly salient for young adolescents who are exposed to risky environments. This finding underscores the importance of continued study into the interrelations among microsystems of urban adolescents, and provides further support that substance use is a social practice that is constituted within the unique geography of young adolescents' lives.

Keywords

Young adolescents; Urban adolescents; Microsytems; Parents; Peers; Activity space

Introduction

Substance use is increasing over the last 3 years among a national sample of students, with 8th graders showing statistically significant increases in any illicit drug use (Johnston et al. 2014). Population density matters among young adolescents, as 8th graders residing in large metropolitan statistical areas (MSAs) are using illicit drugs at higher rates compared to youth in smaller MSAs and non-MSAs (Johnston et al. 2014). In particular, urban youth are

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vulnerable to early substance use and consequently, future problematic use of both illicit drugs and alcohol (Martino et al. 2008; Wright 2004). Many of these youth are disproportionately exposed to trauma (e.g., violence, crime) which increases vulnerability to substance use (e.g., Lee 2012; Zinzow et al. 2009). To adequately understand individual development and change among urban adolescents, the interplay of social and geographical niches in which the individual is embedded must be considered. Ecological models of behavior can be applied to investigate the social, intrapersonal, and environmental influences on risky health behaviors of adolescents, such as substance use (Flay 1999; Flay et al. 2009).

However, researchers seeking to understand adolescent health and risk behaviors continue to struggle with systematic approaches of observing, distinguishing, and interpreting the vital ecological properties associated with the multiple environments that constitute modern adolescent development. Capturing the developing person in context as he or she engages with family, peers, and community members within a dynamic activity space (i.e. one's routine locations) and the accompanying psychological, social, and health-related experiences of these locations, is extremely challenging. An important construct that assists in the application of Bronfenbrenner's (1979) ecological developmental approach is activity space. Activity space can be defined as comprising all the locations that an individual has direct contact with as a result of his or her daily activities (Miller 1991). More broadly, activity spaces are the manifestation of our spatial lives, serving as an index representing routine locations and all the accompanying psychological, social, and health-related experiences of these places (Golledge and Stimson 1997; Sherman et al. 2005). Multiple approaches to measuring activity space have been used to capture location data within a given time-frame such as travel diaries (Goodchild and Janelle 1984), structured interviews (Mason et al. 2004), and using Geographic Information System (Kwan 2013; Mennis et al. 2013).

Research has shown that youth, and urban adolescents in particular, spend their time in a variety of geographically dispersed locations that are not delimited by conventional geographic boundaries, such as census tracts, zip codes, political wards, or even home neighborhood (Browning and Soller 2014). Neighborhood characteristics are known to influence adolescents' perceptions of safety and risk and are associated with substance use and mental health outcomes (Crum et al. 1996; Furr-Holden et al. 2011; Loeber et al. 1999; Mason et al. 2009; Tarter et al. 2009; Lambert et al. 2004), underscoring the importance of this construct for understanding urban youth. Research on activity spaces has also suggested that the places a person frequents out-side the home may expose him or her to a variety of psychological, social, and geographic factors that likely influence substance use, but that may not be observed within the home (Wong and Shaw 2011; Zenk et al. 2011).

A large literature supports that relations with parents is critical to the emotional and behavioral health of young adolescents (Dishion and Stormshak 2007; Kerig et al. 2011; Laursen and Collins 2009; Wills et al. 2000) and that this relationship has been shown to influence adolescent peer relationships (Auslander et al. 2009; Collins 2003; Collins and Sroufe 1999). Even when controlling for gender, age, socio-economic status, and peer effects, relations with parents has shown specific protective effects on health and well-being (Williams and Anthony 2015). Clearly, the adolescent parent relationship is one of many

family-based constructs that effect adolescent emotional and behavioral health and is supported by a large body of research. Of particular interest is an empirically informed theoretical parenting model, named the Social Contextual Model of Parental Influence (Scaramella et al. 2002) which posits that attributes of the family environment such as parenting, directly affect attributes of the peer context (quality of peer relations). A direct pathway from nurturant and active parenting reduces risk for deviant peer affiliations during adolescents (Dishion 1990; Kandel 1996; Spoth et al. 1996), thus providing a protective processes to increase emotional and behavioral health outcomes. Parents who actively engage in their children's lives through nurturing and support will simultaneously guide their children into prosocial peer networks and away from risky peer environments (Scaramella et al. 2002). There is evidence that positive parenting reduces deviant peer affiliation among African American youth living in disadvantaged urban settings and that this effect persists through childhood into adolescence (Lloyd and Anthony 2003).

Social networks have been identified in the literature as a robust predictor of substance use (e.g., Valente et al. 2005). Extensive research has shown that peer context predicts tobacco, alcohol, and drug use (Bauman and Ennett 1996; Knecht et al. 2011; Light et al. 2013; Valente et al. 2005). Peer networks establish group norms that define peer culture, for both prosocial as well as antisocial behavior. Even when controlling for genetic and shared environmental differences, peer network substance use predicts future individual substance use, with stronger effects occurring within high-intensity/best friendships (Cruz et al. 2012). Thus, the need exists to study peer networks capturing both risk and protective dimensions.

As part of a 24 month longitudinal study, we report results from the first year of data collection. We tested a moderated moderation model (Fig. 1) to examine the interactive influence of relations with parents, peers, and activity space risk on substance use involvement with young adolescents. We developed this model based upon 15 years of work with urban adolescents, identifying risk and protective factors associated with peers, activity space, and substance use. In order to integrate a temporal dimension into our models, we used the relations with parents variable (collected at baseline), the peer network variable (collected at 6 months), the activity space variable (collected every 2 months for 1 year), and substance use involvement variable (collected at 12 months). As illustrated in Fig. 1, the first part of the model examines whether peer network will moderate the association between relations with parents and substance use.

We hypothesize that peer network will moderate this direct pathway such that relations with parents will be of greater influence on subsequent substance use for youth with particularly risky peer networks, as compared to youth with more protective peer networks. The second part of the model includes activity space as a moderator to understand whether risk and protective environmental attributes interact with peer network characteristics. We hypothesized that the moderating effect of peer networks on the pathway between relations with parents and substance use will itself be moderated by activity space, such that the moderating effect of peer networks will be greater for youth who spend time in riskier, as compared to safer, environments. This hypothesis is based upon the social contextual model of parental influence, which maintains that parents living in high risk environments may exert increased protective parenting efforts, such as influencing the peer network

composition of their children, e.g., in order to buffer against risky settings (Scaramella et al. 2002). This hypothesis is also grounded in our work with urban adolescents' where we posit that peer networks are an important mechanism by which the urban environment exerts its influence on protective or risk enhancing behaviors (Mason et al. 2010; Mennis and Mason 2012). If activity space moderates the association between peer network and substance use, it is also likely that peer networks will conditionally influence the strength of the direct association between relations with parents and substance use. Specifically, we hypothesized that peer networks will moderate the direct effect when activity space is risky, but not protective- demonstrating a pattern of moderated moderation between our study variables.

Method

Recruitment

This study examined 12 month outcome data from the Social-Spatial Adolescent Study, a longitudinal study of the interacting effects of peer networks, activity space, and substance use. Participants for the study were recruited between November 2012 and February 2014. The majority of participants (72 %) were recruited from an urban adolescent medicine outpatient clinic at a large academic medical institution in Richmond, VA. This ambulatory care clinic provides comprehensive primary and adolescent-specific specialty care services to over 3000 patients annually between ages 12 and 22 years. The present study is part of an urban youth and family initiative that seeks to test brief interventions in health care settings. Age-eligible adolescents presenting to the adolescent clinic for routine or acute care were approached and invited to participate in this study by a research assistant while in the clinic's waiting room or pending arrival of the physician into the patient's exam room after nurse triage. Participants were also recruited from Richmond City Health District satellite clinics. These clinics, located within city-subsidized housing developments, offer limited primary care and adolescent-specific health programs to adolescents and families at little or no cost. These participants were recruited by referral to the study team from the primary patient advocate at each of the satellite clinics. The patient advocate provided information about the study to all teens presenting to the satellite clinic who met the age criteria (13–14 years old). The name and phone number of interested teens was then provided to the study's project manager for follow-up by phone. Over 400 adolescents and parents were either approached at the outpatient hospital clinic or referred from the satellite clinics; of these, 57 % enrolled in the study (N = 248). Enrollment and data collection procedures were the same across sites. All procedures (consent/assent, and baseline survey) were completed in one visit; all participants completed the 30-min baseline survey on a study laptop. Participants completed follow-up surveys upon receiving a text message and email, with an imbedded URL link to complete a web-based follow-up survey. Chi square tests revealed no significant differences in age, sex, or race of participants between the recruitment sites. Data collection procedures were the same across sites.

Adolescents who met eligibility requirements (i.e. age 13 or 14 years old, registered clinic patient, and Richmond area resident) were recruited to participate. Written informed consent was obtained from all parents and adolescent participants prior to conducting any research activities. The first authors' university and the Richmond City Health Department's

institutional review boards approved the research protocol, and the study received a federal Certificate of Confidentiality from the National Institutes of Health. At enrollment, participants completed an initial survey in a private room separate from parents and any clinic staff. Participants received nominal incentives for their time and effort.

Ecological Momentary Assessment (EMA) Procedures

Ecological Momentary Assessment (EMA) methods collect real-time data within participants' natural settings, using repeated measurements of momentary states and behaviors which characterize participants' real-world experiences over a given period of time (Shiffman 2007). We collected EMA data to characterize adolescents' moods, behaviors, and activities of their close friends. All participants were given a smart phone for the duration of the study with unlimited texting, data, and limited voice minutes. Participants were trained during enrollment on responding to the EMA surveys on their phones. Participants received a text message with an embedded URL (webpage link) where upon clicking, they were directed to the secure web-based EMA survey. Our use of EMA data collected in brief, yet dense periods of time, enabled us to specify young adolescents' activity space, by utilizing Global Positioning System (GPS) generated longitude and latitude coordinates derived from adolescents' phones.

Every 2 months for 12 months, participants received EMA surveys beginning on Thursday through Sunday, with between 4 and 6 EMAs per day for a total of 18 per month. This time parameter allowed for the capturing of both weekday and weekend EMA surveys, thereby providing a more representative characterization of adolescents' lives. Each survey took less than 60 s to complete, and participants provided windows during the week days that they were available (e.g., not in school) to receive surveys. Following typical EMA procedures, participants were given an 8 min time window in which to complete each survey, with an additional 1 min grace period, before a survey was marked as "missed". At the 7 min mark, a reminder text message was sent to any participant who had not yet completed the current survey. The gathered data included the EMA survey responses along with timestamps noting when each survey was begun and finished. Survey data submitted beyond the designated time window was still gathered, with timestamps used to differentiate out-of-window data as needed.

Geo-spatial Data Procedures

Each EMA survey automatically generated location data at the moment of EMA data capture using GPS embedded within the phone and recorded as latitude and longitude coordinates. GPS can vary substantially in accuracy over time, according to the geometric configuration of the GPS satellites that provide location information and related factors, particularly in urban environments where structures can inhibit communication between the GPS receiver in the phone and the GPS satellites (Zandbergen and Barbeau 2011). Fortunately, the GPS receiver embedded within the phone also provides a measure of location uncertainty for each coordinate position recorded. For the current study, we used participants' EMA response coordinates with a location uncertainty less than 300 feet, which provides location data at an accuracy sufficient for linking each activity space location to

other geospatial data describing socioeconomic disadvantage and neighborhood disorder, as described below.

Measures

Demographics

Participants (N = 248) reported on their age, sex, and race during the initial survey at enrollment. Age was not used in our models due to the lack of variation (inclusion criteria of age 13 or 14). Gender was coded as 0 = girls, 1 = boys. Race was recoded as dichotomous (black = 1, not black = 0) because the sample was 88 % African American.

Substance Use

Substance involvement was measured using the Adolescent Alcohol and Drug Involvement Scale (AADIS) (Moberg and Hahn 1991). The AADIS has good internal consistency (Cronbach's alpha of 0.94) and is highly correlated with self-reported measures of substance use (r = 0.72), clinical assessments (r = 0.75), and subjects' perceptions of the severity of their own drug use problem (r = 0.79). We used the AADIS to characterize alcohol and drug involvement and problem severity total score as dependent variable. Scores above 37 indicate likelihood of meeting a substance use disorder diagnosis. We also used the drug use history section (part A) of the AADIS to measure the frequency with which participants engaged in use of tobacco, alcohol, and marijuana for descriptive purposes. Frequency of use of substances were coded as 1 = never used, 2 = tried but quit, 3 = several times a year, 4 = several times monthly, 5 = weekends only, 6 = several times a week, 7 = daily, 8 = use several times per day. Scores range from 1 to 8 for each substance measured.

Relations with Parents

Relations with parents were measured with the Behavior Assessment System for Children Relations with Parents Scale (Reynolds and Kamphaus 2004). Relations with parents construct is defined as the perception of being important within the family unit, the perceived quality of the child–parent relationship, and the degree that the child experiences trust and concern. The ten item scale had a Cronbach's alpha of 0.84 in our sample. Higher scores indicate positive adjustment, at-risk scores (31–40) indicate disturbed relations with parents, and clinically significant scores (≤30) indicate severe family problems.

Peer Network Characteristics

Peer network data were gathered using the Adolescent Social Network Assessment (ASNA) (Mason et al. 2004). The ASNA captures information on each subject's close personal contacts, which constitute their personal or egocentric peer network. Because our study focused on the influence of close peer networks, we aligned the number of nominated close to friends to three as this is within the range commonly reported for close peer network size (3–5), and because close friends have more influence on substance use than general peer networks (Beckmeyer 2014; Cruz et al. 2012; Haas et al. 2010). Adolescents were asked to think of up to three close friends. Respondents provided information about each of their close peer's substance use, influence on behavior, and types of activities. Specifically, subjects were asked about negative/risky activities such as whether they know if each

nominated peer uses substances, if the peer is a daily user, and whether the subject has been directly or indirectly influenced to use or not to use substances by each peer, as well as participating in illegal, violent, or dangerous behaviors. In addition, subjects were also asked about positive/protective activities with their peer affiliates such as receiving help with school or transportation, or providing support by talking through problems. These items create a total score for each peer and are based upon a weighted scoring procedure, with scores ranging from −14 to 14. Weights are based upon our previous research that has shown, for example, that risk for substance use increases with one substance user in a network, and risk for mental health problems is elevated with one daily substance user in a network (e.g., threefold increase) (Mason et al. 2004). Given these data, we developed the following weighted scoring procedures: risk quality: substance user = −1, daily user = −3, negative activity = −4, influence to use = −6 and protective quality: non-substance user = 4, absence of negative activities = 4, influence not to use = 6. Each peer's score is summed. Assuming three peers per participant, total network quality scores range from −42 to 42. Higher scores indicate greater peer network protection, and lower scores indicate increased network risk. The ASNA has favorable internal reliability (Cronbach's $\alpha = 0.84$) and correlates significantly in the expected direction with self-reported measures of substance use (any alcohol, marijuana or other substance) ($r = -0.64$), with self-reported alcohol use ($r = -0.66$) and with self-reported marijuana use ($r = -0.54$) (Mason et al. 2011).

Activity Space

The activity space for each participant was captured using each participant's GPS coordinates encoded from the set of their EMA responses over the 1 year period of data capture. We used geographic information systems (GIS) software to join these EMA response coordinates to other geospatial data to develop a measure of relative environmental risk and protection afforded by each participant's activity space. Environmental risk was characterized via an index of neighborhood disorder, which we derived from a set of variables commonly for this purpose (Sampson et al. 2009), and which we acquired from the U.S. Census Bureau's 2008–2013 American Community Survey at the tract level. These variables included indicators of educational attainment (percentage over age 25 with a bachelor's degree or higher), residential stability (percent residing in the same residence for at least 1 year), housing infrastructure (percent housing units vacant, percent housing units owner-occupied), poverty (median household income, percentage of households receiving public assistance income, percentage of families living below the poverty line), employment (percent employed), and race (percent Hispanic, percent white, percent African American). We also included a crime variable, a census tract level index of assaults normalized to the national average (SimplyMap, Inc.). Using GIS, each EMA response was attributed with these variable values according to the tract within which that EMA response occurred.

Following Sampson et al. (2009), we employed principal components analysis (PCA) to identify a smaller number of components that expressed the variation in these highly collinear environmental variables. Such an approach is often used to develop theoretically meaningful variable constructs in models of neighborhood effects (Mennis and Mason 2012; Sampson et al. 2009). PCA identified a single factor with Eigenvalue >4 that explained 66 % of the variance in seven of the 12 neighborhood disorder variables. We used a single

component, representing four protective dimensions: median household income, percent housing units owner occupied, percent employed, percent with a bachelor's degree or higher, and three risk dimensions: percent living below poverty line, percent receiving public assistance income, and the assault index score. The continuous factor value from this analysis was used as a variable to represent relative environmental risk and protection associated with the location of each EMA response. Higher values of the variable represent an increase in protective environmental influences (i.e. lower neighborhood disorder), and lower scores represent an increase in risk (i.e. higher neighborhood disorder). The activity space variable for each participant was then calculated as the mean neighborhood disorder component value for all EMA responses for each participant.

Analytic Plan

We began our analysis with a regression model that examined the direct effects of all predictor (relations with parents, peer networks, and activity space) and demographic variables (gender and race) on substance use involvement in order to confirm all variables' hypothesized contributions within our moderation models. Missing data was handled using multiple imputation procedures (i.e. expectation maximization algorithm) in SPSS V. 21. Missingness for self-reported data ranged from 0 to 15 %. A Little's MCAR tests (Missing Completely At Random) was subsequently conducted ($\chi^2 = 3.140$, $df = 6$, $p > 0.05$), indicating no systematic missingness. Imputed data were then combined using methods described by Rubin (1987). To test the hypothesis that peer network characteristics moderates the relationship between relations with parents and substance use, we created a moderation model with demographic variables (gender and race) as controls, and also including the predictor variable (relations with parents), the moderator variable (peer network characteristics), and then the interaction term peer network × relations with parents. To facilitate interpretation of results, we mean-centered peer network, activity space, and relations with parents variables. Next, to test the hypothesis that activity space will moderate the moderating effects of peer network on relations with parents influence on substance use, we conducted a 3-way interaction analysis. We then estimated the conditional effect of relations with parents on substance use as a function of peer network using an inferential test to better interpret the interaction (Hayes and Preacher 2013). Specifically, we tested the conditional effects on the 3-way interaction with activity space interacting with peer network, moderating relations with parents influence on substance use. This allows the moderation of relations with parents' effect on substance use by peer network characteristics to depend on levels of the degree of activity space risk [1 standard deviation (SD) below the mean, the mean, and 1 SD above the mean]. We conducted all analyses using IBM SPSS (2012, V21) and the Hayes and Preacher (2013) Conditional Process Analysis program.

Results

The study sample was 57 % female, 88 % African American, 9 % other or unknown, and 3 % White. The mean age was 13.4 years old (SD = 0.49) ranging from 13 to 14 years old. The mean AADIS score was 8.4 (SD = 13.7) with a range of scores from 1 to 64. Lifetime substance use is provided in order to compare our sample's use of tobacco, alcohol, and marijuana to the U.S. National Survey on Drug Use and Health 8th grade 2012 data

(SAMHSA 2013). Our sample's lifetime tobacco use is 16.1 % compared to 10.3 % nationally, alcohol use is 13.7 % compared to 20.4 % nationally, and marijuana use is 11.2 % compared to 7.8 % nationally. The peer network mean score was 22 (SD = 10) with a range of scores from −23 to 38. Relations with parents mean score was 28.2 (SD = 6.4) with a range of scores from 7 to 38. The mean activity space principal component value for this sample was 0.0 (SD = 1.0) with a range from −1.99 to 2.34.

As a first step towards building our moderation models, we regressed substance use involvement on the three predictor variables, relations with parents, peer network, activity space, and the two control variables, race and gender. Table 1 shows that all predictor variables, relations with parents ($p < 0.01$), peer network ($p < 0.001$), activity space ($p < 0.05$), significantly predicted substance use involvement in the expected direction, where positive relations with parents and protective peer networks and activity spaces are all associated with lower substance use. Neither of the demographic variables significantly predicted substance use involvement and consequently were dropped from further analyses.

We hypothesized that peer network would moderate the association between relations with parents and substance use. Supporting the hypothesis, the direct effect between relations with parents and substance use was significantly moderated by peer network ($p < 0.05$). Figure 2 provides a graph of this interaction. Complete model coefficients for all variables are provided in Table 2.

We hypothesized that the association between peer network and substance use would be stronger for adolescents with higher levels of environmental risk associated with their activity space than for adolescents with less risk. Results indicated that the interaction term between peer network and activity space was significantly related to substance use ($p < 0.05$). Figure 3 provides a graph of these interactions. Complete model coefficients for all variables are provided in Table 3. In order to specifically assess the conditional effects model reported in Table 3, the moderating effect of peer network on relations with parents influence on substance use involvement was examined at three values of activity space risk: 1 standard deviation (SD) below the mean, the mean, and 1 SD above the mean. This addresses the question of what level of activity space risk is significant in moderating the effects of peer network. Findings revealed that the interactive effect of peer network with relations with parents influencing substance use involvement was observed when activity space risk was high ($b = 0.061$, $SE = 0.01$, $p < 0.001$), and moderate ($b = 0.032$, $SE = 0.01$, $p < 0.01$), but not low ($b = 0.02$, $SE = 0.01$, $p > 0.05$). Thus, the moderation by peer networks is itself moderated by activity space, such that the moderating effect of peer networks on the relationship between parental relations and substance use is greater for teens with riskier activity spaces.

Discussion

An important contribution of the present study was integrating geographic, social, and psychological data to better understand young urban adolescents' microsystems and subsequent substance use involvement over the course of 12 months. This study adds to a very limited literature on the longitudinal interplay of parent–adolescent relations, peer

networks, activity space, and substance use among a predominantly African American urban sample. Utilizing location specific activity space data and characterizing the risk and protective attributes of these dynamic data, provides insight into the effects of place for these urban youth.

Our study confirms previous research that has found protective family, peer, and place-based effects for youth related to substance use and other behaviors (Light et al. 2013; Mennis and Mason 2012). In addition, we found that peer networks moderated the association between relations with parents and substance use involvement for these young urban adolescents. Peer networks moderated the relations with parents influence on substance use, such that the adolescent–parent relationship influence is greater for adolescents with riskier peer networks than for those with protective networks. One reasonable interpretation is that when these variables are examined without regard to contextual factors such as activity space, the interaction between relations with parents and risky peer networks exerts a greater risk-enhancing effect on adolescents. Without taking into account the environmental influences, conclusions regarding social interactions and subsequent health behaviors are restricted or narrowed. These adolescents are situated within an urban context that produces important interactive effects with both peers and parents, as is evidenced in our second hypothesis below.

Our findings support our second hypothesis, with activity space interacting with peer networks, such that the moderating effect of peer networks on the relationship between parental relations and substance use is greater for teens with riskier activity spaces. Indeed, results indicate that the effect of relations with parents on substance use is amplified for teens with particularly risky peer networks and risky activity spaces. In other words, the riskier a teen's social and environmental contexts, the more influential are the teen's parents in mitigating substance use. This finding is a place-based conditional effect that supports the social contextual model of parenting (Scaramella et al. 2002), and leads us to speculate that parents in our sample may increase efforts at communicating caring, trust and concern (elements of the positive relations with parents variable) when their child is active in high-risk settings (defined in our study as elevated rates of poverty, public assistance, and assault). This conditional effect finding also supports Lloyd and Anthony's (2003) work, where positive parenting reduces deviant peer affiliation among African American youth living in disadvantaged urban settings. While our data precludes us from identifying specific parenting practices that may have changed over the course of our study, from the adolescents' perspective, increases in positive qualities such as feeling important in the family, trust, concern, and improved quality of adolescent–parent relationship may serve as a proxy for positive parenting. Finally, these results support our work in utilizing spatial, social, and psychological data in addressing substance use urban adolescents (Mason et al. 2009) by providing confidence in the utility of collecting comprehensive and nuanced data relative to substance use involvement.

There were limitations in this study that should be considered when interpreting these findings. First, our sample was an urban, almost entirely African American sample and therefore our findings may not apply to other populations. While this is an important population to study due to historic underrepresentation, replications with more diverse ethnic

and geographic populations are needed. Second, we used only self-report measures for the substance use outcome. Obtaining biological specimens would increase confidence in these results. Third, purchasing smart phones for participants inherently limits the scalability of such research. Future research is needed that uses existing phones of participants in order to test real-world data collection strategies. Finally, a convenience sample was used for this study, limiting the generalizability of these results.

This study supports the assessment that social influences are not aspatial, but rather are embedded within place, and in fact play an important role in creating adolescents' experiences of place through the social interactions that occur at particular locations. By examining the influence of peer networks within the context of activity space, a place-based approach illuminates an interactive dynamic among peer networks, place, and health outcomes. We acknowledge the challenges associated with incorporating microsystems such as place and peers into longitudinal models, as stated by Bronfenbrenner in 1979. Nevertheless, without systematic investigations of the complex and more realistic models of urban adolescents' dynamic social and spatial lives, we are severely narrowing our lenses that seek to observe and understand risk and protective factors for vulnerable populations.

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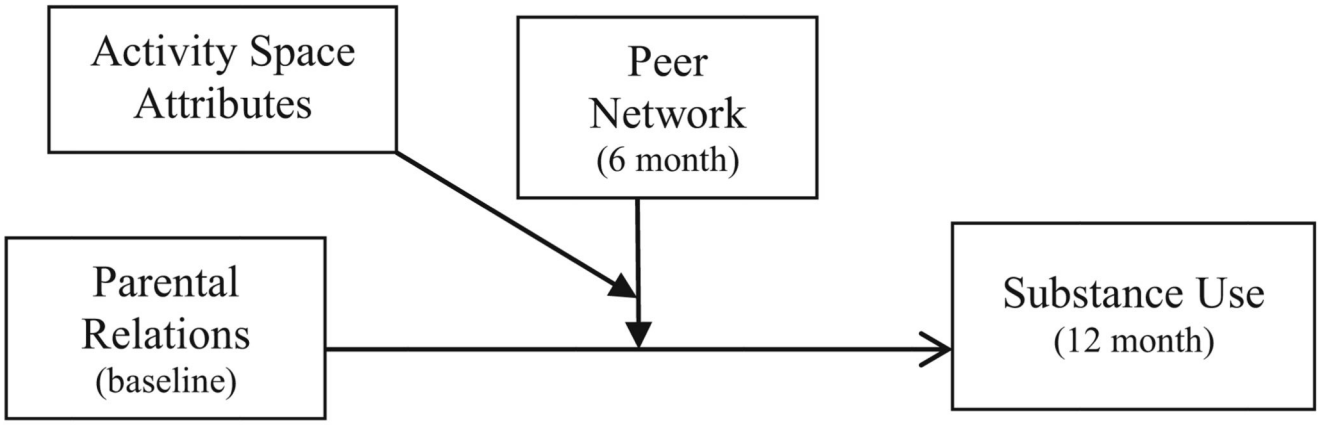

Fig. 1.

Conceptual model of the direct effect of teen–parent relationship on substance use moderated by peer networks, which is moderated by the risk and protective attributes within adolescents' activity spaces

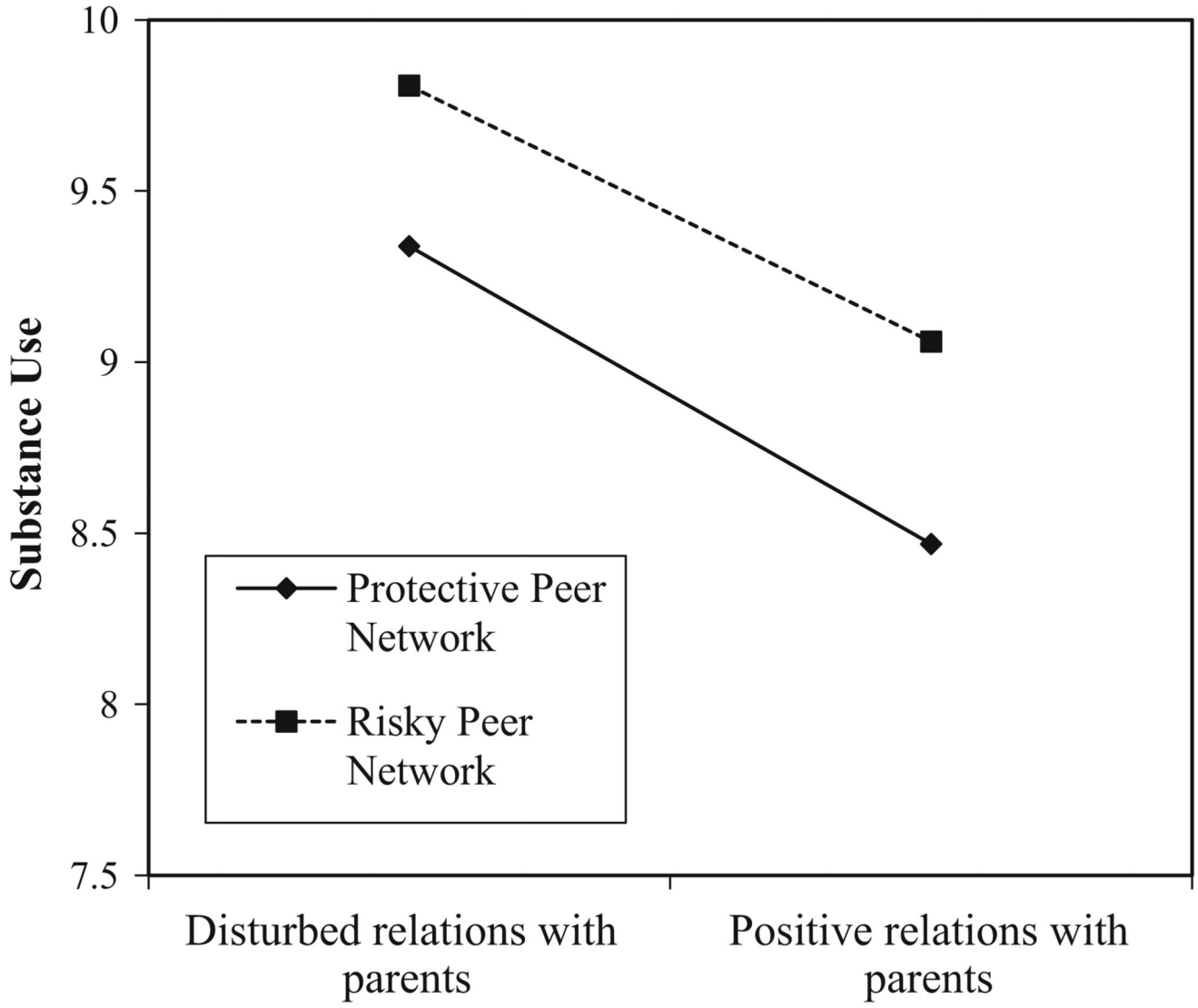

Fig. 2.
Moderating effect of peer networks on relations with parents' influence on substance use

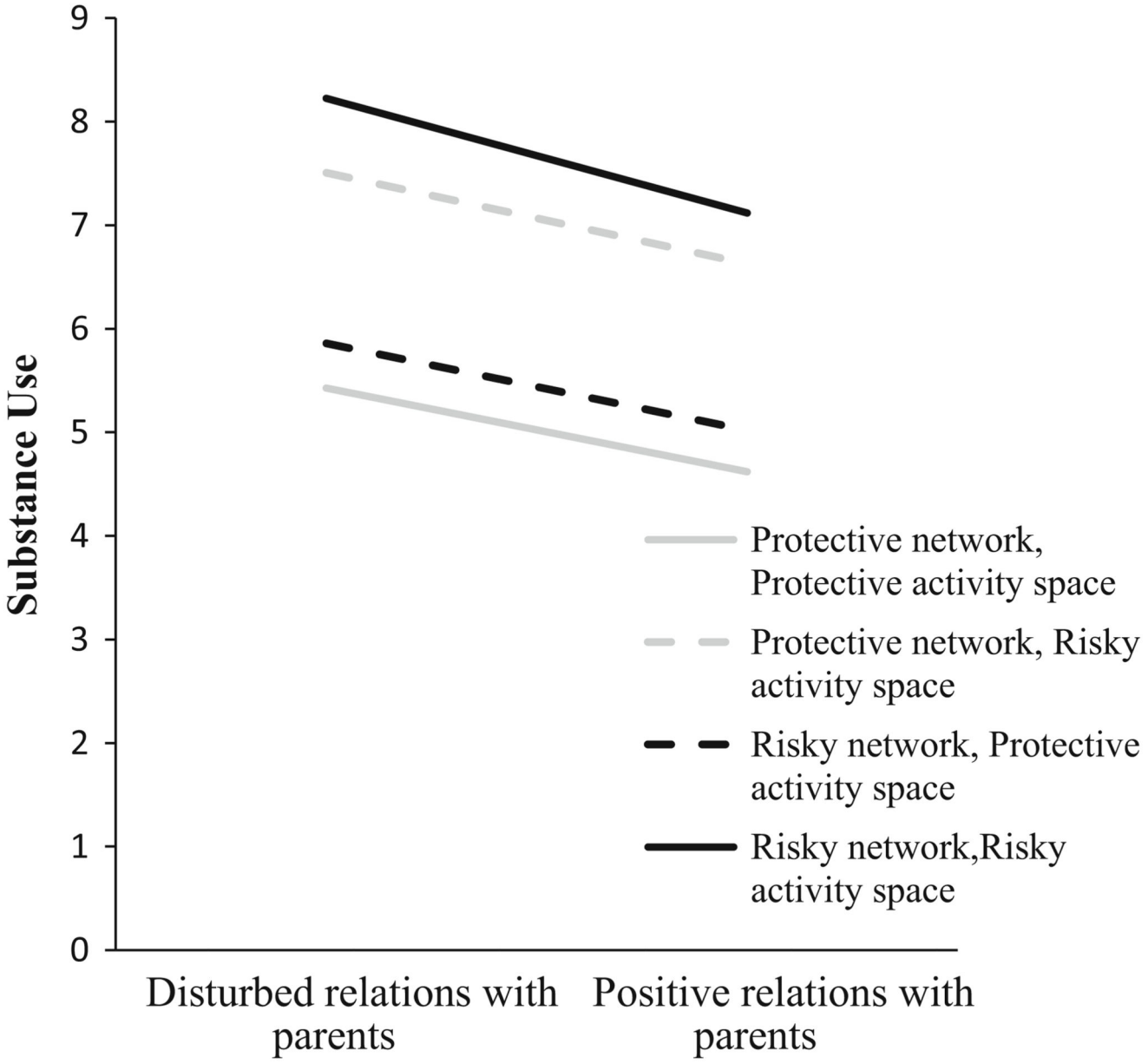

Fig. 3.
Moderating effect of activity space on peer networks moderation of relations with parents' influence on substance use

Table 1

Key variables predicting substance use involvement

Predictor variables	β (SE)	*t*	LLCI	ULCI
Gender	−0.57 (1.54)	−0.36	−3.60	2.46
Race	0.71 (1.12)	0.63	−1.51	2.92
Parent relations	−0.39 (0.12) **	−3.20	−0.62	−0.15
Peer network	−0.29 (0.64) ***	−4.53	−0.42	−0.16
Activity space	−1.48 (0.68) *	−2.16	−2.82	−0.13
Constant	23.93 (5.70)	4.19	12.69	35.17

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$

Table 2

Moderation model predicting substance use involvement

Predictor variables	β (SE)	*t*	LLCI	ULCI
Parent relations	−0.40 (0.11) ***	−3.40	−0.64	−0.17
Peer network	−0.26 (0.63) ***	−4.19	−0.39	−0.14
Parent relations × peer network	0.03 (0.01) **	2.95	0.01	0.05
Constant	9.16 (0.76) ***	12.0	7.66	10.66

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$

Table 3

3-Way moderation model predicting substance use involvement

Predictor variables	β (SE)	*t*	LLCI	ULCI
Parent relations	−0.45 (0.12) ***	−3.77	−0.69	−0.21
Peer network	−0.25 (0.62) ***	−4.08	−0.37	−0.13
Activity space	−1.03 (0.68)	−1.48	−2.42	0.28
Parent relations × peer network	0.03 (0.01) **	3.03	0.01	0.05
Parent relations × activity space	0.04 (0.10)	0.46	−0.15	0.25
Peer network × activity space	0.04 (0.06)	0.81	−0.07	0.17
Parent relations × peer network × activity space	−0.02 (0.01) *	−2.64	−0.04	−0.01
Constant	9.18 (0.74) ***	12.25	7.71	10.66

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$