Direct and Indirect Peer Socialization of Adolescent Nonsuicidal Self-Injury

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This study examined direct and indirect forms of peer socialization of nonsuicidal self-injury (NSSI) in adolescent friendship networks. Data were collected among 348 adolescents (55% females; M_{age} = 15.02 years; SD = 0.53) at four assessment waves. Stochastic actor-based models revealed no evidence for direct socialization of NSSI: adolescents whose friends reported higher NSSI did not increase their NSSI over time. However, indirect forms of socialization were found. After controlling for direct socialization and selection effects, friends' depressive symptoms predicted changes in male and female adolescents' NSSI, and friends' impulsivity predicted changes in male adolescents' NSSI. Findings highlight the importance of extending peer influence research beyond the classical "modeling" paradigm by providing evidence that peers may indirectly socialize adolescents' NSSI.

For decades, peer influence research has shown that during adolescence peer behavior represents a major source of influence for youths' own behavioral development. Ample evidence reveals direct forms of peer socialization, in which friends' behaviors predict changes in similar adolescents' behaviors, including delinquency, aggression, and substance use (for a review, see Brechwald & Prinstein, 2011). Yet, several aspects of this phenomenon remain unexplored as previous research has been limited in a number of ways. First, prior work is limited with respect to the behavioral domains that have been examined as potentially subject to peer socialization processes. Most literature has focused on externalizing behaviors (Brechwald & Prinstein, 2011), but recent evidence suggests that peer influence may also pertain to internalizing behaviors, such as depressive symptoms (e.g., Giletta et al., 2011; Van Zalk, Kerr, Branje, Stattin, & Meeus, 2010). Recent studies also suggest that peer influence may generalize to more extreme forms of internalizing distress, including nonsuicidal self-injurious behaviors (i.e., intentional, self-inflicted tissue damage without suicidal intent, nonsuicidal self-injury [NSSI]; Heilbron & Prinstein, 2008). Because NSSI is a strong predictor of

suicidal ideation and attempts (Guan, Fox, & Prinstein, 2012), such an assumption deserves particular consideration as NSSI may directly undermine adolescent development.

Second, past research on peer influence has almost exclusively focused on one model of socialization, namely direct socialization, but far less is known about indirect forms of peer socialization. Direct socialization is consistent with a "modeling" paradigm of peer influence, in which friends' behavior X is predictive of adolescents' engagement in the same behavior X. However, peer socialization processes may be more complex and assume different, more indirect forms, in which a certain friend's behavior Y may also influence adolescents' related behavior X (Brechwald & Prinstein, 2011). Therefore, the aim of the present study was to analyze adolescent friendship networks across four time points in order to answer two novel questions: (1) does peer influence relate to NSSI within a friendship network context? and (2) is NSSI influenced by direct or indirect forms of peer socialization? Specifically, we examined whether adolescents' NSSI may be predicted by friends' impulsivity and depressive symptoms.

Direct Peer Socialization of NSSI

During the last decade, an increasing number of studies have suggested that NSSI is a relatively

common health-risk behavior, which affects approximately 15%–20% of adolescents in the general population (Rodham & Hawton, 2009). NSSI is associated with several psychological difficulties (e.g., Bjärehed, Wangby-Lundh, & Lundh, 2012) and represents a serious health problem as it may become a stable maladaptive strategy to face developmental tasks resulting in severe negative consequences for adolescents' psychosocial development and, in the most extreme cases, in suicidal behaviors (Guan et al., 2012).

Peer socialization has been proposed as one of the processes to explain the rise in NSSI rates that seemed to occur in the last several decades among nonclinical adolescents (Nock, 2010). Adolescents whose friends engage in NSSI may be at high risk to increase their engagement in NSSI. Several existing theoretical models provide clear rationales for this process (Heilbron & Prinstein, 2008). Specifically, in addition to internal functions (e.g., relieving negative emotions), NSSI can serve an interpersonal function during adolescence, similar to other socialized behaviors (e.g., alcohol use, aggression). Peer influence models, in particular social learning theories (Bandura, 1977), posit that adolescents tend to emulate others' behaviors especially when these are associated with social rewards and reinforcements. Thus, adolescents may imitate their friends' NSSI due to the social reinforcements associated with it, such as gaining social attention or creating social bonds (Heilbron & Prinstein, 2008). This hypothesis might be particularly valuable given the visibility of NSSI among adolescents. For instance, prior work has suggested that adolescents who engage in NSSI are likely to share their experiences on web communities and online forums (Whitlock, Powers, & Eckenrode, 2006). Other work has shown that some adolescents may engage in NSSI within a group context, in the presence of their peers, rather than while alone (e.g., Klonsky & Olino, 2008). This evidence, along with theoretical models positing that NSSI may represent a way to communicate with others, suggests not only that NSSI may be socialized among adolescents, but also that socialization processes may occur across different relationships.

Whereas, to date, one study has reported direct evidence for peer influence of NSSI within best friend dyads (Prinstein et al., 2010), socialization of NSSI has never been examined within adolescent friendship networks. Yet, it is well-known that adolescents have multiple, interconnected friendships; each relationship offers potential to exert peer influence (Hartup, 1993). Within friendship networks, adolescents are connected with a number of different peers, which increases their probability to be exposed to and model NSSI. Specifically, the study of the broad friendship network offers the opportunity for identifying socialization effects, which in case of NSSI likely occur within groups of peers (e.g., subcultures), and therefore may not be evident when examining dyadic relationships. Moreover, taking into account multiple peers provide a more comprehensive view of adolescents' friendship network, allowing to examine how having friends with certain characteristics (e.g., high depressive symptoms), who tend to be more in the periphery of the network, may influence adolescent NSSI.

Indirect Peer Socialization: Friends' Impulsivity and Depressive Symptoms on Adolescent NSSI

In addition to direct peer influence, indirect forms of peer influence might also explain changes in adolescent behaviors (Brechwald & Prinstein, 2011). Indirect peer influence suggests that adolescents' engagement in a certain behavior may be socialized, not by their friends' engagement in the same behavior, but by other characteristics of their friends. Such a phenomenon may be explained by at least two potential processes.

First, it is possible that an adolescent's behavior may be influenced not by friends' engagement in identical behaviors, but by related psychological characteristics, dispositions, attitudes, or values of his or her friends. This may occur either because socialization of attitudes among friends may lead each adolescent to engage in disparate behaviors, driven by a shared set of values (e.g., friends' shared attitudes toward breaking rules may predict one adolescent's engagement in vandalism and another's in alcohol use), or because one friends' behavior implicitly communicates a general predisposition that signals approval of similarly themed behaviors (e.g., "my friends smoke pot, so they may approve of my use of other drugs"). Thus, behaviors X and Y would represent different developmental outcomes endorsing a similar function; that is, the behavior X in which adolescents engage would be functionally equivalent to the behavior Y in which their friends engage. Possibly, the way in which dispositions are manifested may depend on third factors, such as individual specificities (e.g., personality traits) or external conditions (e.g., behavior availability), therefore resulting in different behavioral outcomes.

This notion offers potential hypotheses for this study. For example, considerable evidence suggests that high levels of adolescents' impulsivity are

strongly related to repeated NSSI experiences during adolescence (e.g., Glenn & Klonsky, 2010). Prior work has also demonstrated that impulsive adolescents, especially males, are at greater risk for engagement in a number of highly visible risk-taking behaviors, such as substance abuse and delinquency (e.g., Vitaro, Ferland, Jacques, & Ladouceur, 1998; White et al., 1994). Thus, adolescents with impulsive friends may be likely to engage in NSSI because NSSI may represent an impulsive behavior, similar to other impulsive behaviors in which their friends engage. Hence, impulsivity may be considered as a common disposition that drives adolescents and their friends to endorse diverse behavioral outcomes.

A second possibility underlying indirect peer influence effects suggests that adolescents' exposure to their friends' characteristics promotes a risk environment for adolescents' own development. As suggested by person–environment models (e.g., Sameroff, 1993), the context created by a friendship network (i.e., friends' behaviors, attitudes, values) may serve as a stressor for adolescents and may alter their developmental trajectory in related domains of adjustment. Concerning NSSI, this may be especially relevant to adolescents with friends who exhibit depressive symptoms. Interpersonal theories of depression (e.g., Coyne, 1976; Rudolph, Flynn, & Abaied, 2008) posit that depressed individuals tend to engage in maladaptive interactional patterns, such as excessive reassurance seeking or co-rumination (Rose, 2002). These patterns may lead to stress in the relational partners increasing not only their chances of experiencing higher depressive symptoms, that is, direct forms of peer influence related to depressive symptoms (Van Zalk et al., 2010), but also the possibility of engaging in other behaviors indicative of stress dysregulation, such as NSSI.

The present study offered a preliminary initial step toward the investigation of indirect forms of peer influence by testing whether friends' impulsivity and depressive symptoms affect adolescents' NSSI within friendship networks, beyond the potential direct socialization effects between adolescents' and their friends' NSSI. In examining indirect socialization effects, specific attention was given to gender differences. Past theory and research offer some reasons to hypothesize that friends' impulsivity and depression may be most relevant to NSSI among males and females, respectively. First, males are more highly exposed to impulsive friends and females to depressed friends. Indeed, adolescents are most likely to befriend same-gender peers (Poulin & Pedersen, 2007), and

impulsivity and depression are more evident among males and females, respectively (Cross, Copping, & Campbell, 2011; Hankin & Abramson, 2001). Second, male and female adolescents may react differently to impulsive and depressed friends, respectively (Perry & Pauletti, 2011). For instance, females are especially vulnerable to interpersonal stress; they experience higher emotional involvement with their friends' feelings and show a higher tendency to co-ruminate as compared to male adolescents (Rose, 2002; Rose & Rudolph, 2006). Therefore, females may be more at risk for NSSI when confronted with their friends' depression as compared to male adolescents. Conversely, as impulsive behaviors tend to be more socially accepted when expressed by males (Perry & Pauletti, 2011), males may more easily manifest their impulsivity in tangible behaviors, such as NSSI, when interacting with impulsive friends.

The Present Study

In the present study, we applied stochastic actor-based modeling (Snijders, Van de Bunt, & Steglich, 2010) to examine direct and indirect forms of NSSI socialization within adolescent friendship networks. These models are capable of estimating peer socialization effects while overcoming the limitations inherent in previous peer influence studies, for instance by controlling for several network and selection effects (see Veenstra, Dijkstra, Steglich, & Van Zalk, 2013; Veenstra & Steglich, 2012). We aimed to test the assumption that peer influence may take indirect form, by examining the role of friends' depressive symptoms and impulsivity on adolescents' NSSI. Based on the aforementioned theoretical models, we hypothesized that NSSI may be socialized both directly and indirectly. Specifically, we expected adolescents to increase their NSSI engagement when they were friends with peers with high NSSI engagement. Moreover, we anticipated that friends' impulsivity and depressive symptoms would predict adolescents' NSSI over time. We also expected gender differences, with friends' impulsivity to specifically affect males' NSSI and depressive symptoms to influence more strongly females' NSSI over time.

METHOD

Participants and Procedure

Data were drawn from the first four waves of a larger longitudinal study focused on adolescent peer

relationships and psychosocial development. At baseline, participants were recruited by distributing consent forms to all families of students attending ninth grade in three high schools located in a rural community in the southeast United States. Of the targeted adolescents, roughly 75% returned consent forms, and approximately 60% of the contacted families (55%, 61%, and 76% for the three schools respectively) granted consent to participate. For each school, retention varied between 90% and 99% between consecutive time points. To properly estimate socialization effects and to limit the impact of missing data, adolescents who took part in at least three of the four waves were selected for inclusion in the primary analyses. This resulted in a final sample of 348 adolescents (55% female), aged between 14 and 18 years (M_{age} = 15.02; SD = 0.53) at baseline. Participants' ethnicity matched that of the school district's population, with 48.7% Caucasian, 23.8% African American, 19.1% Latino American, and 8.4% other ethnic groups. Over half of adolescents reported that they lived with two biological parents (47%) or in a family with two adults in the household (30% with a parent and a step-parent, grandparent, or other relative); 23% reported living in a single-parent household. Attrition analyses revealed no differences in any study variable between adolescents in the analytic sample and adolescents who participated only at one (n = 35) or two (n = 24) time points, with the exception of age, indicating that adolescents in the analytic sample were somewhat younger than those excluded due to attrition, $t(60.64)$ = 2.50, p = .02 (M = 15.03 vs. M = 15.27).

Trained research assistants administered surveys during the school hours at four time points, every 6 months from the spring of 9th grade to the fall of 11th grade. Participants were informed that they could withdraw from the study at any time, and their responses would be kept confidential. The study received approval by the human subjects committee of the University of North Carolina at Chapel Hill.

Measures

Friendship nominations. Adolescents were asked to select an unlimited number of best friends from a list of peers including all their grade-mates. The human subjects committee and school personnel involved in the project requested that all students be included in the nomination roster to avoid any attention they might receive from the conspicuous absence on a class list. Subsequently, nominations received by unconsented students were excluded from the final data set. A few participants nominated an extremely high number of friends (>30) that might have biased our results. Therefore, for these adolescents, data were considered missing (n = 14).

Friendship nominations were used to create friendship networks, represented at each time point by an adjacency matrix with ones indicating directed friendship ties and zeros the absence of a tie.

Nonsuicidal self-injury. Adolescents were asked to report on a 5-point scale (1 = *never*, 5 = *10 or more time*) how frequently they engaged in six different nonsuicidal self-injurious behaviors (e.g., cut or carved skin, burned skin, hit self) during the previous months (during the past year at baseline and the past 6 months at the other time points). This measure has been used previously to assess NSSI among adolescents (e.g., Giletta, Scholte, Engels, Ciairano, & Prinstein, 2012a; Prinstein et al., 2010). Because stochastic actor-based models require the behavioral outcome to be a discrete ordinal variable, NSSI was collapsed in three categories distinguishing between adolescents who did not engage in any self-injurious behavior during the previous months, adolescents who reported occasional NSSI incidents (1–3 times), and adolescents who reported repetitive NSSI incidents (4 or more times).

Depressive symptoms. Depressive symptoms were measured using the Mood and Feeling Questionnaire (Costello & Angold, 1988). Adolescents were asked to rate on a 3-point scale (0 = *not true*, 1 = *sometimes true*, 2 = *true*) 33 items (e.g., "I felt I was no good anymore") assessing their depressive symptoms over the last 2 weeks. An individual mean score of depressive symptoms was computed across items, with higher values indicating higher depressive symptoms (Cronbach's α = .92–.95 across time points).

Impulsivity. Impulsivity was assessed at baseline using 13 items adapted from the Barratt Impulsiveness Scale (BIS-11; Patton, Stanford, & Barratt, 1995). Items (e.g., "I plan tasks carefully") referred to the three dimensions identified in the original scale (i.e., motor, attentional and nonplanning impulsiveness; Stanford et al., 2009) and were rated on a 4-point scale (1 = *rarely or never*, 4 = *almost always or always*). An individual mean score was computed across items, yielding a global measure of impulsive behavior with higher values indicating higher impulsivity (Cronbach's α = .77).

Friends' characteristics. For each adolescent, two composite scores were calculated that

described friends' impulsivity and depressive symptoms. Because impulsivity was collected only at baseline, a score of friends' impulsivity was computed by averaging the individual scores of impulsivity of all peers whom the target adolescent nominated as friends at baseline. For depressive symptoms, an average score of friends' depressive symptoms was computed at each time point across those peers nominated as friends by each adolescent at that specific time point.

If adolescents did not nominate any friend at one of the time points, scores of friends' characteristics were considered to be missing. This procedure allowed us to calculate a score of friends' impulsivity for approximately 90% of participants. Moreover, for 98.6% of participants, a friends' score of depressive symptoms was available for at least one time point.

Missing Data Analyses

Of the 348 adolescents in the analytic sample, 21% ($n = 74$) completed the survey only at three of the four time points due to absenteeism ($n = 58$) or because they joined school after Time 1 ($n = 3$) or left it after Time 3 ($n = 13$). This yielded missing data (i.e., wave nonresponse missing). Additional missing data were due to incomplete or invalid answers or because it was not possible to compute a friends' score of depressive symptoms or impulsivity (i.e., item nonresponse missing). The percentage of missing data ranged across time points and measures from 0% to 28.2% (for friends' depressive symptoms at Time 4) with an overall mean of 6.7%. Although Little's (1988) missing completely at random test was significant (χ^2 (679) = 801.92, $p < .01$), the normed chi-squared (χ^2/df) of 1.18 justified the inclusion of adolescents with missing data in the analyses (Bollen, 1989).

Strategy of Analyses

A series of four stochastic actor-based models were conducted in the RSiena package (Ripley, Snijders, & Preciado, 2012) implemented in the statistical system R (R Development Core Team, 2011). These models investigate the co-evolution of friendship networks and individual behaviors over time, thus allowing estimating socialization effects while controlling for selection effects (for a detailed description of stochastic actor-based models, see Snijders et al., 2010; Veenstra et al., 2013). Missing data were handled through the SIENA missing data method (Huisman & Steglich, 2008), and

participants who joined and left friendship network in between the four time points were treated using the method proposed by Huisman and Snijders (2003). Time heterogeneity in parameter estimates (i.e., whether parameter estimates differed across periods) was assessed with score-type tests (Lospinoso, Schweinberger, Snijders, & Ripley, 2011), which allowed examining whether socialization effects equally occurred across the different periods. To gain sufficient power to detect socialization effects, the three school networks were combined in a global network using structural zeros. Although a few differences were observed across schools with regard to adolescent behaviors (see the appendix for descriptive statistics by school), this procedure allowed for a simultaneous parameter estimation (Ripley et al., 2012), by assuming homogeneity in parameter estimates across schools.

Changes in friendship ties and adolescents' NSSI were simultaneously modeled by two main sets of parameters. The first constituted network dynamic effects estimating changes in friendship ties over time. These parameters included structural network effects (effects of network structure on friendship ties) and selection effects (effects of adolescents' attributes on friendship ties), which represented control parameters in our analyses. Using a forward selection procedure based on score-type tests (Schweinberger, 2007), five structural network effects were included in the final model: outdegree, reciprocity, and three triad structure effects (transitivity triplets, three-cycle, and geodesic distance-two effects; for a detailed description of these effects, see Veenstra et al., 2013). Selection effects included the same-ethnicity parameter (tendency to nominate same-ethnicity peers as friends) and the ego (effect of adolescents' attribute on outgoing nominations), alter (effect of adolescents' attribute on ingoing nominations), and selection similarity (effect of adolescents' attribute similarity on friendship selection) effects for gender and NSSI (see Veenstra et al., 2013). The second set of parameters constituted behavioral dynamic effects estimating changes in adolescent NSSI over time. Additional control effects included basic behavioral tendencies (i.e., linear and quadratic shapes of NSSI) and the main effect of gender. Direct socialization effects were assessed through the average alter parameter, expressing the tendency of adolescents who had friendship ties with peers reporting on average higher NSSI to increase themselves their NSSI (as compared to adolescents whose friends reported lower NSSI). This first basic model allowed us to

examine direct socialization of NSSI. Further, to test for gender differences in NSSI socialization, a second model was estimated by adding an interaction term between gender and the average alter parameter.

Indirect socialization of NSSI was assessed in a third model which included several additional effects. Parameters predicting friendship dynamics included the ego, alter, and selection similarity effects for adolescent impulsivity and depressive symptoms. Moreover, the main effects of adolescents' impulsivity and depressive symptoms on their own NSSI were included in the behavioral dynamics. Indirect socialization of NSSI was assessed through the main effects of friends' impulsivity (modeled as an individual constant covariate) and depressive symptoms (modeled as an individual changing covariate) on adolescents' NSSI. Finally, to test for gender differences in indirect

socialization of NSSI, a fourth model was performed by adding two interaction terms with gender on the one side and friends' impulsivity and depressive symptoms on the other side.

RESULTS

Descriptive Analyses

Descriptive statistics of friendship network and adolescent behaviors are presented in Table 1. Increases in network density were observed within school years (e.g., from Time 2 to Time 3), while decreases emerged between school years (e.g., from Time 1 to Time 2). Despite changes in network density, the indices of reciprocity and transitivity showed high stability across time points, with an average of 43% of friendship ties being reciprocated and 24% of relationships forming cohesive

TABLE 1
Descriptive Statistics of Friendship Network and Adolescent Nonsuicidal Self-Injury (NSSI) per Time Point (Left)
and Longitudinal Transition Between Time Points (Right)

	T1	T2	T3	T4		T1–T2	T2–T3	T3–T4
Sample size	345	348	348	335	Number leavers	0	0	13
Respondents missing	2	0	13	43	Number joiners	3	0	0
Fraction females (%)	54.8	55.1	55.1	55.4	Number stayers	345	348	335
Friendship					Friendship change			
Number of ties	1,829	1,205	1,871	935	Distance	1,760	1,705	1,504
Average outdegree	5.28	3.46	5.50	2.83	Jaccard index (%)	26.3	27.4	25.1
Density (%)	1.5	1.0	1.6	0.8				
Reciprocity (%)	41.1	44.0	42.9	45.8				
Transitivity (%)	26.2	22.3	23.8	25.4				
Same-gender (%)	67.0	66.6	65.6	70.9				
NSSI (%)					NSSI change (%)			
Males					Stable actors	77.8	79.3	83.6
Never	75.2	85.8	86.1	91.0	Decreasing actors	13.9	13.7	10.0
1–3 times	19.3	9.0	10.4	7.5	Increasing actors	8.3	7.0	6.4
4 or more times	5.5	5.2	3.5	1.5				
Females								
Never	67.2	73.1	82.0	86.4				
1–3 times	22.2	11.6	10.9	8.7				
4 or more times	10.6	15.3	7.1	4.9				
Depressive symptoms								
Males								
Mean	0.27	0.22	0.25	0.20				
SD	0.28	0.25	0.30	0.27				
Females								
Mean	0.36	0.44	0.42	0.38				
SD	0.29	0.37	0.39	0.35				
Impulsivity								
Males								
Mean	2.17							
SD	0.45							
Females								
Mean	2.25							
SD	0.50							

peer groups at each time point. At each period, an acceptable proportion of friendships that were stable over time was identified (on average 26% across periods; see Jaccard index in Table 1).

Concerning NSSI dynamics, an overall decrease in the number of adolescents reporting NSSI across each period was observed ($z = -2.10$, $p = .04$; $z = -3.06$, $p = .002$; $z = -2.04$, $p = .04$, respectively for periods 1, 2, and 3). Although most adolescents did not change their NSSI across consecutive time points (see Table 1), at each period, a sufficient number of adolescents who decreased and increased NSSI were observed. Gender differences in NSSI were found only at Time 2 (χ^2 (2) = 10.53, $p = .005$), indicating that in the previous 6 months

a higher proportion of females engaged in NSSI at least four times, while a higher proportion of males did not report any NSSI experience.

Gender differences were also observed in depressive symptoms, $F(3, 262) = 4.39$, $p = .005$, $\eta^2 = .05$, indicating that females reported consistently higher depressive symptoms than males. No gender differences were found in impulsivity.

Direct Peer Socialization of NSSI

Network dynamics: Control effects. Parameters predicting changes in friendship ties are reported in the upper part of Table 2 (see Model 1). All structural network effects were significant. Due to

TABLE 2
Parameter Estimates for Stochastic Actor-Based Models of Friendship Network and Nonsuicidal Self-Injury (NSSI)

| Parameters | Direct NSSI socialization | | | | Indirect NSSI socialization | | | |
| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Network dynamics								
Outdegree	−2.16***	0.04	−2.16***	0.04	−2.15***	0.04	−2.15***	0.04
Time dummy 2	0.78***	0.04	0.78***	0.04	0.79***	0.04	0.79***	0.04
Time dummy 3	−0.19**	0.05	−0.19**	0.05	−0.19***	0.05	−0.18**	0.05
Reciprocity	2.12***	0.05	2.12***	0.05	2.13***	0.05	2.12***	0.05
Transitivity triplets	0.32***	0.02	0.32***	0.02	0.32***	0.02	0.32***	0.02
3-cycles	−0.31***	0.04	−0.31***	0.04	−0.31***	0.04	−0.31***	0.04
Geodesic distance-2	−0.23***	0.01	−0.23***	0.01	−0.24***	0.02	−0.24***	0.01
Same ethnicity	0.40***	0.03	0.41***	0.03	0.41***	0.03	0.40***	0.03
Gender alter	0.05	0.03	0.05	0.03	0.06	0.03	0.06	0.03
Gender ego	0.01	0.03	0.01	0.03	0.02	0.03	0.02	0.04
Gender similarity	0.32***	0.03	0.32***	0.03	0.32***	0.03	0.31***	0.03
NSSI alter	0.01	0.06	0.01	0.06	0.02	0.07	0.02	0.06
NSSI ego	0.02	0.06	0.02	0.06	0.04	0.06	0.04	0.07
NSSI similarity	0.00	0.13	0.01	0.14	−0.02	0.14	−0.02	0.14
Impulsivity alter					−0.01	0.03	−0.02	0.03
Impulsivity ego					0.02	0.04	0.02	0.04
Impulsivity similarity					0.16	0.10	0.16	0.10
Depression alter					−0.01	0.06	0.00	0.06
Depression ego					−0.08	0.07	−0.08	0.07
Depression similarity					0.11	0.11	0.11	0.11
NSSI dynamics								
Linear shape	−3.29***	0.20	−3.30***	0.22	−3.24***	0.21	−3.25***	0.20
Quadratic shape	1.61***	0.16	1.60***	0.16	1.47***	0.16	1.46***	0.17
Average alters (socialization)	0.21	0.39	0.24	0.55	−0.36	0.63	−0.37	0.69
Effect from gender (1 = female)	0.39*	0.18	0.40*	0.18	0.26	0.18	0.28	0.21
Average alters × gender			−0.18	1.35				
Effect from impulsivity					0.22	0.16	0.28	0.17
Effect from depression					0.50*	0.21	0.51*	0.21
Effect from friends' impulsivity					0.25	0.28	0.41	0.27
Effect from friends' depression					1.00**	0.37	1.05**	0.39
Effect from friends' impulsivity × gender							−1.12*	0.56
Effect from friends' depression × gender							0.37	0.70

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

the substantial differences in the average degree across periods (see Table 1) and based on a significant score-type test, two dummy variables were included to account for time heterogeneity on network density. The negative outdegree parameter suggests that at period 1 (from Time 1 to Time 2), adolescents were selective in choosing their friends and nominated a limited number of peers from the pool of all possible peers. However, the statistical significance of the two dummy variables indicated that selectivity in friendship nominations fluctuated across periods, with adolescents at period 2 (from Time 2 to Time 3) being significantly less selective in choosing their friends as compared to period 1 and, conversely, becoming more selective in their nominations at period 3 (from Time 3 to Time 4) as compared to period 1. The other structural network effects indicated that adolescents tended to nominate as friends peers from whom they received a friendship nomination (positive reciprocity), to form triadic relations demonstrating transitive network closure and characterized by local hierarchies (positive transitivity triplets and negative three-cycle) and to avoid maintaining indirect (i.e., mediated by a third person) relationships with other peers (negative geodesic distance-2).

With regard to selection effects, the significant same-ethnicity and gender similarity effects indicated that friendship ties were more likely between adolescents of the same ethnicity and gender. Conversely, the nonsignificant NSSI selection similarity effect suggested that adolescents did not select as friends peers with similar levels of NSSI. None of the ego and alter effects for gender or NSSI emerged to be significant, indicating that adolescents' NSSI did not affect their number of given and received nominations.

NSSI dynamics: Socialization effects. Parameters predicting changes in adolescent NSSI are presented at the bottom of Table 2 (see Model 1). Both behavioral basic tendencies emerged to be significant. The negative linear shape represented a model intercept and reflected the low prevalence of NSSI among network participants. The positive quadratic shape suggested that adolescents with higher NSSI were more likely to further increase their NSSI over time, and adolescents with lower NSSI showed a tendency to decrease their NSSI over time (i.e., self-reinforcing effect). A significant main effect of gender was also found, indicating that overall females reported a higher tendency toward increases in NSSI than male adolescents. However, the average alter parameter was not significant, implying that adolescents did not increase their NSSI when they were friends with peers with higher NSSI. This implies absence of direct socialization effects.

Based on a significant time heterogeneity score-type test, an additional model was conducted including one time dummy variable for the average alter parameter to examine whether the effects of direct socialization of NSSI differed at period 3 compared to periods 1 and 2. Yet, no significant effect was found indicating that direct NSSI socialization effects were not present at any period. Also, the interaction effect between gender and the average alter effect introduced in the second model was not significant suggesting that direct socialization of NSSI behaviors did not differ as a function of gender (see Model 2, Table 2).

Indirect Peer Socialization of NSSI

Network dynamics: Control effects. None of the additional network dynamics effects (ego, alter and selection similarity effects) introduced in the third model (examining indirect peer socialization of NSSI) were found to be significant, indicating that changes in friendship ties were not predicted by depressive symptoms or impulsivity (see Model 3, Table 2).

NSSI dynamics: Socialization effects. Four effects predicting changes in NSSI over time were added in the model testing indirect peer socialization (see Model 3, Table 2). With regard to individual attributes, adolescents' depressive symptoms, but not adolescents' impulsivity, emerged to positively predict changes in adolescents' NSSI over time. Similarly, after accounting for these individual effects, a significant effect of friends' depressive symptoms, but not friends' impulsivity, was revealed. This indirect peer socialization effect implies that adolescents whose friends reported higher depressive symptoms were more likely to increase (as well as decrease less) their NSSI as compared to adolescents with friends reporting lower depressive symptoms. Score-type tests indicated that the effects of friends' depressive symptoms and friends' impulsivity did not differ across the three periods of change.

The final model including two interaction terms to test gender differences in indirect peer socialization revealed a significant interaction between gender and friends' impulsivity but not between gender and friends' depressive symptoms (see Model 4, Table 2). Figure 1 presents a plot of the
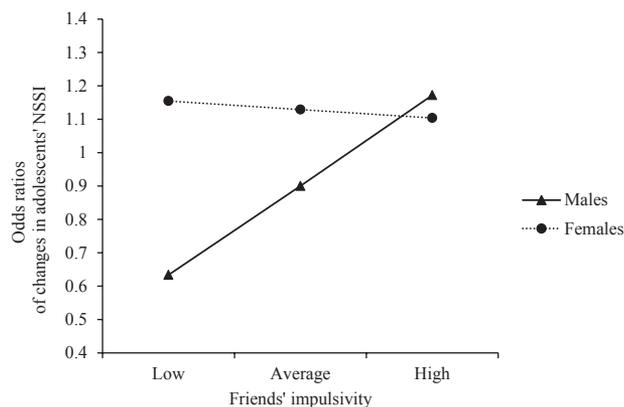
FIGURE 1   Effect of friends' impulsivity on changes in the odds ratios of adolescents' nonsuicidal self-injury (NSSI) for male and female adolescents based on SIENA's parameter estimates. "Low," "Average," and "High" friends' impulsivity indicate scores one standard deviation below the mean, at the mean, and one standard deviation above the mean, respectively.

statistically significant interaction involving friends' impulsivity. This plot represents the contribution of friends' impulsivity to the odds ratios of changes in adolescents' NSSI. Notably, while friends' impulsivity did not affect changes in NSSI among females, the odds ratio of increasing NSSI compared with no change increased from approximately 0.6 for males whose friends reported low impulsivity to 1.2 for males with highly impulsive friends.

Additional Analyses

To further examine the robustness of indirect socialization effects, two stochastic actor-based models were also conducted in which two additional selection effects were introduced (i.e., ego NSSI × alter depression effect and ego NSSI × alter impulsivity effect). In these models, indirect socialization effects were estimated while accounting for the possibility that adolescents with higher NSSI selected peers with higher depressive symptoms or impulsivity as friends, thus contributing to generate their own risk environment. Both interaction effects did not emerge to be significant, and importantly, friends' depressive symptoms still predicted adolescents' NSSI for both males and females and friends' impulsivity for males only.

DISCUSSION

The present study expands the existing literature on peer influence in two ways: first, by examining within friendship networks peer influence effects related to NSSI; and second, by testing direct (i.e., friends' behavior X on adolescent behavior X) and indirect forms of socialization (i.e., friends' behavior Y on adolescent behavior X). Findings suggest that within friendship networks, there is support for indirect models of peer influence on adolescent NSSI. Across gender, adolescents whose friends engaged more frequently in NSSI were not more likely to engage in NSSI themselves more often over time. Yet, adolescent NSSI was predicted by their friends' depressive symptoms. Moreover, among males, friends' impulsivity longitudinally predicted adolescents' NSSI.

Contrary to our expectations, evidence for direct peer influence of NSSI was not revealed. This may be because socialization of NSSI takes place exclusively within some highly specific groups of friends. For instance, socialization processes may specifically occur within certain subgroups of adolescents only (e.g., Goth subculture; Young, Sweeting, & West, 2006), which may be associated with stronger social rewards (i.e., peer acceptance) for NSSI engagement. The finding that adolescents who engaged in NSSI did not receive more friendship nominations compared with other peers (i.e., nonsignificant NSSI alter effect) is consistent with this idea, suggesting that within the overall friendship network NSSI may not be socially rewarded. Also, socialization of NSSI may pertain to best friend dyads only, as has been previously shown (Prinstein et al., 2010), perhaps because the best friend context is associated with high levels of intimacy and self-disclosure (e.g., Buhrmester, 1990; Rose, 2002). In stochastic actor-based models, socialization effects are usually estimated by averaging across all adolescents' friends' behaviors (i.e., peers nominated as friends by each adolescent), and thus, socialization occurring only within certain relationships might be diluted when examining the network as a whole. Future studies may want to analyze individual (e.g., peer group identification) as well as dyadic (e.g., dyadic mutuality) moderators allowing to identify specific subgroups at risk for NSSI socialization. In addition, the combined use of dyadic analyses next to social network analyses may represent a strategy to provide more fine-grained results (Giletta et al., 2012b).

Although no direct forms of socialization were found, results support the hypothesis that indirect forms of NSSI socialization may occur within friendship networks. Overall, both adolescents' and friends' depressive symptoms predicted changes in adolescents' NSSI over time. The finding that adolescents' depressive symptoms prospectively

predicted adolescents' own NSSI replicates results from previous work on the role of depressive symptoms as a strong risk factor for adolescent NSSI (e.g., Hankin & Abela, 2011). Notably, friends' depressive symptoms had an additive effect on adolescents' NSSI above adolescents' depressive symptoms. Thus, having friends with depressive symptoms may be particularly harmful for those adolescents with underlying predispositions to endorse NSSI, for instance adolescents having difficulties in regulating their emotions (Nock & Prinstein, 2004). This evidence supporting indirect peer influence, in conjunction with interpersonal models of depression (e.g., Coyne, 1976; Rudolph et al., 2008), suggests either that having depressed friends promotes socialization of poor emotional regulation and sad affect (which may present risks for NSSI among some, but not all members of a friendship network), or possibly that participation in a friendship network with high levels of depressive symptoms creates stressors that are relevant predictors of NSSI for adolescents. Future work examining the mechanisms of indirect peer influence is needed.

Contrary to our expectations, this indirect socialization effect did not differ as a function of gender; that is, male and female adolescents emerged to be equally at risk to engage in NSSI if their friends reported high levels of depressive symptoms. Thus, NSSI may represent a common reactive strategy for both male and female adolescents when confronting depressed friends. This finding is in line with prior work showing that also direct depression socialization occurred similarly among male and female adolescents (e.g., Schwartz-Mette & Rose, 2012; but see also Giletta et al., 2011). Future studies are warranted to replicate these results and elucidate why, although females may seem to be at higher risk than males for socialization processes involving depressive symptoms, male adolescents may equally endorse NSSI when confronted with depressed friends.

Indirect forms of socialization related to friends' impulsivity were found for male adolescents. Peer influence not only may be relevant for tangible behavioral outcomes, but may also involve predisposing characteristics underlying these behaviors. In other words, indirect peer influence may result from shared underlying attitudes or values that lead to different, but functionally equivalent behaviors. In this study, impulsivity among adolescents' friends may be associated with increases in adolescents' own NSSI because adolescents observe their friends' engagement in impulsive acts and are influenced not to engage in identical behaviors, but in behaviors that similarly reflect impulsivity (and perhaps that adolescents assume will be similarly rewarded within their friendship context). These findings were consistent with gender predictions; friends' impulsivity was more salient among male, as compared to female adolescents. Males may be more exposed and sensitive to their friends' impulsivity; therefore, males may be more likely to engage in behaviors that are as impulsive as their friends'.

Findings have been interpreted as relevant to understanding risks for increased NSSI over time. It should be noted, however, that in this sample, an overall decrease in adolescent NSSI over time was observed. While adolescents are often assumed to increase their behaviors as a consequence of peer influence effects, socialization processes may also contribute to weaken or decelerate a normative developmental trend in adolescent behaviors. Thus, in this specific case, it should be acknowledged that adolescents whose friends reported higher levels of depressive symptoms (or impulsivity among males) may have been less likely to decrease NSSI, as compared to adolescents whose friends showed low depressive symptoms (or impulsivity). Future work may benefit from recent advances in stochastic actor-based modeling (i.e., creation and endowment effects), which may allow disentangling these different socialization processes.

This study is the first to provide preliminary evidence supporting the unexamined hypothesis that socialization processes may take indirect forms. Our findings carry implications for future peer influence research as well as for clinical practice. At a broad level, future peer influence research may benefit from these findings by expanding the traditional "modeling" approach and recognizing that peer socialization processes may be more complex and less linear than what previous work has shown so far. Specifically, when examining socialization processes, researchers should consider assessing and investigating multiple dimensions of the friendship contexts in which adolescents are embedded. Indeed, by focusing exclusively on direct peer influence, prior work may have underestimated the role that peers exert on socializing adolescent attitudes and behaviors.

In addition, our findings suggest that the behaviors in which adolescents engage should be seen as the result of more complex interactional patterns between the behavioral outcomes and the psychological dispositions of adolescents and their

friends. In this regard, an important open question for future research is to underscore what may lead adolescents to engage in a behavior different than the one endorsed by their friends (i.e., indirect socialization), rather than engaging in the same exact behavior (e.g., direct socialization). To answer this question, future work should take into account the role that individual (e.g., genotype, temperament) and contextual factors (e.g., behavior availability) may have in determining the forms of peer socialization processes. These factors may not only affect (e.g., attenuate or enhance), but also *redirect* peer socialization effects.

Concerning clinical practice, results from this study suggest that clinicians and professionals involved in prevention and intervention programs should be aware that adolescents with depressed and impulsive friends, even if these friends do not engage themselves in NSSI, may be at risk for future NSSI or slower desistance from NSSI. While prior evidence indicated that adolescents befriending peers who endorsed NSSI are specifically at risk for engaging in these behaviors themselves (Prinstein et al., 2010), our findings suggest that intervention should also attend to other characteristics of the friends with whom adolescents associate.

This study has a number of strengths, including the examination of multiple-wave data through stochastic actor-based modeling, the investigation of an unstudied indirect form of peer influence and of a potentially socializing behavior. However, some important limitations need to be acknowledged. A first limitation is the relatively low participation rate, which yielded the exclusion of friendship ties directed to adolescents who did not participate in the study and the inclusion in the analytic sample only of adolescents who participated in at least three of four time points. The low participation rate might have provided a somewhat limited picture of adolescents' friendship network and reduced statistical power to detect direct socialization effects. Despite this, however, it is important to note that network characteristics emerged to be in line with previous social network studies and appropriate to investigate socialization effects (Snijders et al., 2010; Veenstra et al., 2013).

A second limitation is the relatively small number of participants who engaged in NSSI. Clearly, this aspect is not a limitation in itself, especially considering that the percentage of adolescents engaging in NSSI in our sample reflected percentages found in previous studies (about 15%–20%; Rodham & Hawton, 2009). It may, nevertheless, represent a constraint for stochastic actor-based modeling due to low statistical power. Specifically, the rate of NSSI in our sample gave rise to a small proportion of adolescents within each behavioral category and high behavioral stability across time points, which, although in line with other studies examining socialization effects related to extreme forms of risk behaviors (e.g., weapon carrying; Dijkstra et al., 2010), might represent a reason for the lack of results on direct NSSI socialization. Moreover, as previously mentioned, the low proportion of adolescents engaging in NSSI prevented us from testing additional moderation effects. A third limitation is the use of structural zeros to combine school networks in an overall friendship network. This procedure was adopted to gain adequate power in estimating model parameters; yet, it should be acknowledged that, as this procedure assumed homogeneity in parameters across schools (see Ripley et al., 2012), potential school differences may have been hidden. Finally, limitations rise from the global self-report measure of impulsivity. Previous studies have shown that impulsivity is a multidimensional construct, and measures other than self-report (e.g., laboratory-based measures) may better assess impulsivity (e.g., Janis & Nock, 2009). Therefore, the examination of the different dimensions of impulsivity as well as the use of a laboratory-based measure might have provided different results. Further, impulsivity was assessed only at baseline. This prevented us from investigating changes over time in impulsivity and may therefore have underestimated selection as well as indirect socialization effects.

In conclusion, findings from this study provide important preliminary evidence about indirect peer socialization effects related to adolescent NSSI. Specifically, this study highlights the complexity of peer socialization and gives raise to several questions about the nature and dynamics underlying indirect socialization processes, thus contributing to the beginning of a potentially new branch of research within peer influence literature.

APPENDIX

Descriptive Statistics of Friendship Network and Adolescent NSSI per Time Point by School

	School 1				School 2				School 3			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
Sample size	168	168	168	165	124	127	127	123	53	53	53	47
Respondents missing	2	0	4	20	0	0	8	19	0	0	1	4
Fraction females (%)	53.6	53.6	53.6	53.4	54.0	54.8	54.8	54.9	60.4	60.4	60.4	63.8
Friendship												
Number of ties	943	587	951	536	600	402	617	292	286	216	303	107
Average outdegree	5.72	3.49	5.98	3.62	4.76	3.17	5.23	2.70	5.40	4.08	5.83	2.18
Density (%)	3.4	2.1	3.6	2.2	3.8	2.5	4.1	2.1	10.4	7.8	11.2	4.2
Reciprocity (%)	38.8	45.3	39.2	47.6	44.1	41.3	42.8	42.4	42.0	45.4	54.3	46.2
Transitivity (%)	25.0	22.0	22.6	26.4	25.8	17.3	21.4	22.1	31.7	30.6	31.6	28.4
NSSI												
Males (%)												
Never	78.9	90.9	88.7	94.0	78.5	87.7	90.6	90.0	50.0	61.9	65.0	81.3
1–3 times	16.9	5.2	5.7	4.5	16.1	8.8	9.4	10.0	38.9	23.8	30.0	12.5
4 or more times	4.2	3.9	5.6	1.5	5.4	3.5	0	0	11.1	14.3	5.0	6.2
Females (%)												
Never	73.2	81.8	86.5	89.7	70.6	71.0	80.6	85.7	43.4	53.1	71.9	78.6
1–3 times	17.1	9.1	11.3	6.5	23.5	14.5	9.7	10.7	33.3	12.5	12.5	10.7
4 or more times	9.7	9.1	2.2	3.8	5.9	14.5	9.7	3.6	23.3	34.4	15.6	10.7
Depressive symptoms												
Males												
Mean	0.24	0.21	0.22	0.17	0.26	0.17	0.24	0.19	0.41	0.36	0.38	0.36
SD	0.25	0.25	0.25	0.26	0.25	0.19	0.33	0.19	0.42	0.32	0.36	0.44
Females												
Means	0.30	0.37	0.36	0.31	0.38	0.49	0.46	0.43	0.51	0.54	0.52	0.47
SD	0.25	0.32	0.33	0.32	0.27	0.37	0.42	0.39	0.37	0.45	0.44	0.33
Impulsivity												
Males												
Mean	2.18				2.16				2.17			
SD	0.44				0.48				0.47			
Females												
Mean	2.19				2.29				2.30			
SD	0.52				0.42				0.61			

Note. At Time 1 and Time 2, adolescents in School 3 reported higher depressive symptoms than adolescents in both School 1 and 2 ($\eta^2 = .05$, $\eta^2 = .03$, for Time 1 and Time 2, respectively). At Time 3 and Time 4, adolescents in School 3 reported higher depressive symptoms than adolescents in School 1 ($\eta^2 = .02$, $\eta^2 = .03$, for Time 3 and Time 4, respectively). Moreover, adolescents in School 3 reported higher nonsuicidal self-injury (NSSI) than adolescents in School 1 and 2 at Time 1 ($\eta^2 = .04$), Time 2 ($\eta^2 = .04$) and Time 3 ($\eta^2 = .03$).

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