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Peer network studies and interventions in adolescence
René Veenstra and Lydia Laninga-Wijnen

Abstract
Peer influence occurs across a wide variety of behavioral domains, which is an important reason for peer-led interventions: interventions in which peers are involved in the delivery of the program. These programs are promising in combatting undesirable behaviors (e.g. risk behavior) and promoting desirable behavior (e.g. healthy lifestyle), but it was shown recently that the effectiveness of these programs is modest at best and the mechanisms underlying programs’ effectiveness are poorly understood. Research is needed that promotes understanding of the relative, cumulative, and interactive impacts of different types of peer relations and unpacks the various mechanisms underlying peer selection and influence. This has the potential to yield insights that advance theory and optimize peer-led interventions.

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Introduction
In adolescence, when adult supervision wanes, young people become increasingly attuned to relate with their peers. Fitting in with what peers do increases their chances of being included in the peer group, whereas standing out poses the risk of peer exclusion [1]. Not surprisingly, adolescent peer networks are characterized by strong similarities in behaviors, values, beliefs, and inner thoughts. Half a century ago, scholars noted that these similarities may be due to at least two processes [2,3]. First, adolescents may select peers based on similarities in behaviors or proclivities [4]. Second, adolescents may start behaving or thinking in ways that they might not otherwise do because of peer influence [1]. Failure to account for selection processes may result in the overestimation of peer influence. Only in this century, advanced statistical analyses were developed to disentangle selection and influence processes in a sophisticated and reliable way [5]. To date, an impressive number of studies offer empirical support for both selection and influence processes across diverse behaviors in varying populations of young people [6].

In line with findings on peer influence, peer-led interventions (referring to interventions in which peers are involved in the delivery of the intervention) have been designed to combat undesirable behaviors, such as substance use or sexual violence, and promote desirable behaviors, such as helping behaviors in classrooms or a healthy lifestyle [7]. Evaluations of these programs initially led to enthusiasm; peer-led interventions often provided better outcomes than individual-level approaches, for instance, for substance use [8]. This initial enthusiasm has been somewhat dampened recently by the realization that the effect sizes of these programs are modest at best [9,10]. Moreover, programs vary in how peers are targeted, which complicates the detection of underlying mechanisms for the effectiveness of programs. For instance, peer-led tobacco prevention programs range from preparing older students to deliver structured classroom lessons to train influential students to discourage their peers from smoking through informal interactions [11]. Knowledge of the underlying mechanisms is critical for maximizing the impact of peer-led interventions.

This article summarizes research focusing on selection and influence processes and illuminates challenges in peer network studies and interventions that should be tackled in the future. Using this information, peer network studies can optimize the potential of peer-led interventions to promote healthy and desirable behaviors, values, beliefs, and inner thoughts.
Peer influence across different behavioral domains

Peer-led interventions are considered promising because peer influence is often thought as a ubiquitous process that can substantially alter adolescents’ adaptation and behavior. But how powerful is the effect of peer influence, and does it vary across behavioral domains? Various recent systematic reviews and meta-analyses of peer network studies found that peer influence occurred more for internalizing problems, victimization, delinquency, alcohol use, and indirect aggression than for smoking or direct aggression [12–17]. These effects were found after controlling for selection effects, which were present for many behaviors as well: individuals select friends based on similarity in delinquency, as well as alcohol and tobacco use [13–16]. Peer selection is less likely for internalizing symptoms and aggression [12,14].

Peer processes related to prosocial behaviors and academic achievement in adolescence have not been reviewed systematically. Peer influence has nevertheless been found for prosocial behaviors [18–20] and academic behaviors, such as school engagement, educational performance, expectations, and choices [21–24]. Peer influence has also been examined for health-related behaviors. Friends become more similar over time in physical activity [25,26] and body weight [27,28].

Thus, peer network studies have documented peer influence effects for a wide variety of behaviors and characteristics, even after selection based on similarity in these attributes has been controlled. This finding aligns with a recent meta-analysis of experimental studies and survey studies applying cross-lagged path models, which detected peer influence effects across diverse behavioral domains [29]. The consistency of peer influence across behavioral domains may have important theoretical and practical implications. Theoretically, influence is relevant not only to observable, socially sanctioned, explicitly communicated, or consciously encoded behaviors but also to values, beliefs, and inner thoughts [30]. Practically, peer-led interventions may be effective for reducing not only externalizing but also internalizing problems, such as suicidal thoughts [31].

This recent meta-analysis suggests, however, that the size of peer influence effects may not be as large as often thought [29], which leads to the question of how powerful peer-led interventions can be. To answer this question, it is important to reflect on a few reasons for the small magnitude of the peer influence effect found.

One reason may be that adolescents influence each other in different ways. Some adolescents may influence others to increase certain behaviors or attitudes over time; others might cause a decrease in those behaviors or attitudes, resulting in an overall ‘cancelling out’ and reduction in the magnitude of the average influence effect. Longitudinal social network analyses can differentiate between influence on increases and decreases in behavior or between initiation and cessation of behavior over time [32].

Another possible reason for the small magnitude of peer influence detected in the meta-analysis [29] is that adolescents are influenced not only by their friends — which to date has been the primary focus of peer studies — but also by the peers in their wider network. Social network analyses allow researchers to examine the relative, cumulative, and interactive impacts of the different relationships in which adolescents are embedded and should move beyond examining friends as the sole or primary source of influence. This would enable researchers to better estimate the magnitude of peer influence and assess how powerful peer-led interventions can be.

Types of peer relationships

Most peer network studies in childhood and adolescence examine influence processes within friendship networks (who is friends with whom). Friendships do not occur in isolation but are embedded in larger networks and interplay with other relationships [33,34], including positive relationships, such as social facilitation (who hangs out with whom), cooperation (who cooperates on a school task with whom), defending (who defends whom), and helping (who helps whom), as well as negative relationships, such as bullying (who bullies whom) and antipathies (who dislikes whom). The relative, cumulative, and interactive importance and interdependencies among these various peer relationships sorely need greater research attention to understand the roles of various types of peer relationships across various types of behaviors, as well as to estimate the effect size of peer influence reliably.

Peer network studies have recently started to examine interdependencies between multiple positive and negative relationships. A longitudinal study of the co-development of bullying and friendships found that bullies befriend other bullies and that the friends of bullies are influenced to also target the bullies’ victims [35]. Another study examined the co-development of who bullies whom and who perceives whom as popular. That study found that those who bully received more popularity nominations over time and that the popular bullies discontinued bullying the same victims, replacing them with new victims [36].

More insights into the interdependencies among various peer relationships are also vital for understanding mechanisms underlying and moderators shaping the
effectiveness of peer-led interventions. For instance, social network analyses can help us to better understand the diffusion of peer leaders’ actions and thoughts across their classmates. Specifically, adolescents’ closeness to trained peer leaders (referring to influential peers who are trained to conduct intervention activities) may determine the extent to which the program is effective for them. For instance, adolescents benefitted more from a tobacco prevention curriculum when they were affiliated more closely with the peer leaders who delivered the intervention [37]. Similarly, adolescents may profit more from interventions when they have multiple positive relationships and no negative relationships with the peer leaders. Peer-led interventions may also work better if they are delivered by peers with a reputation for popularity. Social network analyses may help to determine what types of peers may be most suitable as peer leaders based on the nominations they receive.

Types of influence
Theoretically, multiple types of influence can be distinguished [6]. It is often thought that peer influence occurs because peers pressure adolescents into behavioral change particularly for negative behaviors, such as substance use and risk behaviors [10]. Peer pressure is a direct form of peer influence, referring to peers’ active attempts to bring about change in an individual’s behaviors, attitudes, or other characteristics [38]. This negative peer influence can be accompanied by coercion, teasing, or taunting if individuals resist the pressure [39]. Many peer-led interventions involve teaching adolescents resistance skills to prevent peer influence on undesirable behaviors. The second type of peer influence, which has received less attention in peer-led interventions, is imitation. This more passive, implicit form of peer influence implies that individuals observe and imitate peer behaviors, without being urged to do so. Social learning theory suggests that individuals learn to imitate the behaviors that are modeled by people around them, particularly if these behaviors are socially rewarded, including gains in status or affection [40].

Observational and experimental studies have compared the relative extent to which active (peer pressure) or passive (imitation) peer influence takes place in relation to adolescent substance use and risk behaviors. Imitation rather than peer pressure was found to affect adolescents’ smoking behavior [41]. Similar findings emerged for alcohol consumption, with observational studies showing that emerging adults imitated the drinking behavior of peer models [38,42]. Two experimental studies tested the relative effects of both types of influence on risky decision-making. One study detected more evidence for imitation than for peer pressure [43], whereas the other study indicated that a combination of imitation and peer pressure was most predictive of discouraging risk behavior [44]. Together, these studies suggest that even though many peer-led interventions assume that teaching refusal or resistance skills is key in counteracting detrimental peer influence, imitation is a more important mechanism of influence. In line with this, a review of the effective components of school-based drug prevention programs did not find support for resistance training (resisting peer pressure) as a significant mediator in the success of the programs [45].

Imitation and peer pressure are likely to occur in smaller peer groups. In the broader peer context, such as the classroom, norm conformity may take place. Norms provide important guidelines for how individuals should behave to align with peer expectations and avoid being dissimilar to the group [46]. The behavior of popular peers is often more important for imitation than the average behavior of all peers in a particular setting [47,48]. The behavior of popular children and adolescents is very noticeable and might be used as a guideline to increase one’s own chances of becoming popular [49]. In that sense, popular peers can be seen as norm-setters; this has also been found in experimental studies of willingness to consume alcohol [50] and prosocial volunteering behaviors [51]. Interestingly, adolescents tend to misperceive the risk behaviors of their popular peers, and these misperceptions rather than the actual behaviors of these peers influenced adolescents’ behavior [52]. Sometimes, these misperceptions reflect pluralistic ignorance. Pluralistic ignorance refers to situations where individuals privately reject a norm but incorrectly assume that most others accept it, and therefore go along with it in public [53]. Evidence suggests that adolescents systematically perceived their peers to hold more pro-bullying norms (e.g. to be more tolerant of bullies, less empathic toward victims, and less inclined to believe they have a responsibility to protect victims) than they themselves did. The more individuals incorrectly assumed that most others accepted pro-bullying norms, the more they stayed outside bullying situations and did not side with victims [54]. Peer-led interventions increasingly consider peer norms an essential form of peer influence and acknowledge the importance of popular peers. For instance, in an anti-conflict intervention, popular peer leaders were used as role models to set the norm and spread perceptions of conflict as less socially normative [55].

Taken together, the findings of experimental work suggest that peer-led interventions may profit most from targeting more implicit forms of peer influence, such as imitation or norms, and from using popular peers as role models. A few peer network studies indicate that the diffusion of behavior is indeed most likely in classrooms where popular peers set a norm for that behavior [56,57], but more social network research is needed to unpack the different mechanisms of
influence. Imitation, pressure, and norm conformity can be considered unidirectional mechanisms [1] but peer influence can also be mutual. Peers can mutually exchange ideas, attitudes, or values. They may discuss and encourage antisocial behavior through positive reinforcement and laughter in direct response to deviant ideas, a process referred to as deviancy training [58]. Others may excessively discuss problems and dwell on negative affect together, a process labeled co-rumination [59,60], which can be a major source of peer influence on internalizing behaviors, as it promotes passive and maladaptive coping processes and a vicious cycle of emotional distress [61].

A way to expand the effectiveness of peer-led interventions is to evaluate their components, what type of peer influence is targeted? Is the peer influence mechanism unidirectional or mutual? To examine these mechanisms in detail, social network researchers might collect network data on imitation (who feels internal pressure to conform to whom), negative peer pressure (who pressures whom to do things that they would not do by themselves), positive peer pressure (who prevents whom from doing things that they should not do), mutual encouragement (who mutually exchanges ideas, attitudes, or values with whom), deviancy training (who laughs with whom about deviant ideas), and co-rumination (who discusses problems with and dwells on negative affect with whom).

We expect that some types of influence will be contagion processes (e.g. imitation, peer pressure), and other will be convergence processes (e.g. mutual encouragement, deviancy training, co-rumination). Contagion refers to a process in which individuals with friends who have relatively higher levels of behaviors increase in these behaviors, whereas convergence refers to a process in which the average behaviors of friends affects one’s behavior; this can be in upward or downward directions. An exemplary peer network study modeled two types of influence effects on depressive symptoms to directly test these two mechanisms [62]. The findings suggested that influence processes can lead to both increases and decreases in adolescent depression, providing evidence for convergence rather than contagion. As such, social network analyses can be used to evaluate the directionality of influence processes, which may also help researchers to better understand the type of peer influence.

Types of selection
A vital insight produced by peer network studies is that similarity in peer networks is important for peer-led interventions. To date, peer-led interventions mostly focused on increasing peer influence rather than on strengthening relationships among peers. However, the facilitation of strong ties between peer leaders and their class- or schoolmates may be a key ingredient of a successful peer-led intervention. More knowledge of how these ties are naturally formed will provide important insights into what processes should be stimulated for peer-led interventions.

Theoretically, multiple types of selection can be distinguished [6]. Active selection refers to the process where individuals actively choose to hang out with certain peers. They prefer to do so, for instance, because they share similarities (preferential attraction). Sharing similarities facilitates communication, understanding, and getting along, minimizes conflict, and increases the stability of friendships [1].

The avoidance of peers because they are dissimilar (repulsion) is another type of active selection. Dissimilarity may breed negative thoughts and invite conflicts that jeopardize friendship stability. Experimental studies suggest that both preference for similarity and repulsion from dissimilarity play a role in the formation of friendships [63].

Passive selection may occur when individuals end up with peers who are not necessarily their first friendship choice. Some individuals may hold a relatively marginal position in the group and be limited in their possibilities to establish friendships [64]. Consequently, they may end up with others who are also at the periphery of the peer group, referring to default selection. For instance, aggressive adolescents prefer to befriend nonaggressive, prosocial peers but end up with other aggressive peers [65].

So far, social network researchers have not disentangled preferential attachment, repulsion, and default selection mechanisms. To examine these mechanisms in detail, researchers might collect network data on preferential attachment (who admires, respects and wants to be like whom), repulsion (who wants to be different from whom), and default selection (who ends up with whom because there are no alternatives). This would provide insight into what types of selection drive network similarity for various behaviors or characteristics and how interventions may either stimulate or discourage the strengthening of different relationships.

Conclusions
Peer network studies have been burgeoning and have contributed to the development of peer-led interventions to reduce undesirable behaviors and promote desirable behaviors in adolescence. Peer-led interventions are promising given that they tap into
adolescents’ increasing attunement to peers [1], but their effectiveness may be less optimal than desired [10]. In the current article, we have indicated directions that peer researchers can take to increase the potential of peer-led interventions.

The first way to increase the potential of peer-led interventions is to uncover the relative, cumulative, and interactive importance of various peer relations. Most research on selection and influence processes focuses on friendship networks. An avenue for further research is to examine the interdependencies between multiple positive and/or negative relationships using multiplex social network analysis [66]. Examining the relative impacts of different types of relationships for various behaviors may provide unprecedented insights for interventions into who should be selected as a peer leader, depending on the desired behavioral change and into the relationships that facilitate the diffusion of behaviors or attitudes.

Second, it is unclear which mechanisms underlie the effectiveness of peer-led interventions. Peer network studies can help to disentangle the different theoretical influence and selection mechanisms. We propose collecting network data on imitation, negative peer pressure, positive peer pressure, mutual encouragement, deviancy training, and co-rumination (as types of influence) and preferential attraction, repulsion, and default selection (as types of selection). To better understand these mechanisms, it is also important to acknowledge that different types of influence may occur across different time spans. Most peer network studies have relied on questionnaire-based (semi-)annual assessments, but influence mechanisms may occur rapidly (e.g., peer pressure) or slowly (e.g., co-rumination). In the same way, some relationships (e.g., helping) may change more rapidly than others (e.g. friendship). These rapid network-behavior dynamics suggest that ecological-momentary assessment approaches would be useful in future research [67,68], not only to better understand mechanisms of peer selection and influence but also to evaluate peer-led interventions.

To conclude, the field needs to better understand the impacts of various types of relationships and the mechanisms underlying selection and influence. The insights generated by such studies will not only advance theory but will also be essential in optimizing the potential of peer-led interventions to generate positive behavioral and attitudinal changes in young people.

Conflict of interest statement
Nothing declared.

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References
Papers of particular interest, published within the period of review, have been highlighted as:
* of special interest
** of outstanding interest


This literature review focuses on factors that make adolescence a period of special vulnerability to peer influence and advances the influence-compatibility model, which integrates converging views about early adolescence as a period of increased conformity with evidence that peer influence functions to increase affiliate similarity.


This chapter shows that social networks of peers play a prominent role in risk behavior, internalizing symptoms, and adaptive behaviors, and describes various types of selection and influence. Most evidence has been found for selection based on preferential attraction, and influence based on imitation and norms of popular peers.


This article reports the results of a systematic review of studies that used longitudinal social network analysis to test for peer selection and influence effects for depression, anxiety, and victimization.


This article reports the results of a systematic review of studies that used longitudinal social network analysis to test for peer selection and influence effects for alcohol and tobacco use.


This article reports the results of a systematic review and meta-analysis of studies that used longitudinal social network analysis to test for peer selection and influence effects for alcohol use.


This chapter presents a review of recent empirical studies that used longitudinal social network analysis to examine peer influence effects for bullying and victimization.


This article examines the role of popular peers as norm-setters. Peer selection and influence based on similarity in aggression only take place in classrooms where aggression is related to popularity. Adolescents are not influenced by their friends to engage in these negative behaviors in classrooms where aggression is not rewarded with popularity.


Educational expectations are a key predictor of educational attainment. This study found that adolescents adapted their expectations toward the average expectations of their friends but only in secondary school tracks that supported diverse educational paths.


This study evaluated mechanisms underlying the relation between school punishment and reductions in adolescent academic achievement. The findings indicate that school punishment facilitates selection into academically underperforming peer networks and that this change in network composition is largely responsible for the association between school punishment and reductions in adolescent academic achievement.


29. Giletta M, Choukas-Bradley S, Maes M, Linthicum KP, Card NA, ** Prinstein MJ: A meta-analysis of longitudinal peer influence effects in childhood and adolescence. Psychol Bull 2021, This synthesis and meta-analysis quantified the magnitude of peer influence effects across externalizing, internalizing, and academic behaviors. The findings revealed that a peer influence effect was small in magnitude but significant and robust. Peer network studies were not part of this review.


This study investigates the meaning of friendship. Analysis of focus group and survey data suggests that adolescents construe friendship based on relational norms and expectations for mutual behavior. The meaning of friendship differs for boys and girls.


This multiplex longitudinal peer network study examined how bullying affects the creation, dissolution, and maintenance of status attributions, and vice versa. High-status bullies seemed to avoid continual bullying of the same victims, pointing to explanations of why their status can persist.


This study examined vaping-prevention efforts. Key components of the network-informed intervention were the use of students nominated and trained as Peer Leaders, and the implementation of prevention campaigns informed by communication science, including gain-loss messaging and social norming. The findings reveal that adolescent peer leaders combined with ongoing mentoring and science-informed campaigns can potentially reduce vaping acceptability and use.


