Adolescent Intergroup Connections and their Developmental Benefits: Exploring Contributions from

Social Network Analysis

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Abstract

Because diverse school settings provide students with opportunities to form same- and cross-group relationships with youth of various ethnicities and races, an important question arises: How are these opportunities taken up, and what are the developmental implications of doing so? Accumulating evidence suggests that these connections are beneficial to youth. Yet, we currently have a limited understanding of the specific peer mechanisms that produce these benefits. Addressing this gap requires adopting a relational perspective and using social network analysis tools to characterize the theorized developmental mechanisms through which intergroup connections promote adolescent psychological and academic adjustment. To do so, we present an integrative account in which

intergroup connections are viewed as developing and influencing adolescent outcomes in the context of broader peer networks. We then discuss the need to disentangle peer network selection from peer influence dynamics to provide an accurate account of multiple processes through which intergroup connections shape development and briefly explore how these goals are achieved by using statistical approaches to modeling of social networks. This review seeks to guide the next generation of research to more thoroughly test and refine the developmental theory and advance knowledge that will inform interventions to promote intergroup connections and their academic and socio-emotional benefits.

Keywords: intergroup contact; peer relationships; friendships; adolescence; social network analysis

In the United States and Europe, school settings are composed of youth from diverse backgrounds in terms of their ethnicity, race, and immigrant heritage (Crosnoe & Benner, 2015; Titzmann & Jugert, 2019). In these settings, adolescents have an opportunity to develop relationships with peers from other groups (i.e., intergroup connections). Evidence suggests that such relationships have distinct developmental benefits. Attending schools with diverse peers and having intergroup friends has been linked to improvements not only in intergroup attitudes (Davies et al., 2011; Pettigrew & Tropp, 2006), but also in social skills and competencies (Kawabata & Crick, 2008; Lease & Blake, 2005), school belonging and safety (Graham et al., 2014), and academic outcomes (Williams & Hamm, 2018). These benefits have inspired many calls to promote diversity and inclusion in schools (e.g., Graham, 2018; Juvonen et al., 2019). Although peer relationships have been prominently featured in these models, the peer mechanisms responsible for the benefits have been conceptualized only in very broad terms. Because intergroup relationships do not occur in a social vacuum but rather are embedded in peer networks where they influence developmental outcomes, the present review introduces a social network perspective and analytical approaches to the developmental audience to better understand the benefits of intergroup connections.

Guided by Allport's (1954) influential intergroup contact theory, a substantial body of research has examined the role of contact, exposure, and friendships in race relations and attitudes (Davies et al., 2011; Pettigrew & Tropp, 2006). Much less scholarship has considered the implications of intergroup processes for the development of adolescents' academic and social competencies. As discussed below, a growing body of research posits that intergroup connections promote academic and socio-emotional development through various developmental mechanisms, including social support, belonging, and capital. These mechanisms should also be understood as operating within social networks (e.g., Berkman et al., 2000; Borgatti et al., 2009). Adopting a social network lens reveals that intergroup connections are in and of themselves network phenomena (e.g., Moody, 2001)—these relationships are actively selected and influence youth development over time. Thus, to understand how developmental provisions of intergroup connections are distributed in peer networks, it is instructive to adopt a relational perspective and use social network analysis (SNA) methods to characterize them.

We start by making the case for the need to understand intergroup peer relationships in school settings during adolescence. We then review the documented patterns and developmental benefits of intergroup connections. Next, we summarize key developmental and sociological models of the mechanisms through which intergroup connections promote adolescent psychological and academic adjustment. We then identify conceptual, measurement, and analytical limitations in the existing developmental research on intergroup friendships and recommend ways that these gaps can be addressed by more accurate theoretical predictions and theoretically informed measurement of peer relationships. Subsequently, we discuss how SNA methods can be used to characterize the developmental mechanisms through which intergroup connections promote adolescent adjustment. To accomplish this central aim of our review, we apply network thinking to the understanding of intergroup, developmental, and peer network processes and discuss the need to disentangle peer

network selection from peer influence dynamics. Finally, we provide a brief overview of statistical approaches for modeling social networks to achieve these objectives.

Focus on Intergroup Relationships in Adolescence and in School Contexts

Two main issues underscore the need to study adolescent intergroup friendships in schools, namely, developmental transformations and contextual factors. Adolescence is a prime time for investigating the role and consequences of intergroup relationships for learning and social development as it is a period of increased cognitive flexibility and behavioral malleability (e.g., Dahl et al., 2018). These critical contributions are promoted by a heightened social orientation towards peers, increased motivational salience, and increased time spent in the company of peers (Brown & Larson, 2009). Youth are also uniquely attuned to peer status and have a nuanced understanding of autonomy, respect, and fairness (Yeager, Dahl, & Dweck, 2018), making them sensitive to peers as sources of social support, influence, and identity development (Brechwald & Prinstein, 2011). The transformations that occur during the teen years intensify psychosocial processes that have been theorized to promote the benefits of intergroup connections.

By the time children reach adolescence, they have already had myriad intergroup exposures and experiences of socialization in their family, school, and community. A meta-analysis of 131 studies revealed a positive medium effect size for a correlation between parent and offspring intergroup attitudes, which increased in strength from childhood to adolescence, partially owing to measurement overlap (Degner & Dalege, 2013). Although parental socialization is a powerful predictor of intergroup attitudes, peers become a potent source of attitudes, behaviors, and socialization for adolescents (Laursen, 2018). Thus, it is vital to examine the role of peers and schools because they create a developmental context that is consequential for intergroup friendships and adolescent adjustment (Crosnoe & Benner, 2015; Graham, 2018).

Schools represent a salient context for adolescent development because they are primary arenas for developing friendships and intergroup contact with students of different ethnic and racial backgrounds (Brown & Larson, 2009; Crosnoe & Benner, 2015). There is a decline in the strength of similarity-attraction for same-race or same-ethnic friends in adolescence compared to childhood (Aboud & Mendelson, 1998). However, the increased exposure to a diverse pool of peers may not always result in intergroup friendships due to second-generation segregation caused by academic tracking (Orfield, & Lee, 2007; Mickelson, 2001). Nevertheless, understanding the role of school context is critical because increased cognitive flexibility and exposure to a larger and more diverse pool of peers makes adolescents capable of changing their intergroup attitudes and cultural norms (Gopnik et al., 2018).

Many studies have shown that attending diverse schools is beneficial to adolescent psychosocial development. Students attending such schools demonstrate decreased social vulnerability, peer victimization, and loneliness (Graham, 2018; Juvonen et al., 2019). A meta-analysis of 26 studies examining changes in prejudice towards immigrants and ethnic minorities across adolescence documented that having intergroup friendships in schools was associated with a lower level of prejudice, though intergroup attitudes and behaviors had a high rank-order stability across adolescence (Crocetti, et al., 2021). School contexts may represent a last window for acquiring intergroup relational competencies. Upon leaving high school, youth move into the increasingly segregated educational, professional, and residential spheres of adulthood (McPherson et al., 2001). This evidence underscores unique provisions of in-school intergroup connections that need to be systematically investigated.

Patterns and Benefits of Intergroup Connections in Adolescence

Cross-group connections cannot be understood without acknowledging same-group relationships because evidence across the lifespan shows that people prefer befriending those who are

similar to them in multiple ways, including ethnicity and race (e.g., Moody, 2001). This preference to befriend similar others is referred to as *homophily*. It has been documented across sociodemographic categories (e.g., gender, religion) and behavioral and psychological characteristics (McPherson et al., 2001). Affiliating with similar others enriches social interactions and prevents conflict (Cole & TeBoul, 2004). The developmental literature shows that same-race and same-ethnicity friendships are more frequent than cross-race and cross-ethnic friendships (Aboud & Mendelsohn, 1998). They provide a sense of familiarity, support, trust, and social belonging (Laursen, 2017). For ethnic minority youth, same-group friends also promote enculturative tasks (i.e., learning and maintaining heritage culture) that contribute to the development of cultural values and ethnic-racial identity (Graham et al., 2014; Jugert et al., 2019).

Although same-group friendships are widespread, they do not represent the totality of adolescent connections in diverse schools. Indeed, small proportions of cross-race and cross-ethnic friendships have been documented in representative samples of youth from European countries and the United States (Moody, 2001; Smith et al., 2016). The developmental literature has shown that such friendships are less prevalent, stable, and intimate than same-race friendships, and they become less common with age (Aboud et al., 2003; Graham et al., 2014; Kao, et al., 2019). Despite these challenges, cross-race friendships offer concurrent and lifelong benefits, improving intergroup relations, attitudes, and values (e.g., Graham, 2018).

Beyond their benefits for race relations (Davies et al., 2011; Pettigrew & Tropp, 2006), cross-group interactions and relationships have other advantages. This is supported by evidence from many disciplines. For example, in sociology and organizational science, intergroup ties are viewed as sources of new knowledge and skills (Rivera et al., 2010). Migration researchers regard them as engines of economic and social mobility (Gold, 2005). In developmental research on immigrant and ethnic-minority youth, intergroup friendships are viewed as a marker of successful acculturation and adaptation in the receiving society (Titzman, 2014). Developmental scholars have also linked

intergroup friendships to improved academic outcomes (Baysu, et al., 2014; Hamm & Williams, 2018), social skills (Lease & Blake, 2003), psychological adaptation (Kawabata & Crick, 2015), and social belonging and safety (Graham & Echols, 2018).

Mechanisms Underpinning the Developmental Benefits of Intergroup Connections

Several mechanisms for how intergroup connections shape adolescent academic and social development have been theorized and examined. First, intergroup connections have been posited to promote adolescent adjustment by boosting *social belonging and safety* (Graham, 2018; Juvonen et al., 2019). Research has shown that an increased proportion of intergroup friendships promotes school climate, safety, and social belonging (e.g., Chen & Graham, 2017), and reduces adverse peer victimization and rejection (Graham, et al., 2014). For ethnic minority youth, having a higher proportion of cross-group friends protects against the adverse effects of discrimination on well-being (Benner & Wang, 2017).

Another mechanism through which intergroup friendships are beneficial involves the provision of *instrumental and informational academic support*. The receipt of academic support from peers and friends was linked to better academic and psychological adjustment in recent meta-analyses (Chu et al., 2010; Wentzel et al., 2018). Also, being exposed to new information, ideas, and perspective taking in the context of intergroup friendships has been associated with improved psychological adjustment, social competence, and school adaptation (Kawabata & Crick, 2008).

A third mechanism through which peers foster psychological and school adaptation and academic achievement is *social capital* (e.g., Williams & Hamm, 2018; Lessard & Juvonen, 2019). This powerful concept has been imported into the developmental and educational sciences from sociology. Two main types of social capital have been identified: (1) *bridging capital* that provides access to new skills, information, and opportunities, and (2) *bonding capital* that provides emotional support, a sense of belonging, and familiarity (Putnam, 2000). In line with sociological thinking,

bridging capital can be distributed through cross-group connections, whereas same-group connections represent bonding capital (Lin, 1999). Moreover, certain social network positions are theorized to transmit social capital. For example, occupying a position in a network of relationships in which one connects otherwise unconnected sections of a network (i.e., brokerage) can promote *bridging capital* (Lin, 1999). Alternatively, being embedded in a densely interconnected network where there is a higher proportion of mutual friends can promote *bonding capital* (Lin, 1999; Walker et al., 1993).

The final promotive mechanism of intergroup friendships includes *peer influence or socialization,* by which adolescents become similar to their friends by adopting their attitudes, values, and behaviors (for a meta-analysis, see Giletta et al., in press). Developmental scholars have long been interested in understanding the mechanisms (e.g., social learning, imitation, deviance training, emotional contagion, social identity enhancement) and moderators (e.g., social status of a friend) of peer influence (Laursen, 2018; Prinstein & Giletta, 2020). When considering the role of intergroup peer relationships, bridging capital and academic support perspectives suggest that peer influence on academic adjustment could be stronger in cross-group friendships if they transmit culturally dominant social capital to boost academic and social competence (Lewis et al., 2018; Williams & Hamm, 2018), but not feelings towards school (Lewis et al., 2018). However, some evidence suggests that the benefits of diverse peers on academic success are contingent on the presence of same-race peers (Benner & Crosnoe, 2011). This implies that both bridging and bonding capital play a role. Other theoretical models suggest that if peer influence is mediated via social learning (Bandura, 1986) or identity enhancement (Cialdini & Goldstein, 2004) mechanisms, its strength would be higher in same-group connections. Indeed, evidence indicates that peer influence on ethnic-racial identity attachment and private regard is stronger in co-ethnic friendships during adolescence (Jugert et al., 2020). However, other theoretical accounts ascribe a critical role to being in the company of other-group peers for the initiation and socialization of ethnic-racial identity development (Syed, et al., 2018).

Limitations of the Research on the Developmental Benefits of Intergroup Connections and

Recommendations to Address Them

A critical appraisal of the developmental scholarship on the benefits of intergroup connections reveals several conceptual and analytical limitations that need to be addressed to provide an accurate depiction of these processes. One conceptual limitation is that scholars have not measured relational mechanisms through which intergroup connections are theorized to promote adolescent development. Although focusing on friendship (i.e., "Who are your (best) friends?") or peer relationships (i.e., "Who do you hang out with?") is appropriate for investigating peer influence, models of the developmental benefits of intergroup connections assume the existence of other types of peer relationships and interactions (e.g., emotional or academic peer support) that are largely understudied. Thus, this scholarship has been based on an unwarranted assumption that all friendships or peer relationships provide the same levels of emotional, instrumental, and informational support (Bagwell & Schmidt, 2013). This limitation can be addressed by using a theoretically guided and better tailored measure of peer relationships (Neal, 2020). To examine the hypothesized relational mechanisms through which intergroup connections promote adolescent development, scholars could use specific peer nomination prompts to measure academic relationships ("Who do you study with?") as well as emotional supports ("Who makes you feel supported and cared for?"), instrumental supports ("Who do you go for help/advice?"), and informational supports ("Who knows how to navigate X?"). Research has begun to examine such mechanisms and showed that studying together with peers of different linguistic status has been prospectively associated with better academic outcomes (Hwang et al., 2021).

Once this tailored approach has been used to measure the specialized functions of intergroup connections, researchers can create composite indices of same- vs. other-group peers who provide these theorized supports. Various operationalizations have been used in non-network developmental research. For instance, aggregate composites are constructed using mean or sum functions for

continuous attributes (e.g., Medina et al., 2019), and a proportion function is used for binary attributes such as race or ethnicity (e.g., Williams & Hamm, 2018). A more sophisticated way to describe the composition of one's peers is by using diversity or segregation indices that account for the representation of multiple groups (e.g., racial groups) in a school. Developmental scholars have used the Freeman segregation index to quantify the proportion of ties to members of the same group compared to other group ties (Freeman, 1978). Simpson's index, another measure that captures diversity, considers the number of groups present and the relative size of each group. Diversity of friends, as captured by Simpson's index, has been linked to increased exploration of ethnic-racial identity (Rivas-Drake et al., 2017) and greater school safety (Juvonen, et al., 2006). Such indices can be included in traditional (non-network) statistical models to estimate how specialized measures of intergroup connections are prospectively associated with psychological and academic adjustment outcomes. Another major limitation of the research on the developmental benefits of intergroup relationships has been its overreliance on aggregated and static views of peer groups (the sociological scholarship on social capital is an important exception). Developmental scholarship has taken for granted the need to characterize how intergroup relationships emerge as a part of broader peer networks and influence developmental outcomes in individuals. This lack of a relational perspective in empirical studies is unfortunate because, at a conceptual level, major developmental theories have long acknowledged that relational mechanisms link adolescents and their social contexts (e.g., Bronfenbrenner, 2005; Cicchetti & Rogosch, 2002; Harris, 1995). Specifically, these models posit that adolescents select their peers and are socialized by them over time. Fortunately, with the introduction and proliferation of SNA methods to study the structure and dynamics of peer relationships, developmental scholars now have analytical tools to empirically examine these relational dynamics. In the following section, we argue that SNA can advance developmental research on intergroup connections by (1) identifying relational mechanisms, and (2) replacing static views of peers with statistical modeling of networks.

The Contributions of SNA to Research on the Developmental Benefits of Intergroup Connections

Viewing intergroup connections through a network lens has become popular in developmental and social psychological scholarship. A recent developmental account delineated how social network factors, such as homophily (preference for similar others) and reciprocity (mutual relationships), serve as antecedents of cross-group friendships (Jugert & Feddes, 2017). Wölfer and colleagues provided a conceptual and practical introduction to the use of SNA methods in the social psychological literature to advance understanding of intergroup contact (Wölfer & Hewstone, 2017; Wölfer, et al., 2015). Readers are directed to recent methodological reviews and recommendations for collecting peer nominations data and conceptualizing and quantifying peer networks in developmental and social science research (e.g., Agneessens & Labianca, 2022; Cillessen & Marks, 2017; Neal, 2020; Robins, 2015). Expanding on this work, we focus on how SNA methods can advance our knowledge of the theorized *developmental mechanisms* through which intergroup connections promote adolescent psychological and academic adjustment. To do so, we apply network thinking to the interface between peer networks and developmental processes, discuss the need to disentangle peer selection from peer influence, and provide a brief overview of statistical approaches for modeling networks to achieve these objectives.

Key Issue: Attending to relational mechanisms when studying intergroup ties

Intergroup connections and their developmental benefits do not occur in a social vacuum. Instead, they are embedded and distributed across relationships in peer networks. Thus, as the social network research argues, the nature and developmental consequences of intergroup connections need to be understood using a network perspective and analytical tools. According to this view, peer networks are complex social settings because youth play an active role in choosing their friends through *peer selection* processes (Veenstra et al., 2013). Moreover, youth socialize and become

similar to each other over time via *peer influence* processes. Whereas developmental scholarship has been predominantly interested in characterizing peer influence processes (see Giletta et al., in press), network-informed research argues that an accurate depiction of peer influence requires disentangling it from the peer selection processes through which network structures emerge over time (Veenstra et al., 2013). Failing to account for peer selection can lead to inflated estimates of peer influence on an outcome.

The last two decades have seen the widespread use of social network theories and methods to address developmentally grounded questions about how peer network dynamics shape adolescent adjustment. This body of evidence has documented that multiple network and developmental processes unfold simultaneously in peer networks. Specifically, this work has shown that peer selection drives how friends are chosen on internalizing and externalizing behaviors and how affiliating with particular friends influences adjustment (Neal & Veenstra, 2021; Sijtsema & Lindenberg, 2018). Next, we consider the utility of social network perspective and methods to unpack a host of relational processes linked to intergroup, developmental, and network mechanisms to study the benefits of intergroup connections for adolescent development.

Peer selection in social networks. A key assumption of networks research is that networks emerge through multiple and co-occurring processes that are collectively referred to as network selection processes. They can be organized into three main categories: attribute-, network-, and proximity-based mechanisms (Snijders et al., 2010). Multiple processes operate jointly in producing social ties. Therefore, to accurately account for the role of race or ethnicity in the selection of a peer network, one must statistically control for co-occurring and, thus, confounding selection processes as a function of other peer attributes (e.g., gender, behaviors) and network structural (e.g., reciprocity) and proximity-based (e.g., academic tracking, joint course taking or extra-curricular activity) mechanisms. Peer selection effects can be examined using cross-sectional SNA methods

such as the exponential random graph modeling approach (ERGM; Robins, et al., 2007) and longitudinal SNA, which uses a stochastic actor-oriented modeling approach (SAOM; Snijders et al., 2010).

Network selection on race, ethnicity, and developmental outcomes. Given our primary interest in intergroup connections and their developmental consequences, we start by describing how *attribute-based mec*hanisms are associated with network selection. First, we need to consider the role of ethnicity and race in peer selection. Robust evidence has shown that adolescents select friends who are similar to them in terms of race and ethnicity (e.g., McPherson et al., 2001). Although this racial-ethnic homophily in friendship or peer affiliation networks is a well-documented phenomenon, it is not total; some cross-group peer and friend connections are formed (Moody, 2001; Smith et al., 2016). We know substantially less about the role of ethnicity and race in the selection of individuals who provide focal adolescents with emotional and academic support. These processes need to be examined to test the theorized developmental mechanisms through which intergroup connections promote youth development.

Adolescents also consider behavioral and psychological characteristics in selecting their friends. Applications of SNA methods in developmental research have shown that youths prefer to befriend others who are similar to them in many ways, including internalizing behavior (Neal & Veenstra, 2021), externalizing behavior (Sijtsema & Lindenberg, 2018), academic performance and motivation (Shin & Ryan, 2014), intergroup contact and immigrant attitudes (Rivas-Drake et al., 2019; Van Zalk et al., 2012; Zingora et al., 2019), and ethnic-racial and national identity development (Santos et al., 2017; Rivas-Drake et al., 2017; Jugert et al., 2020; Umaña-Taylor et al., 2020). Thus, SNA methods can show how peer selection is uniquely shaped by both race or ethnicity *and* changing developmental outcomes or individual differences in psychological processes related to intergroup relations (e.g., intergroup contact attitudes). These behavioral or psychological outcomes can be used as covariates in peer selection models that test how peer selection is shaped by race and ethnicity.

Alternatively, understanding peer selection and influence on these behavioral or psychological outcomes can be of primary theoretical and empirical interest to developmental scholars who can examine these associations while accounting for peer selection on ethnicity and race. The research to date has focused on friendship and peer affiliation networks, regardless of whether the peer network processes related to race and ethnicity were conceptualized as covariate or primary outcomes. Future work needs to focus systematically on how emotional and academic support networks are selected by youth.

Social networks research has shown that individual attributes are consequential for peer selection through several mechanisms because individuals with such attributes differ in their number of connections and whom those connections are with. First, an attribute may be associated with an increased tendency to "send out" friendship ties (i.e., network gregariousness, activity, ego effect; Snijders et al., 2010). Second, an attribute can increase the likelihood that an individual receives a high volume of friend nominations (i.e., network popularity, preferential attachment, alter effect; Snijders et al., 2010). Third, the preference to befriend others who have a similar attribute is observed in social networks across the lifespan (McPherson et al., 2001).

It is noteworthy that the existing theoretical perspectives on the mechanisms through which intergroup connections promote adolescent development do not explicitly theorize the role of same- or cross-group ties in peer selection processes. However, each model assumes that adolescents select their networks to access particular developmental resources. Therefore, it is reasonable to assume that a bonding capital model would predict the selection of same-group friend, peer, and emotional-support relationships. School safety and belonging as well as bridging capital models would predict the selection of other-group connections. These propositions need to be tested to show how intergroup connections emerge in networks and shape adolescent outcomes.

Intergroup Connections & Peer Networks

Network structural mechanisms. These mechanisms characterize how connections between individuals depend on the nature of each individual's ties with other members of a group *regardless* of their own attributes (Veenstra et al., 2013; Snijders et al., 2010). For example, *reciprocity* is a tendency to befriend those who consider you their friend, and t*ransitivity* is a propensity to form friendships with the friends of friends. Another network structural mechanism is *popularity,* or the tendency to receive incoming friendship nominations because one is already popular. Each of these processes needs to be statistically accounted for because they can amplify ethnicity- or race-based segregation that is present initially at low levels. For example, a single adolescent who has a preference for same-group friendships can promote segregation through transitivity by bringing their same-group friends together. Thus, such network structural mechanisms must be accounted for via SNA approaches to prevent inflated estimates of peer selection on developmental outcomes (Veenstra et al., 2013).

Proximity mechanisms and opportunity structure. Finally, models should account for *proximity or propinquity mechanisms* in evaluating how peer networks are selected in a school setting. These mechanisms describe how the organizational features of schools as social settings (e.g., academic tracking and joint course taking) increase or decrease the likelihood of relationship formation. Educational researchers have identified that youth of color are more likely than white youth to be placed in non-advanced academic tracks; this leads to second-generation segregation in which educational opportunities are correlated with race (Mickelson, 2001). Such racialized practices also shape proximity mechanisms of network selection by decreasing the diversity of the pool of potential friends. Again, SNA methods allow for the inclusion of these school features in a model, making it possible to account for their effects on relationship formation and prevent inflated estimates for peer selection of same-race friends.

Intergroup Connections & Peer Networks

Beyond network-specific mechanisms, peer selection is shaped by *opportunity structures* beyond schools (e.g., neighborhoods). Smith and colleagues (2016) found differing patterns of ethnic homophily in friendships across 529 school networks in four European countries. Their results showed that ethnic minority youth were more likely to befriend co-ethnic students in schools in which they were in a numeric majority. A more complex pattern emerged for ethnic majority youth for whom ethnic homophily remained low across school settings, but their preference to befriend other ethnic majority peers increased only in schools where the networks of ethnic minority youth were more densely interconnected. This study showed that the proportion of intergroup friendships is malleable as a function of opportunity structure (school composition) and network structure.

Peer influence and network effects on individual outcomes. Viewing intergroup connections through a relational lens suggests that they could be associated with changes in youth developmental outcomes via (1) network composition with regards to same- or other-group peers and (2) peer influence processes. Moreover, developmental and networks research suggest that a mechanism involving network popularity is relevant to network effects because youth tend to adopt and emulate the behaviors of individuals who are popular or central in their networks (e.g., Dijkstra, Cillessen, Lindenberg, & Veenstra, 2010; Valente, 2012). Peer influence and network effects can be examined using a longitudinal SAOM approach (Snijders et al., 2010). The key advantage of the SAOM approach is that it enables a more accurate depiction of how network effects mediate and moderate developmental benefits of intergroup connections by disentangling them from peer selection dynamics (Snijders et al., 2010).

Several studies have considered *network composition effects*. The bonding capital model suggests that the proportion of same-group relationships is positively associated with psychological adjustment (Lin, 1999). Furthermore, the school safety and social belonging models predict that the proportion of other-group relationships will be positively associated with psychological adjustment

(Graham, 2018). Alternatively, the bridging capital (Lin, 1999) and academic support models posit that the proportion of other-group relationships promote academic adjustment. No studies to date have tested how network composition is associated with developmental outcomes over time while accounting for peer selection processes.

Peer networks also shape development via *peer influence* such that the psychological adjustment of friends predicts changes in an adolescent's adjustment outcomes over time (Brechwald & Prinstein, 2011). There has been an increase in theoretical and empirical interest in the nature, mechanisms, and moderators of peer influence processes in the developmental literature (e.g., Laursen, 2018; Prinstein & Giletta, 2020). Developmental studies using SNA methods have shown that peer influence occurs in adolescent networks on an array of outcomes, including internalizing behavior (Neal & Veenstra, 2021), externalizing behavior (Sijtsema & Lindenberg, 2018), academic outcomes (Shin & Ryan, 2014), intergroup contact and immigrant attitudes (Rivas-Drake et al., 2019; Van Zalk et al., 2012), and ethnic-racial and national identity development (Santos et al., 2017; Rivas-Drake et al., 2017; Umaña-Taylor et al., 2020).

These studies have not examined whether the strength of peer influence differs between same- and cross-group peers. However, current models of intergroup connections suggest that the strength of peer socialization effects may vary as a function of same- and other-group peers. The bridging social capital and academic support models suggest that peer influence would be stronger in cross-group friendships because these friendships may deliver culturally dominant social capital to boost academic success (Williams & Hamm, 2018). Similarly, the school safety and belonging model assumes that other-group connections serve a promotive function for adolescent adjustment (Graham et al., 2014). Conversely, the bonding social capital model prioritizes same-group ties as beneficial to psychological adjustment via emotional support provision (Lin, 1999). No empirical research to date has examined these suppositions.

Further, theoretical models suggest that if the peer influence process is mediated via social learning (Bandura, 1986) and self-concept and identity enhancement (Cialdini & Goldstein, 2015) mechanisms, then same-group connections are the context in which the strength of peer socialization is amplified. Jugert and colleagues (2020) have tested this idea using a longitudinal SNA approach and documented that same-group friends indeed exerted stronger peer influence than cross-group friends on adolescent ethnic-racial identity private regard and attachment. Zingora and colleagues (2019) also tested a hypothesis that youth would be more likely to adopt the intergroup attitudes of their same-group friends but did not find support for a claim that the strength of peer influence on intergroup attitudes was greater within the same-group friendships. Given these differences in the theorized contributions of either same- or other-group friendships to adolescent development, future research needs to draw on the adjustment-domain specific substantive models to test their purported mechanisms. This can be accomplished within the longitudinal SNA modeling framework of SAOM.

One more network-specific mechanism is relevant for understanding peer influence processes as related to intergroup and developmental outcomes. Specifically, longitudinal SNA methods allow for the consideration of *network popularity* as a moderator of the strength of peer influence. Evidence shows that being popular may increase the degree of social influence that an individual can exert on peers (e.g., Dijkstra et al., 2010; Valente, 2012). For example, if youth with a high proportion of intergroup connections are popular in their peer networks, their visibility may amplify their ability to influence others to adopt their intergroup contact attitudes and behaviors. This could result in the establishment of new peer norms. Indeed, a recent study by Zingora and colleagues (2019) found that friends who were popular in their networks were especially influential on others' intergroup contact attitudes, after accounting for a wide range of confounding networks selection and influence processes. An association in the opposite direction may also operate whereby a broader peer context that values cross-group friendships could enhance the peer network popularity of individuals who have a higher proportion of cross-group friendships. This hypothesis is testable within the SAOM

framework and requires data across multiple peer groups with varying norms. We next consider how SNA can advance our knowledge of the structure and dynamics of intergroup connections and their developmental benefits.

Key Issue: Using statistical modeling of networks to avoid static and aggregated views of peers when investigating intergroup connections

Social network theory assumes that networks emerge and contribute to individual outcomes through the multiple and co-occurring processes of peer selection and influence (Robins, 2013). To address these assumptions, SNA approaches use advanced multivariate modeling techniques to test how these processes contribute to network structures and dynamics (Robins, 2013; Snijders, 2011). Two SNA approaches are particularly useful in developmental research for characterizing the patterning and consequences of intergroup connections in networks. Exponential random graph modeling (ERGM) estimates network selection processes that give rise to peer network structures, and stochastic actor-oriented modeling (SAOM) characterizes peer selection and influence processes. Below we provide a brief conceptual overview of these approaches and discuss their similarities and differences. Readers are directed to comprehensive reviews of statistical modeling of networks by Robins (2013, 2015) and Snijders and colleagues (2010, 2011).

In ERGM, the dependent variable is a binary indicator of the existence of a directed friendship tie, which is modeled as a linear function of individual attributes and network characteristics (Robins et al., 2007). ERGM expresses the probability that a tie is present, versus absent, in logit form and can be thought of as logistic regressions with autoregressive features because ERGM estimates complex dependencies in network data by including ties as the outcome and as predictors. ERGM assumes that the observed network is an outcome of multiple network mechanisms, each with a local signature that is measured using counts of particular configurations of ties (model parameters). The goal of ERGM is to test which local mechanisms (e.g., reciprocity, transitivity,

preference to select same-race friends) specified in the model explain the group-level network structure (Robins et al., 2007). This goal is accomplished by estimating model parameters that reproduce the observed network. ERGM uses a Markov chain Monte Carlo estimation method to simulate a distribution of networks that serve as a comparison for the observed network. Through several iterations, this method optimizes the parameter values by comparing the distributions of simulated networks to the observed data. The modeling process produces parameter estimates specifying how a one-unit change in a network parameter would affect the log-odds that a specified tie exists (Goodreau et al., 2009). Positive parameter estimates indicate that the observed network contains a particular configuration of friendship ties in greater quantities than expected by chance, conditional on the rest of the network.

In SAOM, there are two submodels. The first focuses on changes in network structure and the second on changes in individual behavior (Snijders et al. 2010). These submodels are jointly estimated to provide an account of network behavior co-evolution. Thus, peer selection is estimated while peer influence processes are accounted for statistically and vice versa. In the network submodel, the dependent variable is a binary indicator of the existence of a directed friendship tie. SAOM makes several assumptions about the actors (i.e., individuals) and the nature of their relationships. First, network ties are viewed as enduring states as opposed to brief events. SAOM assumes that ties change along a continuous time scale even though the network is only measured at discrete time points. The change in ties follows a Markov process (i.e., the current state of the network probabilistically determines its next state). The actors are assumed to control their outgoing ties, changing only one tie at a time, which precludes coordinated changes involving multiple actors. An evaluation function describes the rules that guide actors' decisions to change ties, which are the model parameters for the hypothesized network selection effects. A rate function determines how many opportunities for change occur between waves. Model estimation uses a method of moments procedure to estimate parameters.

In the behavior submodel, the dependent variable is a behavioral outcome. SAOM estimates changes in it over time as a function of the composition and characteristics of the network during a prior wave. It assumes that an actor can change either one tie or one behavior at a time. Behavioral outcomes must be constructed as ordered categorical indicators, although extensions of SAOM that are under development should allow for continuous behavioral outcomes (Niezink, et al., 2019). This part of the model enables the testing of hypotheses about the roles of peer influence, moderators of peer influence, and network composition with regards to same- versus cross-group friends as predictors of changes in a developmental outcome.

The reader is directed to comprehensive tutorials on ERGM and SAOM for more detailed treatments of these methods (Robins et al., 2007; Snijders et al. 2010). Here we highlight their key similarities and differences. Both ERGM and SAOM are grounded in social network theory. They use simulation-based algorithms to enable statistical testing of similar types of network structural and actor covariate effects. The main differences between ERGM and SAOM stem from their assumptions about how network selection occurs. ERGM takes a relationship-oriented modeling approach, whereas SAOM is actor-oriented in nature. Furthermore, ERGM assumes a discrete network outcome, whereas SAOM assumes that network ties are enduring states. The latter models processes through which a discrete network at time 1 becomes a network at time 2 through a series of unobserved network transitions. ERGM approaches have typically been applied to cross-sectional data to test hypotheses about peer selection, whereas SAOM requires longitudinal panel data on networks and behavioral outcomes to test hypotheses about peer selection and influence. Thus, both approaches provide insight into how the patterns of intergroup connections are selected in peer networks, while statistically controlling for alternative network selection processes. Only SAOM enables the examination of peer influence on developmental outcomes.

Discussion

Intergroup connections that influence adolescent development do not occur in a social vacuum but are embedded in peer networks. Accordingly, we advocate for the adoption of a relational perspective in the study of the benefits of intergroup connections. We illustrated how this relational focus can be achieved by integrating developmental models and a SNA perspective on peer network structures and dynamics. Network thinking and methods are conceptually and methodologically key to developmental scholarship on the benefits of intergroup connections. First, SNA allows consideration of multiple relational mechanisms when studying intergroup peer relationships and their developmental consequences. Specifically, SNA enables a nuanced look at how intergroup peer connections are selected (peer selection) and how peer networks can contribute to adolescent adjustment via peer network composition or peer influence processes. Second, SNA eschews static and aggregated views of peers in favor of describing peer network structures and dynamics in which intergroup connections are fostered and shape adolescent development. This goal is accomplished via statistical modeling of social networks. Our hope is to inspire the next generation of interdisciplinary developmental science researchers to use SNA to better understand the complex but trackable relational processes in ethno-racially diverse networks. Doing so will advance developmental theory and research and identify specific points at which interventions could be used to promote intergroup contact, social competencies, and psychosocial functioning of adolescents growing up in increasingly diverse societies.

The application of a relational lens to extant theoretical models and empirical evidence on the developmental benefits of intergroup connections underscored the divergent predictions about the *exact types* of peer relationships that are beneficial. This critical look revealed that cross-group friendships are expected to promote adolescent development under the bridging social capital (Lin, 1999) and school safety and belonging models, whereas same-group connections are posited to be most important in the bonding social capital model (Lin, 1999), influencing processes that are

mediated via social learning (Bandura, 1986) or self-concept or identity enhancement (Cialdini & Goldstein, 2004) mechanisms. Given these differences in the theorized contributions of same- and other-group connections, their purported mechanisms must be evaluated using adjustment-domain-specific substantive models and statistical modeling of networks. Thus, we encourage scholars to use SNA methods to identify the mechanisms of the academic and socioemotional benefits of intergroup connections.

Beyond their benefits in fostering adjustment, intergroup peer relationships promote current and future functioning in diverse settings. Adolescence represents a vital window of opportunity to develop social competencies through intergroup friendships, which reduce intergroup anxiety and discomfort in young adulthood (Kao et al., 2019). These social skills are needed for successful and equitable functioning in ethno-racially diverse and multicultural societies. Yet, the opportunities to develop these social competencies may be thwarted when youth in ethnic and racial minority groups encounter interpersonal exclusion or discrimination from their peers and friends (Douglass et al., 2016). Because intergroup contact is one of the most effective ways to reduce prejudice and improve intergroup attitudes (Beelmann & Heinemann, 2014), developmental scholars need to continue illuminating the dynamics, benefits, and challenges of intergroup connections in school settings.

The structure and dynamics of intergroup connections and their consequences for adolescent development are shaped by contexts that include schools, communities, and broader societal or historical levels of analysis. As noted, within-school structural features such as joint course attendance (Echols & Graham, 2020), extra-curricular activity attendance (Schaefer et al., 2009), and academic tracking can be explicitly included in social network modeling approaches as proximity-relevant features of school context that moderate the likelihood of intergroup relationships. This can enable SNA models to estimate the strength and direction of intergroup-

related processes that are above and beyond the effects of school organization on network dynamics. However, understanding how peer network dynamics are shaped by between-school contextual factors (Juang & Schachner, 2020) could be more challenging because it requires multilevel data that vary in these distal factors. Specifically, to examine how school-level processes (e.g., composition, policies, and teacher training) shape intergroup network selection and peer influence on adolescent outcomes, researchers need to sample networks embedded in multiple school contexts that vary across the range of these contextual factors. For example, multilevel SNA methods (Snijders, et al., 2013) could be used to compare the strength and direction of intergroup peer selection and influence on psychological adjustment and intergroup attitudes across schools characterized by varying levels of adult interventions to promote intergroup contact.

National, regional, and global events can shift race-ethnic attitudes (e.g., Parker et al., 2020; Ruiz et al., 2020). A multilevel SNA perspective can also examine how these wide-reaching events and national discourses impact intergroup peer network dynamics. Whether we can observe some evidence of spillover of racial justice movements into the racial structure of peer networks in schools and, if so, under what school-level conditions, are empirical questions for future research. Researchers could examine historical trends in network structures and processes to see if there are discernable changes in the patterning and dynamics of intergroup peer relationships. For example, increases in peer network equity (Neal, 2014) and centrality (Borgatti et al., 2009) among ethnically-racially minoritized youth would serve as evidence of improvement in interracial peer networks in school.

We have focused on intergroup peer relationships that exist between adolescents of different ethnic, racial, and immigrant backgrounds due to the distinct role that these categories play in conferring power and privilege. Race, ethnicity, and immigrant background represent key

categories that have been used to exclude, minoritize, and racialize the experiences of developing children and adolescents in the United States and Western Europe. Developmental scholars need to continue paying close attention to heterogeneity in how systems of power, oppression, and exclusion are upheld and reinforced across the globe to increase transparency and comparability in research on developmental processes across minority youth in the United States, Western European countries, and beyond. For example, in the United States, race and ethnicity are the most relevant constructs, whereas in Europe and Australia, immigration and religious status are salient dimensions across which exclusion, discrimination, and xenophobia operate at societal, structural, systemic, and interpersonal levels (for an intersectional account of racialized Others and the implications for adolescent development, see Moffitt et al., 2020). Moving beyond a single dimension of race/ethnicity classification is warranted because increasing numbers of youth now grow up biracial, bilingual, or bicultural; thus, research must adapt to these demographic shifts to fully understand how diversity shapes students' lives (e.g., Echols & Graham, 2020).

Some limitations in the use of SNA to advance research on intergroup connections in school settings should be acknowledged. One limitation is that it is not feasible to simultaneously observe and rate behaviors and interactions between intergroup peers and friends in an entire school. However, it is now possible to use proximity sensors to obtain interaction, communication, and even affective tone data on peer networks within a bounded setting (Pentland, 2012). Such mapping approaches can generate rich data on micro-social peer interactions and allow the examination of their network structure and dynamics (Stadtfeld & Block, 2017). Another limitation, or more accurately, a challenge, involves sampling. Each social network, no matter how large, represents a single observation (Robins, 2015). Thus, researchers should strive to sample multiple networks to improve generalizability of their findings. Furthermore, if one is interested in examining the role of contextual factors (e.g., peer group norms, school composition, teacher training) in shaping network

structures or dynamics, then the challenge is to collect multilevel social network data. In other words, one needs to sample multiple networks across the range of the contextual factor of interest. Fortunately, recent developments in SAOM enable multilevel modeling of network dynamics (Snijders et al., 2013). As with any data collection, missing data poses challenges to SNA and, fortunately, modern approaches to handling missing data in cross-sectional and longitudinal modeling are becoming available for use in SNA (Huisman & Steglich, 2008; Krause et al., 2020; Smith et al., 2022). Finally, the current discussion of the benefits of intergroup connections is limited to peer network structures and dynamics that are bounded in school settings. To the best of our knowledge, there have been no empirical studies of how intergroup connections within community social networks or social media shape youth development. These gaps also need to be addressed.

This review has focused on the benefits of intergroup connections and positively valenced peer relationships. However, emerging research suggests that intergroup relationships may also pose challenges by taxing the well-being and mental health of youth of color (McGill et al., 2012). Indeed, studies reveal that ethnic-racial discrimination and teasing are used among intergroup friends, and these exacerbate anxiety and perceived stress (Douglass, et al., 2016). This evidence paints a complex landscape of the opportunities and challenges of cross-group relationships for adolescent development (Yip et al., 2019). Moreover, cumulative evidence shows that negatively valenced peer relationships, such as those characterized by fighting and bullying, are likely to occur across ethnic and racial lines in school settings (e.g., Kisfalusi, et al., 2020; Wittek, et al., 2020; Xu et al., 2020). A social network perspective could provide conceptual and analytical tools to unpack the benefits and costs of intergroup positive and negative peer relationships for adolescent development (Kornienko et al., *under review*).

Conclusion

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Adolescent intergroup friendships and peer relations can generate developmental benefits and provide critical windows of opportunity to develop social skills and positive intergroup norms for successful functioning in multiracial societies. Yet, the research to date has been limited in its ability to explain the underlying relational mechanisms through which intergroup connections promote adolescent development. It has relied on static and aggregate views of peers. To address these missed opportunities, we integrated developmental and social network perspectives on intergroup peer relationships, generated testable hypotheses about the role of same- and other-group peers in adolescent psychological and academic development, and explored how these research questions could be addressed by using statistical approaches to the modeling of social networks. Our goal is to stimulate future research and prevention and intervention efforts that will enhance intergroup peer relationships and their developmental benefits. Such efforts will support the psychosocial functioning of developing youth as they mature in increasingly diverse societies.

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