Aggression and mental ill-health in adolescent friendship groups : A 4-year longitudinal study

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AGGRESSION AND MENTAL ILL-HEALTH IN ADOLESCENT FRIENDSHIP GROUPS: A 4-YEAR LONGITUDINAL STUDY

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Bachelor of Arts, Psychology

Masters of Psychological Science

A thesis submitted in fulfilment of the requirements of the degree of Doctor of Philosophy

Institute for Positive Psychology and Education

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Australian Catholic University

March 2021

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ACKNOWLEDGEMENTS

In a letter to one of his peers, Isaac Newton once wrote, "If I have seen further, it is by standing on the shoulders of giants". While I am by no means claiming to have seen quite so far as Isaac Newton, this sentiment is still true with respect to this thesis. Without the support of so many wonderful people, I would not be where I am today.

To my supervisors, Baljinder and Joseph, thank you for all of your insight, guidance, and unwavering belief in my abilities. It has been a privilege being your student for the last years, and I am grateful for all that I have learned from you, academically, professionally, and personally. A special thanks, also, to James for always making time to help me, for your patience, and for making R (a little more) fun.

To my family, especially my Mum and Dad, I am immeasurably grateful to have had you in my corner throughout this experience and, indeed, through any and all endeavours that I undertake. I flew and just did it, thanks to you.

Thankfully, my PhD journey has been far from the lonely and isolated one so endemic among PhD students. Instead, I have been so lucky as to be surrounded by the most incredible group of peers. A special thanks to those who welcomed me so whole-heartedly when I arrived. Your support, encouragement, ideas, advice, and exceptional company have all been invaluable to me over the last years.

Finally, to my friends, I am so very grateful for your understanding of the all-consuming nature of a doctorate, your constant encouragement, your patience when I disappeared to meet deadlines, and for celebrating every milestone with me along the way.

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ABSTRACT

Friends can have a powerful influence on each other's behaviours (Brown & Klute, 2003; Brown & Larson, 2009). Investigation of the influence of friends tends to focus either on externalising behaviours, such as aggression, or on internalising behaviours, such as mental ill-health. To date, these two lines of research have remained largely separate from each other with little or no research devoted to the investigation of both aggression and mental ill-health in the context of friendship groups. This is surprising given the well-established association between individual aggression and individual mental ill-health. Thus, the main aim of this thesis was to investigate the links between aggression and mental ill-health over time in the context of adolescents' friendship groups. A further aim was to make a methodological contribution to this area of research by a comparison of the results obtained when different friendship conceptualisations (reciprocal friends, non-overlapping friendship groups, and overlapping friendship groups) are used to investigate the substantive questions related to the associations between aggression and mental ill-health. Data for this thesis came from 2,865 high school students (50.44% female) from 17 Catholic schools in Australia. Longitudinal data were collected yearly from Grade 8 to Grade 11 to measure aggression, mental ill-health, and peer nominated friendships. Multilevel analyses, presented in Study 1, indicated that high levels of individual aggression predicted high levels of friendship group aggression over time. A similar result was found for mental ill-health, whereby high levels of individual mental ill-health predicted subsequent high levels of friendship group mental ill-health. Furthermore, when individuals engaged in aggressive behaviours, they tended to suffer from worse mental ill-health over time. Interestingly, a homeostatic process emerged between the friendship group variables, whereby high levels of group aggression predicted subsequent high levels of group mental ill-health, and high levels of group mental ill-health predicted subsequent lower levels of group aggression. Notably these results differed

somewhat depending on whether the friendship groups were conceptualised as being reciprocal, non-overlapping, or overlapping, suggesting that peer influence processes operate differently across different conceptualisations of friendship. Problematic levels of collinearity observed between group aggression and group mental ill-health, when the overlapping friendship conceptualisation was used, prompted further analyses, presented in Study 2. Specifically, I investigated how attributing different group weights impacted the relations between aggression and mental ill-health at both the individual and the group level. The results of this study demonstrated the importance of selecting a theoretically driven weighting metric when analysing overlapping friendship groups, with an individual's most influential group being the most appropriate for achieving the research aims of this thesis. Finally, in Study 3, I sought to provide further insight into the substantive findings of this thesis by investigating the role of both selection and socialisation processes in the associations between individual aggression and group aggression, and between individual mental ill-health and group mental ill-health. The results supported the simultaneous effects of selection and socialisation processes for aggression. Moreover, socialisation processes, but not selection processes, were observed for mental ill-health. In summary, investigation of both aggression and mental ill-health in the context of three different friendship group conceptualisations has enabled unique insights into, and further understanding of, the developmental psychology field.

Introduction

"We are all connected, like a net we cannot see"

- Mickenberg and Dugan, 1995

During adolescence, the importance of extrafamilial relationships, particularly friendships, rises (De Goede et al., 2009; Smetana, 2011; Way & Greene, 2006). The powerful influence these friends have on the behaviours and beliefs of young people (termed peer influence) is one of the most robust findings in the developmental literature (Brown & Klute, 2003; Brown & Larson, 2009). In Chapter 1, I introduce two processes that are proposed to account for peer influence. The first is selection, which asserts that youth tend to choose friends who already possess behaviours and beliefs similar to their own. The second is socialisation, which argues that friends' behaviours and beliefs become more similar over time. Aggression has been the major focus of peer influence research in previous decades (Dishion et al., 1997; Espelage et al., 2003). However, peer influence processes have also been shown to operate in other domains of adjustment, including mental ill-health (Prinstein, 2007; Van Zalk et al., 2010). So far, these two lines of research have remained largely separate. This is surprising in view of the well-established link between individual aggression and individual mental ill-health (see Chapter 2 for a review of the literature). Moreover, given the co-occurrence of aggression and mental ill-health in adolescent populations, it is important to include both of these variables in the same analysis to determine their unique effects. Furthermore, despite extensive agreement on the importance of friendships in the study of aggression and mental ill-health, there is widespread debate in the literature on how best to conceptualise them. Three different friendship conceptualisations, namely reciprocal friendships, non-overlapping friendship groups, and overlapping friendship groups, are reviewed in the context of adolescence in Chapter 3.

To date, there are no reports of investigations on the longitudinal associations between aggression and mental ill-health that simultaneously examine both individual and friendship group levels. Thus, whether peer influence processes exist for mental ill-health when aggressive behaviours are controlled for, and vice versa, remains unknown. Moreover, it is unclear whether processes linking individual aggression and individual mental ill-health are also occurring between group aggression and group mental ill-health. Furthermore, few studies have directly compared the consequences of using different friendship conceptualisations when investigating peer influence processes in adolescence.

To address these gaps in the literature, I initially explore, in Chapter 4, the longitudinal associations between both aggression and mental ill-health in the context of three different friendship conceptualisations: reciprocal friendships; non-overlapping friendship groups; and overlapping friendship groups. In this investigation, when examining the different friendship group conceptualisations, problematic collinearity was observed between group aggression and group mental ill-health for the overlapping friendship groups, casting some doubt on the validity of this friendship conceptualisation. Thus, in Chapter 5, I focus on resolving the problematic levels of collinearity by investigating both the weighting procedure and the weighting metric used to weight the overlapping friendship groups in the study in Chapter 4. I conclude that collinearity is produced by the weighting procedure itself and highlight the importance of selecting a theoretically driven weighting metric when conceptualising overlapping friendship groups. Moreover, I argue that focusing on an individual's most influential friendship group from the multiple groups of which they are members is the most suitable method for achieving the research aims of this thesis. Thus, in Chapter 6, I use individuals' most influential friendship groups, together with reciprocal friendships and non-overlapping friendship groups, to provide further insight into the substantive findings of this thesis by investigating whether selection and/or socialisation

processes account for the associations between: (i) individual aggression and group aggression; and (ii) individual mental ill-health and group mental ill-health. In Chapter 7, I synthesise and evaluate the five key findings of the three empirical studies and integrate them within the broader psychological literature. I also discuss both strengths and limitations of the studies reported in this thesis, and then outline avenues for future research.

In sum, the studies reported herein make both substantive and methodological contributions to the developmental psychology literature. Substantively, the empirical studies investigated the associations between aggression and mental ill-health in the context of friendship groups. Methodologically, in examining friendship groups, three different conceptualisations of friendships (reciprocal friendships, non-overlapping friendship groups, and overlapping friendship groups) were compared for their ability to answer the substantive questions relating to aggression and mental ill-health.

Chapter 1: The Influence of Friends on Adolescent Development

"We are like chameleons; we take our hue, and the colour of our moral character from those who are around us."

- John Locke

Introduction

The central tenet of this thesis is that friends are a powerful source of influence on each other's behaviours, a phenomenon termed peer influence (see Brown & Klute, 2003; Brown & Larson, 2009). In this chapter, I introduce two processes that are argued to account for peer influence effects: selection, the tendency for individuals to become friends with those who are similar to themselves; and socialisation, whereby friends tend to become more alike over time. I will argue that both processes likely occur simultaneously. I discuss relevant theories for both selection and socialisation including the similarity-attraction hypothesis (Berger & Calabrese, 1974; Byrne & Nelson, 1965) and social learning theory (Bandura, 1973, 1978). Finally, I introduce aggression and mental ill-health, two behaviours that have received considerable focus in the context of peer influence, and review relevant evidence on the influence of friends on these two behaviours.

Influence of Friends During Adolescence

Substantial research has indicated that friendships become increasingly important during adolescence (De Goede et al., 2009; Smetana, 2011; Way & Greene, 2006). Indeed, during this developmental period, the amount of time that youth spend with their friends increases significantly (Brown & Larson, 2009), with the majority of peer interactions occurring in larger group contexts (Steinberg & Monahan, 2007). Notably, such friendship groups become increasingly stable (Değirmencioğlu et al., 1998) and, therefore, more intimate during adolescence (Buhrmester & Furman, 1987). Youth are also increasingly susceptible to peer influence processes during this developmental period (e.g., Steinberg &

Monahan, 2007). Consequently, friendships have received considerable focus in the developmental literature and peer influence processes have been linked to numerous behavioural, social, and emotional outcomes (Rubin et al., 2011), including: academic outcomes (Shin & Ryan, 2014; Wang et al., 2018); alcohol (Leung et al., 2014) and smoking (Mercken et al., 2012) behaviours; and both well-being (Elmer et al., 2017) and mental ill-health (Ueno, 2005; Van Zalk et al., 2010). In sum, adolescents' lives are deeply linked to their friends in their social environment.

Theoretical Perspectives on Peer Influence

Peer influence is characterised by two distinct, yet interrelated, processes (Kandel, 1978). The first is selection, which proposes that the behaviours, beliefs, and attitudes of friends are remarkably similar to one another's due to youths' tendency to associate with friends who have pre-existing similarities (Kandel, 1978). The second is socialisation, whereby friends' behaviours, beliefs, and attitudes become more similar over time (Kandel, 1978). Importantly, while often discussed and analysed separately, it is likely that selection and socialisation processes occur simultaneously. More specifically, as adolescents' peer networks consist of multiple friendships, they may select new friends, while also influencing and being influenced by continuing friendships (Van Zalk et al., 2010). This has important implications such that the combination of selection and socialisation processes may result in even stronger associations between the characteristics of an individual and their friends.

Selection

Selection describes the phenomenon whereby youth tend to choose friends who already possess similar behavioural, social, and psychological characteristics to their own (Kandel, 1978; Prinstein & Dodge, 2008). Selection was first introduced to the developmental psychology literature by Lazarsfeld and Merton in 1954, followed by Homans in 1961. Since then, numerous theories have been proposed to account for selection

processes, including the similarity-attraction hypothesis (Berger & Calabrese, 1974; Byrne & Nelson, 1965). The similarity-attraction hypothesis states that individuals who are more similar to one another will be attracted to each other and, thus, are more likely to become friends (Berger & Calabrese, 1974; Byrne & Nelson, 1965). More specifically, shared characteristics increase trustworthiness and predictability in an interaction, both of which enable individuals to communicate with greater ease. Moreover, similarity increases the likelihood of shared experiences and shared feelings, which strengthens one's sense of belonging. In addition, shared characteristics validate and reinforce an individual's own behaviours and beliefs, which positively influences their social identity (Albarello et al., 2018; Hallinan, 1980; Van Zalk et al., 2010). Taken together, similarity increases the likelihood of positive social interactions which, in turn, makes the formation of a friendship more likely.

Moreover, adolescents may terminate, or de-select, friendships when the difference between their own and their friends' characteristics becomes too great (e.g., DeLay et al., 2013; Van Zalk et al., 2010). The de-selection process may be particularly relevant for characteristics that are not readily observable when a relationship is initially established (Ojanen et al., 2013), such as mental health. Indeed, in a large sample of adolescents, Hafen et al. (2011) report that friends tended to be more similar on observable traits, such as delinquent activities, than on unobservable traits, such as self-worth. It may be that as the friendship unfolds over time, the differences between oneself and one's friends become more apparent, leading to the termination of the relationship. De-selection, therefore, offers a complimentary explanation for why youth tend to be friends with those who are similar to themselves.

Socialisation

Socialisation describes the tendency for friends' behavioural, social, and psychological characteristics to become more similar over time (Kandel, 1978). Socialisation processes are based in an individual's need to experience positive regard from others, as well as a sense of belonging in their social context (Van Zalk et al., 2010). Social learning theory (SLT) has been proposed as one of the most relevant theories for understanding the influence of friends on individual behaviour. SLT emerged in the 1960's, largely as a result of the theorising of Albert Bandura and his colleagues. SLT was developed in response to a widespread belief that behaviours were the product of innate inner forces in the form of needs, drives, and impulses, which tended to operate at an unconscious level. In contrast, Bandura (1973) maintained that behaviour could be better predicted by examining the social context of the individual. Bandura (1973) asserted that no influence was more powerful and ubiquitous than the actions of others with regard to how people learn behaviours.

SLT assumes that a person's biology and genetics create a potential for new behaviours, while the specifics of the behaviours are learned (Bandura, 1973, 1978). Bandura (1973, 1978) proposed two ways in which new behaviours could be learned: direct experience and modelling. The first, direct experience, is based on the premise that either rewarding or punishing consequences follow all behaviours. More specifically, individuals are repeatedly confronted with situations to which they must respond. Some of the responses that they try will prove unsuccessful, while others will result in favourable outcomes. Through this process of differential reinforcement, the successful behaviours are retained and re-used, while the ineffectual ones are not. Based on past experience, individuals can develop thoughts or hypotheses about the types of behaviours that are most likely to succeed in different situations. These hypotheses then serve as guides for future actions.

According to Bandura (1973), the second way new behaviours are acquired is through modelling, also known as learning by example. Learning would be exceedingly time consuming and dangerous if it proceeded solely on the basis of direct experience. For example, it is preferable to learn by modelling the behaviour of others that you should not put your hand in a fire, than it is to directly experience the consequences of putting your hand in a fire. Indeed, most behaviours displayed by individuals are learned either deliberately or inadvertently through modelling processes. When mistakes are costly or dangerous, new behavioural responses can be developed without needless errors, by learning from competent models who demonstrate how the required behaviour should be performed. Of course, some complex behaviours can be produced only through modelling behaviours, such as, for example, reading and writing. Moreover, even when the action could be learned by other means, acquisition time can be significantly reduced by modelling. Under most circumstances, therefore, modelling is often considered the superior learning method, compared to the trial and error of direct experience.

Bandura (1973) maintained that the behaviours an individual can learn, from either direct experience or modelling processes, are limited to behaviours similar to those persons with whom they most frequently associate. In the case of adolescence, the importance of friendship rises during this developmental period and youth spend a greater proportion of their time with their friends (De Goede et al., 2009; Smetana, 2011; Way & Greene, 2006). Thus, it is likely that adolescents are learning behaviours from their friends and that their friends are providing external reinforcements for them to either continue or discontinue using those behaviours.

A Focus on Aggression and Mental Ill-Health

The majority of studies investigating peer influence processes have focused on aggressive behaviours, with consistent support being found for the role of peers in aggressive

behaviours (e.g., Beal et al., 2001; Cairns & Cairns, 1994; Dishion et al., 1997; Prinstein et al., 2001). Indeed, aggression does not solely affect the individual engaging in the aggressive behaviour, with the broader peer group all found to be impacted in some way, whether that be as a victim, a defender, or an observer (Huitsing & Veenstra, 2012; Sijtsema et al., 2010). Therefore, given the involvement of the peer group, aggressive behaviours may be particularly suited to the study of peer influence processes. The emphasis on aggression is also understandable given associations between aggression and maladjustment, as well as the impact of such maladjustment on public well-being. For example, youth who engage in aggressive behaviours are at a higher risk for numerous difficulties in adulthood, including both physical and mental health concerns, marital problems, and legal troubles such as arrests and traffic violations (Huesmann et al., 2009), all of which constitute a heavy burden on society. However, recent work has found that internalising behaviours, such as mental ill-health, are also susceptible to peer influence processes (e.g., Prinstein, 2007; Stevens & Prinstein, 2005; Van Zalk et al., 2010). It is becoming clear that peers can influence an extensive range of behaviours and characteristics. The next sections of this chapter will review the literature associated with peer influence and both aggression and mental ill-health.

Aggression

Over the decades, many definitions of aggression have been proposed. One of the more popular definitions of aggression defines it as a behaviour directed at another person with the intention of causing them harm (Anderson & Bushman, 2002; Berkowitz, 1993). In addition to the perpetrator believing the behaviour will harm the victim, the victim must also be motivated to avoid the aggressive behaviour being directed at them (Anderson & Bushman, 2002). Thus, accidental harm is not classified as aggression because it is not intended. Moreover, harm that results from helpful or solicited actions (e.g., pain experienced during a medical procedure) is also not classified as an aggressive act because the target is

not motivated to avoid the behaviour. Beginning in the 1960s, research on aggressive behaviours in children and adolescents focused exclusively on overt forms of aggression, referred to as direct aggression. Direct aggression encompasses physical behaviours, such as hitting, punching, and throwing objects, as well as verbal behaviours, such as teasing, insulting, and threatening (Lochman & Dodge, 1994; Richardson, 1999).

However, researchers soon realised that aggression was more complex than just direct aggression. In the late 1980s and early 1990s, the scope of aggression research expanded to include covert forms of aggression, such as spreading rumours, gossiping, and purposefully excluding others (Crick & Grotpeter, 1995; Lagerspetz et al., 1988). A number of different names have been proposed for these covert aggressive behaviours, including indirect aggression (Feshbach, 1969; Lagerspetz et al., 1988), relational aggression (Crick & Grotpeter, 1995), and social aggression (Cairns et al., 1989; Galen & Underwood, 1997). When applied precisely, each of these terms refers to a slightly different set of behaviours (Xie et al., 1999). For example, behaviours such as ignoring or not speaking to someone anymore are not considered to be relationally aggressive, but are included in the definition of indirect aggression (Coyne et al., 2006). It is widely accepted that these terms are more similar than they are different in so far as they all refer to a set of behaviours that aim to harm a victim's social relations, most often in a covert way (Archer & Coyne, 2005; Coyne et al., 2006; Voulgaridou & Kokkinos, 2015). Consequently, indirect, relational, and social aggression are often combined into one construct or used interchangeably in the literature. In the present thesis, I will refer to these three forms of aggression (i.e., indirect, social, and relational) as indirect aggression.

Researchers have debated the utility of examining direct and indirect aggression as different manifestations of the same underlying construct, i.e., aggression, or as separate independent constructs. In a meta-analysis of 98 studies that reported associations between

direct and indirect aggression, Card et al. (2008) found direct and indirect aggression to be highly intercorrelated ($r = .76$). Thus, approximately half of the variance in direct and indirect aggression overlaps, while the remaining variance is unique. Card et al. (2008) conclude that there is utility in examining both aggression in general, as well as direct or indirect forms of aggression more specifically.

A number of other constructs exist in the literature that are closely related to aggression, including bullying, violence, antisocial behaviour, delinquency, conduct disorder, and deviancy. Bullying is defined as "long-standing violence, physical or psychological, conducted by an individual or group and directed against an individual who is not able to defend himself in the actual situation, with a conscious desire to hurt, threaten or frighten that individual or put them under stress" (Thompson et al., 2002 p.4). According to this definition, aggression and bullying share a number of common features, including an intention to cause harm, with the main difference between them being how the target is described. The target of bullying behaviours must be someone less powerful than the bully (Nansel et al., 2001; Olweus, 1997). Violence is a form of aggression that is characterised by extreme harm (Olweus et al., 1999). Thus, while all violence is aggressive, not all aggressive behaviours are violent. Antisocial behaviours are those which disregard the rights of others (Frick, 1998; as cited in Fortin, 2003). Delinquency is defined as a violation of principles and values that are assumed to be universal or the violation of a norm, namely a standard of conduct to which most people feel they have to conform (Clinard & Meier, 2015). Conduct disorder, often considered an extension of delinquent behaviour, is defined as repetitive and consistent behaviours that violate the basic rights and/or age-appropriate norms. Thus, antisocial behaviours, delinquency, and conduct disorders can all involve engagement in aggressive behaviours, although they are not limited to them. Finally, deviancy is a broader concept which can include both antisocial (Caron & Rutter, 1991; Russo & Beidel, 1994) and

aggressive (Crick & Bigbee, 1998; Ritakallio et al., 2005) behaviours. In general, aggression and the behaviours mentioned above (i.e., bullying, violence, antisocial behaviour, delinquency, conduct disorder, and deviancy) are all logically and empirically related, such that risk factors and consequences that apply to one are likely to apply to all (Farrington, 2009). Indeed, one of the main differences between these behaviours is the discipline studying them and a lack of communication between disciplines has resulted in little overlap between constructs (Farrington, 2009). For example, conduct disorder is typically studied by clinical psychologists; delinquency, antisocial behaviours and violence are researched predominantly by sociologists; bullying is most often studied by educational psychologists; while aggression is researched by developmental psychologists (Farrington, 2009). Thus, when reviewing aggression in the context of selection and socialisation effects below, I will also include research that has examined other aggressive adjacent concepts, e.g., bullying, where appropriate.

Selection

Aggression is one of the most widely studied behaviours in the context of selection. Selection effects for aggression have been reported in numerous studies (e.g., Cairns et al., 1988; Dishion et al., 1994; Hektner et al., 2000; Laninga-Wijnen et al., 2017; Poulin et al., 1997; Rydell, 2016; Sijtsema, 2016). For example, Espelage et al. (2003) found a significant amount of within-group similarity on self-reported bullying and fighting behaviours in the school setting, suggesting that students affiliate with others who bully and fight at the same frequency. Dijkstra et al. (2011) followed a sample of almost three hundred youth over a one-year period. They observed selection processes for aggression even when socialisation processes were controlled for (Dijkstra et al., 2011). Moreover, in a large sample of elementary school students, bullies who shared the same targets of victimisation were more likely to become friends (Hooijsma et al., 2020). In addition to general aggression, selection

effects have also been observed for subcategories of aggression, including direct and indirect aggression (Dijkstra et al., 2011; Sijtsema et al., 2010). Thus, these findings suggest that aggressive adolescents tend to befriend those with levels of aggression similar to their own. Moreover, there is evidence indicating that individuals are more likely to de-select friends when their levels of aggression differ. For example, Hartl et al. (2015) examined reciprocated friendships in a sample of over four hundred high school students. They found that the friendships between those who had different levels of peer-nominated physical aggression dissolved faster, compared to friendships between those with similar levels of physical aggression (Hartl et al., 2015). Thus, there is empirical evidence supporting both selection and de-selection processes.

Although selection effects appear to be robust for aggressive behaviour, some researchers have argued that studies are overestimating their magnitude. More specifically, some of the strongest selection effects have been observed for demographic characteristics, including gender (Dijkstra et al., 2011; Poulin & Pedersen, 2007). Thus, as aggression is linked to gender (Archer, 2004; Bettencourt & Miller, 1996; Card et al., 2008; Toldos, 2005), and gender is a powerful organiser of peer relationships during adolescence (Kovacs et al., 1996; Poulin & Pedersen, 2007), the selection effects observed for aggression may in fact be gender selection effects. That is, rather than selecting friends because of their levels of aggression, they may be selecting friends of the same gender, who happen to share similar levels of aggression. This proposition is supported by research, wherein selection effects for both direct and indirect aggression were no longer observed when gender, as well as social status and network effects, were controlled for (Dijkstra et al., 2011). The authors conclude that similarity in aggression among friends is mainly a by-product of other selection effects i.e., gender (Dijkstra et al., 2011). In contrast, other studies find selection effects for aggression, even when gender is controlled for in the analysis (e.g., Laninga-Wijnen et al.,

2017; Sijtsema et al., 2010). Thus, the literature is somewhat inconclusive with regard to whether the similarity in aggressive behaviours observed between friends is in fact gender selection.

Socialisation

Given that aggression is an overt behaviour that occurs in social contexts, it is easy to see how friends' aggressive behaviours may be adopted at the individual level, in accordance with SLT. Indeed, aggression was one of the first behaviours to be examined in the context of SLT (see Bandura, 1978). More specifically, if an individual has aggressive friends, they are likely to learn aggressive behaviours from them, predominantly through modelling mechanisms. When faced with situations that trigger an aggressive response, their aggressive friends may endorse and reinforce the individual's behaviour, thus resulting in the continued use of aggressive behaviours (Bandura, 1973, 1978).

There is evidence to suggest that friends' aggressive behaviours may be predictive of individual aggression over time (e.g., Boivin & Vitaro, 1995; Low et al., 2013; Sijtsema et al., 2010; Werner & Crick, 2004; Werner & Hill, 2010). For example, Espelage et al. (2003) found that levels of bullying and fighting behaviours in peer groups were significantly predictive of individual levels of bullying and fighting over time, even after controlling for the baseline levels of these behaviours. In addition, the models for bullying behaviours were found to explain more variance in individual behaviour than did the models for fighting, suggesting that the influence of peers' aggressive behaviours may differ across subtypes of aggression (Espelage et al., 2003). Moreover, other studies have found that selection and socialisation processes co-occur in the context of aggression (Mrug et al., 2004; Werner & Crick, 2004). Taken together, these studies suggest that individuals may simultaneously select friends with aggressive behaviours similar to their own, while also being influenced by the aggressive behaviours of their friends. In contrast, no socialisation effects for aggression

were observed in other studies (Newcomb et al., 1999). For example, although aggressive boys were found to select aggressive peers as friends, Poulin and Boivin (2000) did not observe any socialisation effects over time in a sample of sixth grade boys. Thus, the research on socialisation processes, in the context of aggression, is inconclusive.

Mental Ill-Health

The term mental ill-health encompasses a continuum of mental health complaints, ranging from mental health problems to mental disorders. Mental health problems tend to include mental health complaints that cause personal suffering, such as depression and anxiety (Barry et al., 2019; Stefansson, 2006). At the other end of the continuum lie mental health disorders, which are diagnosable conditions that significantly interfere with an individual's functioning, such as major depression and psychosis (Barry et al., 2019). Mental health disorders tend to be more severe in their symptomatology and endure for a longer period of time, compared to mental health problems (Barry et al., 2019). Often, researchers will focus on a specific mental health problem or disorder. Anxiety and depression are two of the most frequently researched mental health problems, both of which can develop into mental health disorders. Depression is characterised by a cluster of specific symptoms, including but not limited to irritability, low confidence and self-esteem, recurrent negative thoughts, and a diminished ability to think and concentrate (World Health Organisation, 2017). Anxiety encompasses a mix of somatic (e.g., sweating, heart palpitations) and psychological symptoms (e.g., worry, irritability; World Health Organisation, 2017). In the sections below, where I review mental ill-health in the context of selection and socialisation processes, I will also review the literature for subcomponents of mental ill-health, such as depression, where appropriate.

Selection

Two explanations have been proposed for how levels of mental ill-health can affect friendship selection processes. On the one hand, interactions between individuals suffering from comparable levels of mental ill-health are characterised by shared feelings and experiences, along with high levels of self-disclosure, which enhance feelings of closeness and belonging (Rose, 2002; Rose et al., 2007). This, in turn, is proposed to increase the likelihood of these individuals selecting each other as friends, while also reducing the chances of them subsequently de-selecting each other once the friendship is established (Van Zalk et al., 2010). On the other hand, when individuals suffer from mental ill-health, they tend to withdraw from their larger social groups (Schaefer et al., 2011). Consequently, such individuals may become friends with others who are similarly withdrawn from the broader social context, resulting in selection effects for mental ill-health (Schaefer et al., 2011).

Numerous empirical studies have found evidence for selection effects for mental ill-health (e.g., Cheadle & Goosby, 2012; Haselager et al., 1998; Schaefer et al., 2011; Van Zalk et al., 2010). For example, Hogue and Steinberg (1995) monitored a sample of adolescents and their selected peer groups within their school over the course of one year (Hogue & Steinberg, 1995). Adolescents were found to select peer groups with average levels of internalising problems that were similar to their own average levels (Hogue & Steinberg, 1995). In addition, Giletta et al. (2011) report that adolescents and their best friends tended to suffer from similar levels of depressive symptoms. Some studies report conflicting results depending on the type of mental health concern being examined (e.g., Qualter & Munn, 2005). For example, Mercer and Derosier (2010) found that children tended to select friends with similar levels of loneliness, but not depression or social anxiety. Notably, children do not appear to recognise the psychological characteristics of peers until adolescence, with their descriptions of peers typically focusing on physical and overt behavioural characteristics

(Coie & Pennington, 1976; Livesley & Bromley, 1973; Selman, 1980). Thus, one explanation for the lack of similarity effects reported by Qualter and Munn (2005) and Mercer and Derosier (2010) is that they both focused on samples of children instead of adolescents. An alternative explanation is that the strength of selection processes may vary across different mental health concerns. The presence of de-selection effects has also been observed for mental ill-health. For example, Guimond et al. (2019) found that differences in friends' levels of mental ill-health, specifically depression and anxiety, predicted the subsequent dissolution of the friendship. Thus, as with aggression, there is evidence for both selection and de-selection processes in the context of mental ill-health.

Socialisation

Applying socialisation theories to the acquisition of internalising behaviours is less intuitive, but SLT has also been successfully employed to better understand how friendship group levels of internalising problems influence individual internalising behaviours. It is argued that there are a number of overt behaviours that co-occur with mental ill-health. Of particular relevance to this discussion are ruminative behaviours. Rumination is defined as a recycling of thoughts and ideas, causing an individual to remain fixated on a problem (Aldao & Nolen-Hoeksema, 2010; Joormann & D'Avanzato, 2010; Nolen-Hoeksema, 1991). When individuals engage in ruminative behaviours with their peers it is referred to as co-rumination. More precisely co-rumination is defined as a negative form of self-disclosure that involves excessively discussing personal problems and negative emotions with others, to the exclusion of other activities or discourse (Rose, 2002). Consistent with SLT, particularly modelling processes, co-rumination, may prompt and reinforce an individual to adopt and utilise a ruminative response themselves with other friends (Bastin et al., 2015; Rose, 2002). Stone and Gibb (2015) found that co-rumination predicted rumination, which in turn predicted subsequent increases in individual levels of depression. Similarly, Dirghangi et al.,

2015) found that those who engaged in co-ruminative behaviours were more likely to suffer from higher levels of anxiety over time. Additional support for the co-rumination mechanism has been found by Schwartz-Mette and Rose (2012). More specifically, they found that co-rumination mediated the spread of depressive symptoms between friends in a sample of over five hundred adolescents. In addition to adopting ruminative behaviours, youth who are repeatedly exposed to friends' ruminative behaviours and other expressions of negative affect may become more distressed themselves, which negatively impacts their own mental health (Smith & Rose, 2011).

Many empirical studies support this assertion, that youths' mental ill-health can be directly influenced by the mental ill-health of their friends (e.g., Cheadle & Goosby, 2012; Stevens & Prinstein, 2005). Notably, socialisation effects have been observed for mental ill-health, even when controlling for selection effects (Van Zalk et al., 2010). Giletta et al. (2011), for example, found that an adolescent's best friends' level of depressive symptoms predicted increases in their own depression over time, when prior individual levels of depression were controlled for. Moreover, socialisation effects for mental ill-health, particularly depression, have been observed in both close friendships (e.g., Prinstein, 2007; Stevens & Prinstein, 2005), as well as larger friendship groups (Guan & Kamo, 2016; Kiuru et al., 2012). Goodwin et al. (2012), using cross-lagged panel analyses, found friends' depressive symptoms to predict individual depressive symptoms. Moreover, they also report that an individual's depressive symptoms predicted future increases in friends' depression symptoms (Goodwin et al., 2012). Thus, there is evidence that an individual is both influenced by and influences the behaviour of their friends. While the majority of studies have focused on depression, there is some evidence to suggest that socialisation effects are also observed for other types of mental ill-health, specifically for loneliness and social anxiety (Mercer & Derosier, 2010). Further research is needed to establish whether

socialisation effects are as prevalent across these other forms of mental ill-health as well as mental ill-health more broadly.

A final consideration regarding the socialisation and selection of mental ill-health behaviours concerns the co-occurrence of mental ill-health and aggression, a topic which will be discussed in more detail in Chapter 2. Briefly, research indicates that aggression and mental ill-health tend to co-occur, such that individuals who engage in high levels of aggression also tend to suffer from high levels of mental ill-health (e.g., Card et al., 2008; Klomek et al., 2007; Meeus et al., 2016; Ng et al., 2012; Piko & Pinczés, 2014). Thus, a different explanation has been proposed to account for both the selection and socialisation of mental ill-health. Specifically, observed similarity and/or socialisation processes for mental ill-health may be a marker for similarity and/or socialisation processes for aggressive behaviours, or indeed vice versa. Thus, studies that have observed peer influence effects for mental ill-health, without also controlling for externalising behaviours such as aggression, may be detecting similarity and socialisation of externalising behaviours rather than mental ill-health. It is important that future research explores this by including both externalising and internalising behaviours in the same models to determine the unique effects of both variables.

Chapter Summary

The powerful influence of friends on the behaviours and beliefs of young people is one of the most robust findings in the developmental literature (see Brown & Klute, 2003; Brown & Larson, 2009). In this chapter, I discuss two processes that are argued to account for peer influence effects: selection and socialisation. Selection asserts that adolescents tend to select friends who already possess characteristics similar to their own and is best explained by the similarity-attraction hypothesis (Berger & Calabrese, 1974; Byrne & Nelson, 1965). Socialisation refers to the tendency for friends to become more similar over time, a process that is best explained by social learning theory (Bandura, 1973, 1978). Although selection

and socialisation are routinely discussed and investigated as independent processes, I conclude that they are likely happening simultaneously. Next, I introduced aggression and mental ill-health, two behaviours that have been extensively studied in the peer influence literature. To the best of my knowledge, no studies have investigated both aggression and mental ill-health in the context of friendship groups. This is particularly surprising given the well-established relation between aggression and mental ill-health at the individual level, as evident in the literature that I will review in the next chapter.

Chapter 2: The Link Between Aggression and Mental Ill-Health

"Anger itself makes us feel bad and so, ultimately, it is bad for our health."

- The 14th Dalai Lama

Introduction

In the preceding chapter, both selection and socialisation processes were argued as important in accounting for the similar levels of aggression observed between friends, and the phenomenon whereby friends' levels of aggressive behaviours become more similar over time. A similar pattern was described for mental ill-health, whereby friends often report similar levels of mental ill-health, and friends tend to become more similar in their levels of mental ill-health over time. To date, these two lines of research have remained largely separate from each other, with no studies investigating friends' levels of both aggression and mental ill-health. This is particularly surprising given the frequent co-occurrence of aggression and mental ill-health in adolescents at the individual level. The evidence that links aggression and mental ill-health is reviewed in this chapter. Also reviewed are the three causal mechanisms that have been proposed to account for this link, namely aggression as a risk factor for mental ill-health, aggression as a consequence of mental ill-health, and the existence of a reciprocal relationship between these two variables.

At the outset, it is important to note that a limited number of studies have examined the associations between aggression and mental ill-health as they are defined in this thesis. Thus, in subsequent sections, I will also review the literature on both aggression adjacent concepts (e.g., direct aggression, indirect aggression, and bullying) and on mental ill-health adjacent concepts (e.g., anxiety and depression) to draw insights from the broader literature. As discussed in Chapter 1, these concepts are all logically and empirically related and, of particular relevance to the present chapter, risk factors and their consequences that apply to one are likely to apply to all (Farrington, 2009).

Aggression and Mental Health

It is widely reported that individuals who engage in aggressive behaviours experience mental health difficulties (see Card et al., 2008 for a review). Numerous studies have found that those who engage in aggressive behaviours also tend to suffer from mental health problems, including depression (Ng et al., 2012; Piko & Pinczés, 2014), suicidality (Hill et al., 2020; Kaltiala-Heino et al., 1999; Miotto et al., 2003), and anxiety (Marsee et al., 2008; Meeus et al., 2016; Vitaro et al., 2002). In a large cross-sectional study of adolescents aged thirteen to nineteen, Klomek et al. (2007) found that students who bullied others frequently were three times more likely to suffer from depressive symptoms, compared to students who never engaged in bullying behaviour. A similar pattern was found for both serious suicidal ideation and suicide attempts: engaging in bullying behaviours was associated with greater incidence of both suicidal ideation and suicide attempts (Klomek et al., 2007). Moreover, Van der Wal et al. (2003) found both suicidal ideation and depression to be more common in children who engaged in bullying behaviours. This was true for females and males, and for both direct and indirect forms of aggression (Van der Wal et al., 2003). Furthermore, in a study of six large cohorts from European-based populations aged three to sixteen years, aggression showed substantial correlations, of approximately 0.4 in magnitude, with anxiety, depression, and withdrawal behaviours (Bartels et al., 2018). Thus, aggression and mental ill-health appear to co-occur to a large extent in childhood and adolescence.

More recently, there has been a shift away from focusing exclusively on maladjustment when investigating aggression, with researchers reporting that aggression is also associated with several social benefits. For example, adolescents who have above average aggression levels also report high levels of social competence (Bukowski, 2003). In addition, aggressive youth are perceived by their peers as being more popular (Cillessen & Borch, 2006; Cillessen & Mayeux, 2004; Duffy et al., 2017; Leadbeater et al., 2006; Pouwels

et al., 2016; Vaillancourt & Hymel, 2006) and have also been found to have high levels of peer acceptance (Cillessen & Borch, 2006; Hawley et al., 2007; Kawabata et al., 2014). For example, Salmivalli et al. (2000) found that indirect aggression was associated with high peer acceptance among males and low peer rejection among females. However, the social benefits experienced do not appear to mitigate the negative mental health consequences of engaging in aggressive behaviours, and even those adolescents who benefit socially tend to suffer psychologically (Ciarrochi et al., 2019). Thus, it is imperative that we continue to further our understanding of aggression and its links to mental health outcomes in adolescence.

While the link between aggression and mental ill-health has been well-established, the direction of causation has been harder to ascertain. Research addressing this point has been inconclusive, with some studies reporting that aggression is a risk factor for mental ill-health (e.g., Cleverley et al., 2012; Ladd & Troop-Gordon, 2003); while others suggest that aggression is an outcome of mental ill-health (e.g., Kofler et al., 2011). Moreover, some studies propose that aggression shares a reciprocal association with mental ill-health (e.g., Beyers & Loeber, 2003; Measelle et al., 2006). I review the evidence for the three proposed causal directions in the following sections.

Aggression as a Risk Factor for Mental Ill-Health

The failure model (Capaldi, 1992; Patterson & Capaldi, 1990; Patterson & Stoolmiller, 1991) offers one possible explanation for the co-occurrence of aggression and mental ill-health. According to the failure model, those who engage in aggressive behaviours are more likely to experience failures in multiple domains, including their academic and social functioning. Over time, the culmination of these failures can negatively impact the individual, thereby increasing their vulnerability to mental ill-health concerns (Capaldi, 1992; Granic & Patterson, 2006; Patterson & Capaldi, 1990; Patterson & Stoolmiller, 1991). Notably, the failure model stems predominantly from research on conduct disorder and

depression. Due to a lack of rigorous testing (Evans & Fite, 2019), it is unclear how well the model applies to other aggressive behaviours and mental ill-health. However, other empirically grounded theories, such as self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2017) and the interpersonal theory of depression (Coyne, 1976), complement the failure model, thus supporting its basic premise that aggression is a risk factor for mental ill-health.

Self-determination theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2017), a theory of human well-being and flourishing, maintains that three basic psychological needs are critical for psychological thriving: (i) competence i.e., feelings of efficacy and ability; (ii) autonomy i.e., feelings of agency and volition; and (iii) relatedness i.e., feelings of connection and belonging within one's social environment (Deci & Ryan, 1985; Ryan & Deci, 2017). The issue of relatedness is of particular relevance to the current discussion. An individual's ability to meet their need for relatedness is thought to be compromised by engagement in aggressive behaviours (Ciarrochi et al., 2019). More specifically, aggressive individuals tend to engage in behaviours that undermine connectedness, such as using people for their own gains as well as bullying (Hawley et al., 2009; Ziegler, 2014). Moreover, aggressive youth often report low relationship confidence (Hawley et al., 2009). Consequently, aggressive youth are less likely than their non-aggressive peers to form genuine social connections and to have their relatedness needs met, and therefore, are more likely to suffer from worse mental ill-health (Ciarrochi et al., 2019).

Coyne's interpersonal theory of depression supports one of the central tenets of the failure model, namely that failures, especially those experienced in social interactions, are associated with mental health problems. Coyne (1976) postulated that there are a number of behaviours an individual with depression is likely to engage in which result in the maintenance, and even increase, of depressive symptoms. Individuals suffering from

depression tend to seek reassurance from those around them. When others provide such reassurances, they tend to question its sincerity and, therefore, seek further reassurance. Thus, a downward spiral begins, whereby the depressed individual seeks more frequent and more convincing reassurance from others. When unable to obtain them, their depressive symptoms are maintained and even exacerbated. In addition, Coyne (1976) proposed that individuals suffering from depressive symptoms can induce negative affect in others. As this negative affect escalates, so too does the likelihood of the person with depression being rejected by their peers (Coyne, 1976; Marcus & Nardone, 1992; Segrin & Dillard, 1992). Thus, according to Coyne's (1976) interpersonal theory of depression, failures in social functioning are a risk factor for the worsening of depressive symptoms.

Empirically, numerous studies indicate that aggression is, in fact, a risk factor for subsequent mental ill-health (e.g., Cleverley et al., 2012; Espelage et al., 2003; Kiesner, 2002; Ladd & Troop-Gordon, 2003). For example, Moilanen et al. (2010) found that youth who reported high levels of aggressive and delinquent behaviours tended to experience subsequent high levels of internalising problems, including anxiety, withdrawal, and depression, controlling for initial levels of internalising problems. Also, in a longitudinal study of over two hundred children in the third grade, Crick et al. (2006) investigated the causal associations between aggression and mental health problems. They reported that levels of both direct and indirect aggression in third grade independently predicted depression, anxiety, and withdrawal one year later (Crick et al., 2006). Moreover, the strongest effect was found when an individual engaged in both direct and indirect forms of aggression (Crick et al., 2006). Similar results were found in a large Australian cohort. Specifically, Moore et al. (2014) found that perpetrators of aggressive behaviours at age fourteen were at a greater risk for future depressive symptoms at seventeen years of age, controlling for baseline levels of depressive symptoms. In a series of cross-lagged panel models, Blain-Arcaro and

Vaillancourt (2017) found evidence for the failure model, whereby aggression predicted subsequent mental ill-health. Notably, they did not find evidence to support aggression being a consequence of mental ill-health, nor for aggression and mental ill-health mutually influencing each other (Blain-Arcaro & Vaillancourt, 2017). Moreover, in a single cross-lagged panel model, Van der Giessen et al. (2013) investigated whether aggression was predictive of mental ill-health and vice versa. While they found evidence to support aggression being a risk factor for subsequent mental ill-health, they did not find evidence for the converse of this association. Thus, there is strong and consistent empirical evidence supporting the failure model, whereby aggression is a risk factor for subsequent mental ill-health.

With between fifty and sixty-five percent of youth displaying moderate levels of aggression, and between five and fifteen percent of youth displaying high or increasing levels of aggression (Cleverley et al., 2012), rates which are similar across cultures and educational settings (Carney & Merrell, 2001), it is evident there are large numbers of adolescents who are at risk for subsequent mental health problems. Moreover, the association between aggression and subsequent mental ill-health is especially concerning as the onset of mental health problems during adolescence is a known risk factor for future mental ill-health in adulthood (Kessler et al., 2007; Kessler et al., 2005). Thus, it is essential that we continue to advance our understanding of aggression and how it might consequently result in negative mental health outcomes in adolescence.

Aggression as a Consequence of Mental Ill-Health

The acting-out model (Carlson & Cantwell, 1980) proposes that aggression is a consequence of mental ill-health. According to the acting-out model, symptoms of mental ill-health can manifest as observable behaviours, such as aggression (Wolff & Ollendick, 2006). More specifically, mental ill-health is often characterised by behaviours such as distractibility

and irritability, which may manifest in the midst of frustrating situations (Wolff & Ollendick, 2006). Youth experiencing irritability and distractibility may subsequently struggle to accurately perceive and appropriately respond to various situations (Wolff & Ollendick, 2006). For example, mental ill-health can, in some instances, compromise an individual's concern for the negative consequences of their actions, thereby increasing the risk for aggressive behaviours (Lilienfeld, 2003). In addition, the negative affect typical of an individual suffering from mental ill-health may be uninviting or offensive to those around them. Consequently, this can negatively impact an individual's friendships which may subsequently contribute to higher levels of conflict (Oland & Shaw, 2005). Moreover, youth who are suffering from mental ill-health may perceive situations, including interactions with peers, in a negative or threatening manner and subsequently respond with aggression.

Another behaviour typically observed in those suffering from mental ill-health is rumination. Factor analytic studies have revealed two sub-components of rumination, namely sadness rumination and anger rumination. Sadness rumination is conceptualised as rumination whereby an individual becomes fixated on sad thoughts and ideas (Conway et al., 2000). Sadness is consistently found to be associated with depressive symptoms and to predict the worsening of depression over time (Morrow & Nolen-Hoeksema, 1990). In contrast, anger rumination refers to repetitive thinking about angry thoughts and ideas (Sukhodolsky et al., 2001). Empirically, researchers have found anger rumination to be associated with angry mood (Bushman, 2002; Rusting & Nolen-Hoeksema, 1998) and with engagement in aggressive behaviours (Bushman et al., 2005; Collins & Bell, 1997; Maxwell, 2004). Sadness rumination and anger rumination are highly correlated with each other (Peled & Moretti, 2010), leading some researchers to propose that sadness rumination can mutate into anger rumination, which is a precursor to aggressive behaviours (Dutton & Karakanta, 2013; Vansteelandt & Van Mechelen, 2006).

Empirical evidence for the reverse association, wherein mental ill-health precedes externalising difficulties such as aggression, has also been found, albeit less consistently. One of the first studies to propose this temporal association was Kovacs et al. (1988). The authors monitored children with depression over the course of several years, reporting that twenty-three percent of the sample proceeded to develop conduct disorder. Of these comorbid cases, twenty-five percent developed conduct disorder before they developed depression, while fifty-six percent developed depression prior to developing conduct disorder. While these results demonstrated that, at times, depression preceded externalising problems, the sample was small which prevented further generalisations. Moreover, Kovac et al.'s (1988) study selected those with a depression diagnosis for inclusion in their sample. Had the sample cohort chosen been based on a diagnosis of conduct problems, perhaps the reverse temporal associations may have been observed. Despite the limitations of the Kovacs et al. (1988) study, the finding that externalising behaviours are a consequence of mental ill-health has been reported subsequently by other researchers (e.g., Loeber & Keenan, 1994; Overbeek et al., 2001). For example, Ritakallio et al. (2008) found that depression predicted subsequent antisocial behaviour in their longitudinal study of a youth cohort in mid- to late-adolescence. Notably, they did not find evidence to support the converse of this link, whereby antisocial behaviour would predict subsequent depression. In addition, Kofler et al. (2011) performed a nationwide longitudinal study on a sample of adolescents aged twelve to seventeen years of age. They found that a model wherein depression predicted delinquent behaviour, including aggressive behaviours, fit the data better than a model where delinquent behaviours predicted depression (Kofler et al., 2011). Thus, there is also empirical support for the acting-out model.

Aggression Shares a Reciprocal Relation with Mental Ill-Health

The mutual influence model provides a third explanation for why aggression and mental ill-health tend to co-occur by arguing that there is a reciprocal relationship between them. According to the mutual influence model, aggressive behaviours and mental ill-health share common risk factors (Fergusson et al., 1996; Overbeek et al., 2001). Proponents of this model argue that the risk factors for aggression and mental ill-health are similar, therefore, development of one might lead to an increased vulnerability in the other, and vice versa (Overbeek et al., 2001). Thus, the mutual influence model also posits that aggression and mental ill-health reciprocally reinforce each other over time (Overbeek et al., 2001; Ritakallio et al., 2008).

More recently, a number of studies have reported empirical support for the mutual influence model (e.g., Caron & Rutter, 1991; Lahey et al., 2002; Loeber & Keenan, 1994; Wolff & Ollendick, 2006). The negative consequences of having both depression and conduct disorder are greater than having either condition alone (Keiley et al., 2003). In addition, in a sample of approximately five hundred adolescent females, Measelle et al. (2006) found evidence for a bi-directional relation between antisocial behaviours and depression. Specifically, engagement in antisocial behaviour was associated with a subsequent increase in depression, and depression predicted an increase in subsequent engagement in antisocial behaviours (Measelle et al., 2006). Similar findings were observed in an all-male cohort: depression was found to predict subsequent delinquent behaviour and vice-versa, even when the possible confounding factors, such as one's social context, were taken into account (Beyers & Loeber, 2003). Interestingly, this association was not symmetrical. Specifically, although delinquency and depression were both predictive of each other, depression was a stronger predictor of delinquency than delinquency was of depression (Beyers & Loeber, 2003). Thus, the mutual influence model appears to favour the acting-out

model in that mental ill-health is a stronger risk factor for subsequent engagement in aggressive behaviours.

Chapter Summary

The evidence presented in this chapter suggests that aggression and mental ill-health tend to co-occur in adolescent populations, such that individuals who engage in higher levels of aggression also tend to report higher levels of mental ill-health. I reviewed three models, each proposing a causal mechanism for the association between aggression and mental ill-health. The failure model argues that aggression is a risk factor of mental ill-health and has received the most consistent empirical evidence. In the acting-out model, it is proposed that aggression is a consequence of mental ill-health. In the mutual influence model, evidence is presented to suggest that there may be a reciprocal relationship between these two variables. It is imperative that we continue to further our understanding of these associations given the large number of adolescents who suffer from both aggression and mental ill-health. It is indeed surprising that no studies have examined both aggression and mental ill-health in the context of friendships, given the role of peers in each individual behaviour (see Chapter 1). Thus, the main aim of this thesis is to investigate both aggression and mental ill-health in the context of adolescent friendships. Before proceeding with this investigation, friendships need to be defined and conceptualised. In Chapter 3, I will review the debate in the literature regarding how to conceptualise adolescent friendships.

Chapter 3: Conceptualising Friendships

"A good friend is like a four-leaf clover; hard to find and lucky to have."

- Irish Proverb

Introduction

In Chapter 1 of this thesis, I outlined evidence suggesting that friends can have a powerful influence on each other's levels of aggression and mental ill-health. I also highlighted the lack of investigation of both aggression and mental ill-health in the context of a single study of friendship groups. This is particularly surprising given the well-established link between aggression and mental ill-health at the individual level, the evidence for which is reviewed in Chapter 2. Thus, a principal aim of this thesis is to examine both aggression and mental ill-health in the context of friendship groups. However, before I proceed, it is important to note that, despite widespread agreement among researchers of the importance of friends, there is some debate on how best to conceptualise friendships. In this chapter, I will first discuss the methods used to collect friendship data, with a particular focus on peer nomination procedures and frequency of measurement points. I will then review three different friendship conceptualisations, namely, reciprocal friendships and two types of friendship groups: non-overlapping and overlapping friendship groups.

Friendship Data

The term sociometric assessment refers to those methods used to measure youths' social relationships (Cillessen & Bukowski, 2018). Sociometric methods were first developed by Moreno in 1934 and have been used for numerous purposes throughout their long history, including, but not limited to, classroom mapping (e.g., Gronlund, 1959) and examination of friendships (e.g., Endedijk & Cillessen, 2015; van den Berg & Cillessen, 2013). There are many different types of sociometric methods, several of which will be further discussed later

in this chapter. However, peer nominations continue to be the most widely used (Cillessen & Marks, 2017; Poulin & Dishion, 2008, for a review see Avramidis et al., 2017).

Peer Nominations

A standard peer nomination procedure (e.g., Coie et al., 1982; Newcomb & Bukowski, 1983) will typically ask participants to identify peers they like the most, and/or like the least. Those peers an individual can nominate belong to a reference group, which is a clearly defined peer group, or social network, within which the participant operates (Cillessen & Marks, 2017). In most instances of peer nomination research, the school is used as the reference group, as classrooms and grades provide clearly delineated groups (Cillessen & Marks, 2017). As a consequence, the majority of results that stem from peer nomination data are unlikely to be generalisable beyond school settings (Cillessen & Marks, 2017). Moreover, the majority of peer nomination research involves participants aged between four and eighteen, with fewer studies outside of these age limits (for exceptions see e.g., Endedijk et al., 2015; Lansu & Cillessen, 2012).

When collecting peer nomination data, one methodological concern is whether the number of peers a participant can nominate is unlimited or limited, and if there is a limitation, what it should be. Procedures with and without limitations have both been used in different studies from as early as the 1940s. Limited nominations, however, tend to be more common in quantitative research (Cillessen & Marks, 2017) with three or five being the most frequently used limits (e.g., Coie et al., 1982; Fisher & Bauman, 1988; Newcomb & Bukowski, 1983; Sieving et al., 2000). Advocates of the limited nominations procedure do so for a number of predominantly practical reasons. Firstly, a limited nominations procedure is less time consuming than an unlimited nominations procedure (Newcomb & Bukowski, 1983), thereby allowing collection of a substantial amount of data in a short period of time (Poulin & Dishion, 2008). Secondly, the limited nominations procedure has been found to

reduce response fatigue and frustration in participants, allowing higher quality data to be collected. Finally, the statistical analysis of limited nomination data is simpler (Lemann & Solomon, 1952).

However, proponents of the unlimited choice procedure, which include Moreno (1951), the founder of sociometric methods, argue that these practical advantages are outweighed by the cost. Psychometrically, the opportunity to collect a larger number of nominations is always preferred over a smaller number (Cillessen & Marks, 2017). Moreover, advocates of the unlimited nomination procedure have argued that restricting the number of nominations may prevent identification of potentially important friendships and may lead to biases in the estimation of subsequent indices, such as likeability (Terry, 2000; Wasserman & Faust, 1994). Holland and Leinhardt (1973), for example, suggested that the use of a limited-nomination procedure leads to measurement error. They exemplify this with the case of a participant who has four best friends, all of whom are equally liked. In a procedure allowing only three nominations one best friend will not be nominated, leading to an increase in measurement error.

A small number of researchers have empirically compared the limited and unlimited nominations procedures. Results from these empirical studies report that the unlimited nomination procedures result in higher stability scores (Jiang & Cillessen, 2005; Terry, 2000) and internal reliabilities (Marks et al., 2013), compared to the limited nominations procedure. In contrast, other empirical results show only small differences between indices derived from studies using limited versus unlimited nominations (e.g., Bjerstedt, 1955; Gronlund, 1959). More recently, Gommans and Cillessen (2015) directly compared limited and unlimited nominations procedures in a sample of elementary school students using a counterbalanced study design. They report that the results obtained, in the form of descriptive statistics, correlates, and predictors of outcomes, were very similar across limited and unlimited

nomination procedures (Gommans & Cillessen, 2015). Thus, whether one method is substantially superior to the other remains to be established.

Other Sociometric Methods

In addition to peer nominations, three other sociometric methods have been developed for collecting peer relationship data (see Terry, 2000 for a comprehensive description of these methods). The first method is paired comparisons, whereby participants are asked to compare each peer against every other peer. The second method is peer rating, which asks all participants to rate each member of the reference group on a Likert-type scale for a particular metric such as likeability. The third method is rank order, wherein each participant ranks the individuals within their reference group in order of their own preferences on a specific criterion (e.g., likeability). Notably, these three models each provide more detailed and nuanced information when compared with data collected from peer nominations (Thompson & Powell, 1951). However, these alternative methodologies are impractical in larger groups (Keislar, 1957). For example, in a classroom with thirty students, it would take participants a significant amount of time to rate all twenty-nine peers on a 1-5 Likert scale for a single item, time in which they could respond to several peer nomination questions (Parkhurst & Asher, 1992). Moreover, a number of studies have compared peer nominations with the other sociometric methods and report that the results of peer nominations are often comparable (e.g., Maassen et al., 2005), or even superior (Asher & Dodge, 1986) to those derived from other methods. Thus, due to their inherent advantages, peer nominations remain the most commonly used sociometric method.

Frequency of Sociometric Measurement

Another important consideration when it comes to the collection of friendship data is the frequency with which the data is collected as this, in turn, dictates whether static or dynamic network analysis methods can be used for subsequent analyses. Static network

analysis involves analysing fixed instances of a network (Singh et al., 2019; Farine, 2018 and requires fewer rounds of data collection. Indeed, meaningful analysis can be completed on one single static instance of a network. In contrast, dynamic analysis methods require peer relation data to be repeatedly collected on the same participants over relatively short periods of time, for example daily (Boogert, Farine & Spencer, 2014) or weekly (Aplin, Firth et al., 2015). Thus, the application of dynamic methods is often largely dependent on data availability issues (Farine, 2018).

In the context of adolescent friendships, the vast majority of friendship data is collected from the school setting (Cillessen & Marks, 207; Poulin & Dishion, 2008). While this comes with several advantages, in that adolescents spend a substantial part of their time at school and are exposed to a stable peer group (Poulin & Dishion, 2008), it also has its limitations. The most relevant limitation for this discussion concerns the substantial demands on school and teacher time (Bailey & Colley, 2015), meaning that it is often not feasible for friendship data to be collected on a daily, or even weekly basis. As such, it is often the case that there is not enough data available for dynamic analysis methods (Farine & Standburg-Peshkin, 2015). In sum, adolescent friendships are most often measured at a small number of static instances (i.e., timepoints) and are subsequently subjected to static network analysis methods (e.g., Dijkstra et al., 2011; Espelage et al., 2003; Giletta et al., 2011).

Using Sociometric Data

Three different levels are typically examined in studies of peer relations: the individual; the dyadic; and the subgroup levels, all of which can be examined using peer nomination data (Cillessen & Marks, 2017). At the individual level, the number of peer nominations given and received can be used to indicate the peer acceptance, peer rejection, or social preference of each individual (Coie et al., 1982). For example, if person A received more 'liking' peer nominations than person B, then person A would have a higher social

status in the reference group. Dyadic relationships include friendships, romantic

relationships, and bully-victim dyads (Cillessen & Marks, 2017). The dyadic relationships

most commonly investigated in the literature are reciprocated best friendships, which are

derived from best friend peer nomination procedures (e.g., Goodwin et al., 2012). At the

subgroup level, groups or cliques can also be computed from peer nomination data. Groups

or cliques are defined as clusters of individuals within the reference group that are more

connected to each other than they are to individuals outside of their cluster (Lancichinetti et

al., 2009; Newman & Girvan, 2004).

This thesis will use peer nominations to investigate relationships at both the dyadic

and group levels of analysis, using static network data. In particular, reciprocated best

friendship dyads and two forms of groups, namely non-overlapping and overlapping

friendship groups, will be examined and compared. In the next sections, I will review the

literature on reciprocal friendships, followed by non-overlapping and then overlapping

friendship groups.

Reciprocal Friendships

A widely used definition of friendship characterises it as a reciprocal, voluntary, and

terminable relationship that is based on cooperation and trust (Bukowski et al., 1996; Hartup,

1996; Rubin et al., 2006). Thus, reciprocity is often considered to be an inherent feature of

friendships. Indeed, reciprocity indicates that the friendship is real as it is acknowledged by

both individuals (Poulin & Chan, 2010). Reciprocal friendships are reported to be of a higher

quality than are non-reciprocal friendships, the latter being defined as one in which only one

person in the pair nominates the other as a friend (Linden-Andersen et al., 2009). Moreover,

there is evidence to suggest that the benefits of friendship, such as lower risk of internalising

problems, are greater for reciprocal friendships (Ladd & Troop-Gordon, 2003; Laursen et al.,

2007; Parker & Asher, 1993). Thus, researchers often use the reciprocity criterion when operationalising friendships (Goodwin et al., 2012).

It is important to note that, despite widespread use in investigations of adolescent friendships, the reciprocity criterion has some limitations. It is often the case, for example, that friends are not equally close, even in friendships that are defined by closeness. In the widely used Add Health Study, wherein participants were asked to identify five of their closest male and five of their closest female friends, in addition to their very best friend, best friend reciprocity was less than fifty percent (Strauss & Pollack, 2003), with participants tending to have twice as many unreciprocated friendships as reciprocated friendships (Carbonaro & Workman, 2013). It was further reported that, in the Add Health Study, the average reciprocity rate was less than forty percent across all friendship nominations made (Ueno, 2005). Furthermore, Parker and Asher (1993) found that approximately twenty-five percent of adolescents had no reciprocated friendships, when nomination procedures limited to three nominations were used (Parker & Asher, 1993).

A second limitation of the reciprocity criterion is that unreciprocated friendships should not be discounted because they reflect an individual's own perceptions of their friendships (Furman & Buhrmester, 1985; Poulin & Chan, 2010; Vaillancourt et al., 2019). In a study by Faris and Ennett (2012), the results of which were later replicated by Meter et al. (2015), it was found that adolescents without any reciprocated friends were significantly influenced by the aggressive behaviours of their non-reciprocated friends, independent of the influence exerted by their reciprocated friendships. In addition, Aloise-Young et al. (1994) investigated the susceptibility of adolescents with and without reciprocated friendships to their friends' smoking behaviours. They found that adolescents without any reciprocal friendships were influenced to a greater degree by the smoking behaviours of their non-reciprocal friends than were adolescents with reciprocated friends (Aloise-Young et al.,

1994). It has been speculated that the significant, and at times greater, influence of non-reciprocated friendships may be the result of an imbalance in the friendship: the person being nominated as a friend (the nominee) has greater influence over the person nominating them as a friend (the nominator) than the nominator has over the nominee (Faris & Ennett, 2012; Scholte et al., 2009).

The third limitation of the reciprocity criterion relates to the ecological systems theory (Bronfenbrenner, 1986; Bronfenbrenner & Ceci, 1994), which states that an individual's social context can be categorised into four ecological levels (microsystem, mesosystem, exosystem, and macrosystem), each of which influence an individual's development to varying degrees. The microsystem encompasses the relationships and interactions an individual has with their immediate surroundings and, thus, exerts the greatest influence on the individual. In adolescence, the importance of friendships rises (De Goede et al., 2009; Smetana, 2011; Way & Greene, 2006), as does the amount of time spent with peers (Brown & Larson, 2009). Thus, an individual's friendship group serves as an important microsystem that can profoundly impact their development (e.g., Bagwell et al., 2005; Ciarrochi et al., 2017; Parker et al., 2015). The ecological systems theory is supported by research that finds isolated dyadic interactions between adolescent friends to be quite rare. Specifically, during adolescence, even interactions between best friends typically occur within the broader social context, namely a larger group of interconnected peers (Urberg et al., 1995). Moreover, friendship groups possess particular norms and rules that are not present in dyadic interactions, which have a unique potential for influence beyond the effects of reciprocated friendships (Adler & Adler, 1998; Corsaro & Eder, 1990; Wasserman & Faust, 1994). For example, adolescents are more influenced by their friends' behaviour when their friends are friends with each other (Haynie, 2001). Thus, focusing exclusively on reciprocated

friendships may be a conservative, or limited, microsystem view through which to examine the influence of friends.

Friendship Groups

In an attempt to address the limitations of the reciprocity criterion of friendship, developmental researchers have shifted their focus to an examination of the influence of friendships through the broader lens of friendship groups (e.g., Parker et al., 2015). A common conceptualisation of a friendship group is that it has more internal connections than external connections (Lancichinetti et al., 2009; Newman & Girvan, 2004). In other words, the individuals within a group are more closely linked to each other than they are to people outside of their group. Friendship groups can be categorised into two broad types, both of which are based on peer nomination data: non-overlapping groups and overlapping groups.

Non-Overlapping Friendship Groups

Non-overlapping friendship groups can be identified using peer nomination data in several ways. One of the simpler, and perhaps cruder, ways to do this is to include everyone who is either nominated by an individual (e.g., Werner & Crick, 2004), or who is in their reference group, e.g., their classroom (Laninga-Wijnen et al., 2017; Werner & Hill, 2010), as being a member of their group. Another, more statistically advanced method for identifying disjoint, or non-overlapping, friendship groups is Social Cognitive Mapping (SCM; Cairns et al., 1997). Groups are identified by asking participants to identify individuals in their reference group who tend to spend a lot of time together. The individual nominations are then aggregated across all participants to identify all peer groups in a particular network, creating a complete social 'map'. The validity of the SCM approach has been supported by empirical research. Gest et al. (2003), for example, report that the peer groups identified through SCM methods are consistent with those found by observing interactions between individuals. However, in a recent study, Neal et al. (2021) found that SCM methods are associated with

an unacceptably high risk of false positives. Specifically, they showed that SCM will identify peer groups even when applied to completely random data. These results question the validity of the groups identified using SCM procedures.

The most statistically advanced method in which peer nomination data can be used to detect non-overlapping groups is to subject it to analysis using group detection algorithms. Various community detection algorithms have been used in both the aggression (Faris & Ennett, 2012) and the mental health literature (Conway et al., 2011). The NEGOPY algorithm (Richards, 1995) is one of the more frequently used algorithms, particularly in the aggression literature (e.g., Espelage et al., 2003; Low et al., 2013). The NEGOPY algorithm detects groups from friendship nomination data based on the following criteria: (i) at least fifty percent of a participants' reciprocated friendships have to be in their group; (ii) there needs to be connections between each member of the group; and (iii) there must be no more than three non-reciprocated connections in a group (Richards, 1995). It is important to note that the requirements for group detection using the NEGOPY algorithm still centre around reciprocated friendships and, therefore, may be susceptible to some of the same limitations as the reciprocity criterion reviewed in the sections above.

The infoMap algorithm is another group detection algorithm (Csardi & Nepusz, 2006). Like NEGOPY, infoMap can detect disjoint groups based on peer nomination data. However, while NEGOPY is focused on reciprocated connections, infoMap is focused on how information flows within the network (Zhao et al., 2018). Therefore, infoMap creates groups based on the degree to which information flows between individuals. Those individuals between whom information flows quickly and easily are considered to be closely connected and will be placed in the same group (Zhao et al., 2018). Among algorithms for disjoint community detection, infoMap is considered to be one of the most accurate methods available (Newman & Girvan, 2004; Sales-Pardo et al., 2007). In a review of five well-

established group detection algorithms, Wagenseller et al. (2018) recommend infoMap for use in research. Specifically, infoMap was found to outperform others on a range of metrics, including its ability to consistently produce relevant communities of an appropriate size while also including a large proportion of the network. In addition, Zhao et al. (2018) report that infoMap performs well in terms of identification of high-quality groups, where high-quality groups are defined as those that are strongly connected internally and largely isolated from the rest of the network. Moreover, infoMap has successfully been used in research to examine the influence of peers (e.g., Llorente et al., 2015; Parker et al., 2015). However, I have not identified any study in which infoMap has been used to investigate the influence of friendship groups on aggression or mental ill-health outcomes.

The non-overlapping friendship group conceptualisation is also not without limitations, the most prominent, and perhaps serious, being an inability to account for overlap between groups. Overlap is especially prevalent in human social networks and an individual's social network will naturally comprise multiple overlapping group memberships. For example, in the school setting, an individual may be a member of a friendship group from their math class, their science class, and also their school sport team. By their nature, overlapping friendship groups may have more external connections than they do internal connections (Ahn et al., 2010; Palla et al., 2005; Xie et al., 2013). Therefore, the widely used friendship group definition, i.e., that groups have more internal than external connections, does not apply. Moreover, conceptualising friendship groups as being disjoint entities can cause methodological issues. Specifically, disjoint group detection methods may struggle to classify individuals who lie at the boundary of two groups into one group or the other. This can result in misclassifications and/or impair the quality of the groups that have been detected using non-overlapping group methods (Wang et al., 2009).

Overlapping Friendship Groups

A number of algorithms have recently been developed that use peer nomination data to identify overlapping friendship groups. It is important to note that overlapping group detection algorithms are newer, and consequently require further testing and development, compared to the older and more tested methods for detecting reciprocal friendship dyads and non-overlapping friendship groups. Xie et al. (2013) reviewed fourteen overlapping group detection algorithms and noted that, while great advances have been made, there is still room for improvement, particularly regarding the over- and under-detection of overlap in larger social networks. Regardless of this limitation, one overlapping group detection algorithm, the linkcomm algorithm (Ahn et al., 2010; Kalinka & Tomancak, 2011) appears suitable for use in real-world network research. Ahn et al. (2010) compared linkcomm with other well-established community detection algorithms, including infoMap, and found that linkcomm produced the most relevant community structures in real-world networks. Recently the linkcomm algorithm has been used to investigate peer group influence in adolescent samples (Sahdra et al., 2020). To date, the linkcomm algorithm has not been used to investigate aggression or mental ill-health in the context of overlapping friendship groups.

Comparing Friendship Conceptualisations

Despite the many and varied friendship conceptualisations reported in the literature, little research has compared the consequences of using different conceptualisations. The research that has been reported typically only investigates the same level of analysis, for example between reciprocated and non-reciprocated friendship dyads (e.g., Adams et al., 2005; Aloise-Young et al., 1994; Scholte et al., 2009), or between group members and non-group members (e.g., Henrich et al., 2000). Fewer studies have compared different friendship group conceptualisations within the same study, and those that have, have reported mixed findings. For example, Pijl et al. (2011) compared reciprocal friendships with small

friendship groups identified using SCM methods and found the differences between the two methods to be negligible. In contrast, both Faris and Ennett (2012) and Laird et al. (1999) found friendship groups to influence adolescent developmental outcomes over and above the influence of reciprocated friendships. Thus, further research is needed to better understand how peer influence processes operate across different friendship group conceptualisations.

Chapter Summary

It is well-established that friends constitute a powerful and prevailing source of influence in the lives of young people. However, despite this widespread agreement on the importance of friendships in peer influence processes, how best to conceptualise friendships remains a matter of debate in the literature. The central aim of this chapter was to review the different approaches to friendship research that are used in the literature. Firstly, I discussed how friendship data is collected, concluding that, despite some limitations, peer nomination procedures remain the most frequently used method in the literature. Using peer nomination data, three levels of analysis can be examined: the individual e.g., likability; the dyadic e.g., best friendships; and the group e.g., friendship groups. This chapter then focused on reciprocal best friendships and two types of friendship groups: non-overlapping and overlapping groups. The strengths and limitations of these three conceptualisations were discussed. Finally, few studies have compared the consequences of these different conceptualisations on substantive research questions, and those that have, have reported mixed findings. Moreover, to the best of my knowledge, no studies have compared reciprocal, non-overlapping, and overlapping friendship conceptualisations in the same study. Thus, further research is needed to better understand how peer influence processes operate across different friendship group conceptualisations. The following chapter addresses this issue.

Chapter 4: Study 1

Aggression and Mental Ill-Health in the Context of Adolescent Friendships

Introduction

In Chapter 1, I reviewed the literature on peer influence, concluding that youth become increasingly susceptible to peer influence processes during adolescence (Brown & Klute, 2003; Brown & Larson, 2009). Research examining peer influence in adolescents has tended to focus on externalising behaviours, particularly aggression (e.g., Beal et al., 2001; Dishion et al., 1997; Prinstein et al., 2001). However, more recent work has found evidence of peer influence processes in other domains of adjustment, including mental ill-health (e.g., Prinstein, 2007; Van Zalk et al., 2010). Surprisingly, in my review of the literature, I found no studies that examined peer influence processes for both aggression and mental ill-health in the same study. This is surprising given the robust link between aggression and mental ill-health at the individual level (see Chapter 2). Moreover, given the co-occurrence of aggression and mental ill-health (Card et al., 2008; Meeus et al., 2016), it is important to include both aggression and mental ill-health in the same study to determine the unique influencing capacity of both variables. Thus, this study aims to expand the literature by examining the relations between aggression and mental ill-health in the context of friendship groups. Currently, there is debate in the literature as to how best to conceptualise friendship groups (see Chapter 3). The most commonly used friendship conceptualisation is reciprocated friendships (Goodwin et al., 2012; Newcomb et al., 1999). However, numerous researchers have argued that reciprocated friendships constitute a limited or narrow perspective on friendship in adolescence (Aloise-Young et al., 1994; Meter et al., 2015; Urberg et al., 1995). Therefore, friendship groups more broadly, both non-overlapping, and overlapping, are being used more frequently in empirical studies. The debate on the different friendship conceptualisations has remained largely theoretical, with few studies empirically

comparing different conceptualisations within the same study. Thus, in this thesis, I also aim to make a methodological contribution to the literature by investigating the consequences of using reciprocated friendship dyads, non-overlapping friendship groups, and overlapping friendship groups on clarifying the substantive questions related to the links between aggression and mental ill-health.

The Present Study

To the best of my knowledge, no studies have examined how both aggression and mental ill-health may influence each other over time in the context of friendship groups. This is surprising given the well-established link between aggression and mental ill-health at the individual level (reviewed in Chapter 2). Thus, the substantive aim of the present study is to examine the relations between individual and group aggression and mental ill-health over time. Moreover, currently, there is no consensus in the literature regarding the best way to operationalise friendships when investigating peer influence (see Chapter 3). Thus, the second aim of this study is to contribute to the literature methodologically, by comparing the consequences of using different friendship group conceptualisations on clarifying the substantive questions in relation to individual and group aggression and mental ill-health.

Research Questions and Hypotheses

Research Question 1

Will longitudinal associations be observed between individual aggression and individual mental ill-health in the present sample?

Hypothesis 1

Longitudinally, youth have been found to select friends who engage in aggressive behaviours at a similar frequency to themselves, i.e., selection (e.g., Dijkstra et al., 2011; Sijtsema et al., 2010). In addition, numerous studies have concluded that having aggressive friends predicts subsequent increases in individual levels of aggression, i.e., socialisation

(e.g., Espelage et al., 2003; Sijtsema et al., 2010). Taken together, the literature suggests that, over time, friends' aggressive behaviours will positively influence an individual's levels of aggression. Thus, I hypothesised the same result would be observed in the present study, whereby group aggression would positively predict individual aggression over time.

Research Question 2

Will longitudinal associations be observed between individual mental ill-health and group mental ill-health in the present sample?

Hypothesis 2

While there are somewhat mixed findings in the literature (e.g., Mercer & Derosier, 2010), the majority of studies report that individuals become friends with those whose levels of mental ill-health are similar to their own, i.e., selection (Giletta et al., 2011; Hogue & Steinberg, 1995). Moreover, numerous empirical studies report that if an individual's friends suffer from mental ill-health, then the individual is likely to subsequently also suffer from mental ill-health, i.e., socialisation (e.g., Van Zalk et al., 2010). In addition, socialisation effects have been found in the context of close friendships (e.g., Giletta et al., 2011; Stevens & Prinstein, 2005) as well as in larger friendship groups (Guan & Kamo, 2016; Kiuru et al., 2012). Taken together, these findings suggest that friends' mental ill-health influences individual mental ill-health over time. Thus, I hypothesised that friendship group mental ill-health would positively predict subsequent individual mental ill-health.

Research Question 3

Will longitudinal associations be observed between individual aggression and individual mental ill-health in the present sample?

Hypothesis 3

It is widely reported that aggression and mental ill-health tend to co-occur at the individual level, whereby individuals who engage in aggressive behaviours also tend to suffer

from poor mental health (Card et al., 2008; Klomek et al., 2007; Van der Wal et al., 2003). Three different processes have been proposed to account for the directionality of this association: the failure model argues that aggression is a risk factor for mental ill-health (Patterson & Capaldi, 1990); the acting-out model suggests that aggression is a consequence of mental ill-health (Carlson & Cantwell, 1980); while the mutual influence model submits that aggression and mental ill-health share a reciprocal relationship (Overbeek et al., 2001). While there is empirical evidence to support both the acting-out model (e.g., Loeber & Keenan, 1994; Ritakallio et al., 2008) and the mutual influence model (e.g., Measelle et al., 2006; Wolff & Ollendick, 2006), the majority of empirical studies support the failure model whereby mental ill-health is a consequence of prior aggressive behaviours (e.g., Blain-Arcaro & Vaillancourt, 2017; Chen et al., 2012; Moilanen et al., 2010). Thus, in line with the literature reviewed above, I hypothesised that individual aggression would positively predict subsequent individual mental ill-health.

Research Question 4

Will longitudinal associations be observed between group aggression and group mental ill-health in the present sample?

Hypothesis 4

To date, no research has investigated the associations between group aggression and group mental ill-health cross-sectionally or longitudinally. However, at the individual level, aggression and mental ill-health are consistently found to co-occur (Card et al., 2008). Moreover, the majority of empirical evidence supports the failure model, whereby mental ill-health is a consequence of engaging in aggressive behaviours (e.g., Blain-Arcaro & Vaillancourt, 2017; Chen et al., 2012; Moilanen et al., 2010). Thus, it is reasonable to propose that a similar association would be observed at the group level. Therefore, I

hypothesised that group aggression would positively predict subsequent group mental ill-health.

Research Question 5

Will the relations between individual aggression, individual mental ill-health, group aggression, and group mental ill-health differ depending on how friendships are operationalised?

Hypothesis 5

While reciprocal friendships, non-overlapping friendship groups, and overlapping friendship groups have not been directly compared in any empirical studies, there is some evidence to suggest that they may produce different results. Compared to reciprocal friendships, the behaviours of non-reciprocated friendships were found to exert a greater influence on individual aggression (Adams et al., 2005; Aloise-Young et al., 1994; Faris & Ennett, 2012). In addition, friendship groups have been found to influence individual level variables, even after controlling for the influence of reciprocated friendships (Faris & Ennett, 2012). Thus, while I hypothesised that there would be differences in some of the results depending on the friendship operationalisation (i.e., reciprocal friendship dyads, non-overlapping, and overlapping friendship groups), I had no a priori hypothesis about what these differences may be.

Method

Participants and Procedure

Secondary data, from the Australian Character Study (ACS), was used in this study. ACS was a multi-year study that administered a battery of questionnaires to students in seventeen high schools in regional and rural areas New South Wales and Queensland, Australia. The same data collection procedure was used in all schools. Specifically, prior to each wave of data collection, informed written consent was obtained from both the

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participants and their parents. Refusal to participate was negligible. In October and November of each school year, paper and pencil questionnaires were administered to the consenting participants.

Of the seventeen schools that participated, six were single-sex schools (three were boys only and three were girls only), and the remaining eleven schools were coeducational schools. The average number of participants from each school was 168.5 (range: 75 to 232). The schools that participated in this study were Catholic schools, which make up more than twenty-five percent of all secondary schools in Australia (Australian Bureau of Statistics [ABS], 2010). In Australia, the government calculates a socioeconomic status (SES) score for schools across Australia, with the average score being 1,000 (Australian Curriculum, Assessment, and Reporting Authority, 2020). The schools in this sample had a similar average score of 1,026 ($SD = 43$), meaning the sample was representative of secondary schools in Australia with regards to SES.

Of the battery of questionnaires that were administered, measures of aggression, mental ill-health and friendship nominations were of relevance to this study. All schools completed the aggression and mental ill-health measures, while only fifteen of the schools provided friendship nomination data. A total of 2,865 participants, who completed these measures in at least one wave of data collection, were included in the study. Participants took part in the ACS study when they were in Grade 8 ($M_{age} = 13.7$, $SD_{age} = 0.4$), Grade 9 ($M_{age} = 14.7$, $SD_{age} = 0.5$), Grade 10 ($M_{age} = 15.7$, $SD_{age} = 0.4$) and Grade 11 ($M_{age} = 16.6$, $SD_{age} = 0.5$). Notably, the sample changed slightly between time points, as a consequence of the school context and the longitudinal study design, whereby participants may be leaving schools and joining others, or be absent on the day of data collection. Approaches for dealing with this missing data are discussed below.

Instruments

Aggression

Aggression was measured using the aggression subscale of Achenbach's (1991) Youth Self-Report Inventory (YSR). The YSR is a self-report questionnaire comprising two sections, one to measure competencies and one to measure problems in young people (Achenbach, 1991). The problems section assesses a total of nine problematic syndromes, one of which is aggression. The aggression subscale consists of sixteen items which ask students about the degree to which they engage in a variety of aggressive behaviours, including arguing (e.g., "I argue a lot"), destroying things (e.g., "I destroy things belonging to others"), fighting (e.g., "I physically attack people") and bullying others (e.g., "I am mean to other people"). All sixteen items can be found in Supplementary Materials S1. Participants rate each item on a 3-point Likert scale, ranging from one (*not true*) to three (*very true or often true*), with higher scores indicating higher levels of aggressive behaviour. The aggression subscale has been widely used and validated (e.g., Ciarrochi et al., 2019; Ivanova et al., 2007; Semel, 2017). Internal consistency was good in the present sample ($\alpha_8 = 0.88$, $\alpha_9 = 0.90$, $\alpha_{10} = 0.87$, $\alpha_{11} = 0.86$).

Mental Ill-Health

Mental ill-health was measured using the General Health Questionnaire (GHQ; (Goldberg & Hillier, 1979). The GHQ is a self-report screening questionnaire designed to detect levels of mental ill-health in individuals by assessing one's inability to function optimally as well as assessing the presence of feelings and behaviours characteristic of mental ill-health. Its original version had 60-items (GHQ-60; Goldberg & Hillier, 1979), which was reduced to 30 (GHQ-30; Goldberg & Williams, 2000), 28-items (GHQ-28; Goldberg & Williams, 2000), and 12-items (GHQ-12; Goldberg & Williams, 2000). With response fatigue concerns in mind, participants in the present study completed the 12-item

GHQ (see Supplementary Materials S2 for the twelve questionnaire items). Specifically, they were presented with the sentence stem, "Have you recently…" and then with twelve response items, including "felt that you are playing a useful part in things", "lost much sleep over worry", and "been losing confidence in yourself". Participants rated each item on a 4-point Likert scale that ranged from one to four. The wording of the response scale was reversed for the positively and negatively worded items such that higher scores were always indicative of worse mental health. For example, positively worded items go from 'more so than usual' to 'much less than usual' while negatively worded items go from 'not at all' to 'much more than usual'. The GHQ-12 has repeatedly been found to be a valid and reliable measure of mental health in adolescents (for a review, see Tait et al., 2002). Of particular relevance to the present thesis are studies by Tait et al. (2003) and Winefield et al. (1989) where the GHQ-12 was validated in samples of Australian adolescents. In the present sample, the GHQ-12 showed strong internal consistency ($\alpha_8 = 0.89$, $\alpha_9 = 0.93$, $\alpha_{10} = 0.90$, $\alpha_{11} = 0.91$).

Friendship Nominations

A modified version of Coie et al.'s (1982) nomination procedure, which has since been used by numerous researchers (e.g., Parker et al., 2015; Rowsell et al., 2014; Sahdra et al., 2020) was used in the present study. Specifically, participants were asked to consider everybody in their year group at their school and to list up to five of their closest female friends and five of their closest male friends. In same-sex schools, participants were only asked to nominate five of their closest friends of the relevant gender; for example, in all-girls schools, participants were asked to nominate five of their closest female friends only. As discussed in Chapter 3, researchers need to decide between limited and unlimited nomination procedures. In the present study, a limited nominations procedure was used because it is less time consuming than an unlimited nominations procedure (Newcomb & Bukowski, 1983) and, therefore, allowed for the collection of a substantial amount of data from a large number

of schools while simultaneously reducing response fatigue and frustration (Poulin & Dishion, 2008). Notably, the limit of ten friends, five of each gender, is fairly high, with most limited nominations procedures only allowing for a total of either three or five nominations to be made across both genders (Coie et al., 1982; Sieving et al., 2000).

Identifying Friendship Groups

Reciprocal Friendships

An individual was found to have a reciprocated friendship if the person that they nominated also nominated them. For example, if Participant A nominated Participant B and Participant B also nominated Participant A, then Participant A and B were both considered to have one reciprocated friendship. Consistent with previous studies of reciprocal friendships (e.g., Hogue & Steinberg, 1995; Woelders et al., 2010), friends' levels of aggression were computed as the average self-reported aggression scores across all reciprocal friends of each participant. For example, if Participant A had a reciprocated friendship with Participant B and Participant C, then Participant A's group aggression score would be the average of Participant B's and Participant C's aggression scores. The same procedure was used to calculate friends' levels of mental ill-health. Group aggression and mental ill-health scores, based on reciprocated friendships, were used in subsequent analyses.

Non-Overlapping Friendship Groups Using InfoMap

For each year, I created adjacency matrices from the friendship nomination data for each school and submitted them to an analysis in R 3.6.3 (R Core Team, 2019) using the *iGraph* package (Csardi & Nepusz, 2006), where friendship groups were identified using the infoMap community detection algorithm. The infoMap algorithm, which is considered to be one of the most accurate methods available for community detection (Newman & Girvan, 2004; Sales-Pardo et al., 2007), works by partitioning the network into dense regions. These dense regions are defined as those wherein nodes (which in this case are the participants)

have more edges (i.e., friendship connections or links) between each other than to the rest of the network (Xie et al., 2013). The infoMap algorithm uses the map equation approach to detect these dense regions in the network by identifying the regions of the network that a random walker tends to stay for a long time (Rosvall et al., 2009; Rosvall & Bergstrom, 2010). The path of the random walker is determined by starting at a specified node and choosing at random between the links attached to the node, moving along that link to the node at the other end and then repeating the above process numerous times (Newman, 2010). It can be helpful to think of a random walker as a person walking around a city (i.e., the network). At every junction, or fork in the road, the person randomly chooses one of the available paths to continue their walk. Areas of the city (such as suburbs) will have more paths within them than between them, and thus, the person will spend more time walking around these areas. The areas the person spends more time in constitute the dense regions in the network. In the context of friendships, the random walker approaches a person and chooses one person at random from that person's friends (i.e., the paths at a junction) to follow. If, for example, the person chooses Friend A, then the person would next choose from the friends belonging to Friend A, and so on. The random walker will spend more time going between people who are friends than between people who are not friends, thus resulting in the emergence of friendship groups. Importantly, a random walker is allowed to go along edges more than once, visit nodes more than once, and retrace their steps (Newman, 2010). The map equation identifies the theoretical limit of how succinctly we can describe the trajectory of a random walker (Rosvall et al., 2009; Rosvall & Bergstrom, 2010). By minimising the map equation over all possible network partitions, important aspects of the network structure, such as communities (i.e., the friendship groups), are revealed (Rosvall et al., 2009; Rosvall & Bergstrom, 2010).

In line with previous research examining friendship group level effects based on infoMap (Parker et al., 2015), both friendship group levels of aggression and mental ill-health were calculated as the average of the aggression and mental ill-health scores across all members in the friendship group identified by the infoMap algorithm. Group aggression and group mental ill-health scores calculated from the non-overlapping friendship groups were used for subsequent longitudinal analyses.

Overlapping Friendship Groups Using Linkcomm

To identify overlapping friendship communities, I used Kalinka and Tomancak's (2011) implementation of Ahn et al.'s (2010) algorithm in the R package, *linkcomm* (Kalinka & Tomancak, 2011). The linkcomm algorithm first uses the Jaccard coefficient to identify the degree of similarity between two links (i.e., connections) that share a node (i.e., a participant). Next, the links are structured hierarchically, in accordance with their similarity scores, to create a dendrogram. In this dendrogram, each leaf represents a link from the network data, and the branches represent the communities (Ahn et al., 2010). The communities are extracted from the dendrogram by cutting it at a point that maximises the density of links within communities, normalised against the number of possible links in each community, i.e., the partition density (Ahn et al., 2010; Kalinka, 2014; Kalinka & Tomancak, 2011). Each node inherits all memberships of its links (Ahn et al., 2010). In other words, if a participant has two connections and those connections are identified as being part of two separate groups, then the participant becomes a member of both of those groups. Figure 1 visually depicts the summary of one school's linkcomm analysis, including the dendrogram and the partition density plot as well as information regarding the largest community size and the number of edges, nodes, and communities. See Figures S1 to S60 in the Supplementary Materials for the visual summaries for all fifteen schools across the four time points.

For each year, I created an edgelist from the peer nomination data for each school. An edgelist is a list of all the pairs of participants that are connected by a nomination (i.e., a link; Newman, 2010). For example, if Participant A nominates Participant B, then one row in the edgelist would be (A, B), indicating that Participant A has nominated Participant B. Next, I submitted the edgelists to an analysis in *linkcomm* package (Kalinka & Tomancak, 2011) in R, where friendship communities were identified via the linkcomm community detection algorithm. Aggregated group aggression and group mental ill-health scores were calculated in line with previous research by Sahdra et al. (2020). More specifically, friendship group aggression levels were calculated as the average aggression across the multiple groups that an individual belongs to, weighted by the size of each group, such that bigger groups received a larger weight. The same method was used to calculate friends' mental ill-health scores. The friendship group aggression and friendship group mental ill-health scores were used for subsequent longitudinal analyses.

Figure 1

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 1 in Grade 8.

Link Communities Dendrogram

edges = 242 , # nodes = 110
clusters = 14 , Largest cluster = 14 nodes
Hclust method: single
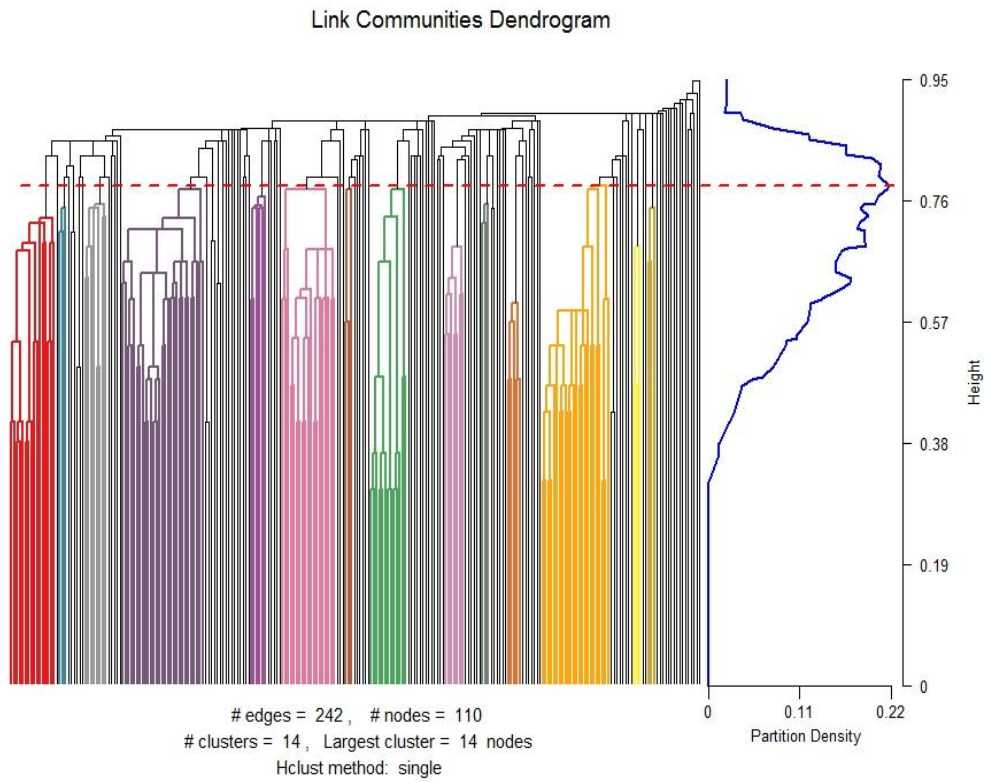
Multilevel Models

Given that the data used in this thesis was collected using a repeated measures study design, it is important to account for the hierarchical nature of the data, whereby time is nested within participants. If not accounted for, the standard errors of the regression estimates will be underestimated, resulting in an overestimation of statistical significance (Gelman & Hill, 2006; Hox et al., 2017). Therefore, I applied multilevel modelling methods, also known as hierarchical linear modelling or linear mixed modelling, to investigate the substantive research questions about the temporal relations between individual and friendship group aggression and mental ill-health. The models in this study had a two-level nesting structure, whereby time (level 1) was nested within participants (level 2). Individuals are assumed to have some stability, or "trait level", of aggression and mental health. Thus, by estimating a random intercept for participants in these models, I am able to assess the prospective effects of temporary deviations from the trait level of aggression on temporary deviations from the trait level mental health, and vice versa (Orth et al., 2020). The multilevel models were run in R using the *lme4* package (Bates et al., 2014). In line with the guidelines put forth by the American Psychological Association's (APA) Publication Manual (APA, 2019), I calculated effect size estimates and confidence intervals for interpretation, as they have been found to be more informative than significance testing, especially when only a single study is being conducted (Cumming, 2013).

Missing Data

The school context, combined with the longitudinal study design, inevitably results in a degree of participant attrition due to some students, for instance, moving schools, joining schools or being absent on the day of data collection. Multiple imputation methods, which are based on theoretical frameworks for missing data estimation as well as statistical theory for missing data estimation, represent the best methods currently available for handling missing

data in longitudinal research (Jeličić et al., 2009; Pampaka, Hutcheson, & Williams, 2016). Specifically, multiple imputation methods ensure that all available data is used, thus preserving the size of the sample as well as the statistical power of the analysis (McCleary, 2002). Moreover, multiple imputation methods produce unbiased estimates (McCleary, 2002). Consequently, results based on multiple imputed datasets are more valid compared to those using other ad hoc missing data approaches (McCleary, 2002). In addition, Schafer and Olsen (1998) carried out a simulation study wherein they showed that the values obtained using multiple imputation methods are accurate reflections of those that would have been obtained had the dataset been complete (Schafer & Olsen, 1998).

In this study, I used the *Amelia II* package (Honaker et al., 2011) in R to derive ten imputed datasets (Rubin, 2004). *Amelia II* uses the expectation-maximisation (EM) procedure with bootstrapping to impute parameter estimates for the missing data (Honaker et al., 2011; King et al., 2001). The algorithm then draws imputed values from each set of bootstrapped datasets and automatically replaces the missing values with the imputed values. In other words, the observed values remain the same, but the missing values are filled with a distribution of imputations that reflect the uncertainty about the missing data. In the present study, the EM convergence was normal and the EM chain lengths of all ten imputed datasets were consistent in length and reasonably short, thus confirming the robustness of the imputation model. I ran all of the multilevel models on the ten imputed datasets and the final effect sizes were obtained through aggregation procedures that followed Rubin (2004) rules, using the *mitools* package (Lumley et al., 2019) in R.

<center>**Results**</center>

Preliminary Analysis

Reciprocal Friendships

In the present sample, the total number of nominations made in each grade appeared to increase from Grades 8 to 10 (Grade 8 = 10,044; Grade 9 = 11,250; Grade 10 = 11,319), before declining somewhat in Grade 11 (9,419). The percentage of reciprocal friendships also followed a similar pattern, whereby the percentage increased from Grade 8 to Grade 10 (Grade 8 = 36.80%; Grade 9 = 38.10%; Grade 10 = 41.13%) and declined in Grade 11 (37.16%). The percentage of reciprocated friendships (approximately 40% in each grade) also indicated that the majority of friendship nominations were not reciprocated in the present study. This finding is in line with other studies that report the majority of friendship nominations to be unreciprocated in adolescence (e.g., Strauss & Pollack, 2003; Carbonaro & Workman, 2013). The increase in nominations and reciprocal friendships from Grade 8 to Grade 10, followed by a decline between Grade 10 and 11, may be a consequence of the Australian school system. In Australia, students transition from secondary to senior secondary school at the end of Grade 10, with disruptions to classroom and friendship group structures being typical during this time. Thus, the differences between Grades 10 and 11 may be a consequence of these disruptions. Table S1, in the Supplementary Materials, presents the descriptive statistics for the reciprocated friendships for each school across all grades. Overall, the pattern of results observed at the school level was similar to the pattern of results observed across the whole sample.

Non-Overlapping Friendship Groups

Roughly 80% of participants were identified by the infoMap algorithm as being a member of a friendship group in Grades 8, 9 and 10 (78.40%, 81.14% and 81.03% respectively) while only 71.39% of participants were identified as being a member of a

friendship group in Grade 11. The number of friendship groups identified in each grade was relatively stable for Grades 8 (n = 119), 9 (n = 188) and 10 (n = 186) before decreasing to 155 groups in Grade 11. The mean number of individuals in each friendship group was similar in Grade 8 (M = 12.0; range = 2-63), Grade 9 (M = 13.9; range = 2-105) and Grade 10 (M = 14.0; range = 2-58) and notably higher (M = 22.2; range = 2-145) in Grade 11. As noted for reciprocal friendships, the changes occurring between Grades 10 and 11 may be a consequence of the Australian school system and the changes to classroom and friendship group structures occurring at this time. Table S2, in the Supplementary Materials, presents the descriptive statistics for the friendship groups for each school across all time points.

Overlapping Friendship Groups

Approximately 80% of participants were identified as being a member of at least one friendship group by the linkcomm algorithm (Grade 8 = 77.59%; Grade 9 = 80.29%; Grade 10 = 82.07%; Grade 11 = 78.87%). The overall trend showed small increases in this percentage from Grade 8 to Grade 10, followed by a decrease in Grade 11, although the trend was less pronounced compared to the results produced by the infoMap algorithm. The number of friendship groups identified in each grade increased from Grade 8 (n = 498), to Grade 9 (n = 576) and Grade 10 (n = 543) before decreasing again in Grade 11 (n = 510). As noted above, it is possible that these differences between Grade 10 and Grade 11 may be a consequence of school transitions. Unlike the non-overlapping groups identified by infoMap, the average size of each group remained consistent across Grade 8 (M =6.02, range = 3-27), Grade 9 (M = 5.71, range = 3-37), Grade 10 (M = 5.93, range = 3-40), and Grade 11 (M = 5.84, range = 3-39). Notably, the average size of the overlapping friendship groups appeared to be smaller than that of the non-overlapping friendship groups. Table S3 in the Supplementary Materials presents the descriptive statistics, including number of groups and average group size, for the overlapping friendship groups for each school across all time

points. Moreover, just under half of all students who were identified as being a member of a friendship group (Grade 8 = 49.4%; Grade 9 = 49.4%; Grade 10 = 47.5%; and Grade 11 = 50.4%) belonged to more than one friendship group. The majority of students were members of 1-4 friendship groups, with 10 being the maximum number of friendship groups an individual was a member of, indicating a high degree of overlap in the present sample. Tables S4-S7 in the Supplementary Materials present the degree of overlap in friendship groups broken down by school and by grade, wherein similar patterns of overlap were observed at the school-level.

Descriptive Statistics

Means and Standard Deviations

Means and standard deviations for the individual aggression and individual mental ill-health variables are presented in Table 1. Notably, the means and standard deviations for these variables appear to be consistent across all grades. At the individual level, means of approximately 1.4 suggest that, on average, participants viewed the aggressive statements as being somewhat/sometimes true, and very true/often true. A mean of approximately 2 suggests that the participants were not experiencing more mental ill-health concerns than normal.

The means and standard deviations for group aggression and group mental ill-health are also presented in Table 1. For the reciprocal friendships and the non-overlapping friendship groups, the means and standard deviations for group aggression and group mental ill-health are comparable in magnitude to those for individual aggression and individual mental ill-health, respectively. Thus, reciprocal friendships and non-overlapping friendship groups also report moderate levels of aggressive behaviours and were not experiencing higher than usual mental ill-health. Notably, the mean scores and standard deviations for overlapping friendship groups were considerably lower, as a consequence of the weighting

procedures they underwent, and therefore, should not be directly compared to those of the reciprocal and non-overlapping friendship conceptualisations. Nevertheless, the levels of both aggression and mental ill-health in overlapping friendship groups were similar in all grades.

Table 1

Means and Standard Deviations for the Study Variables

		Grade 8 M(SD)	Grade 9 M(SD)	Grade 10 M(SD)	Grade 11 M(SD)
Individual Level	**Agg**	1.42 (0.35)	1.45 (0.40)	1.41 (0.35)	1.39 (0.33)
	GHQ	1.87 (0.53)	1.98 (0.55)	1.98 (0.55)	2.07 (0.58)
Reciprocal Friendships	**L2Agg**	1.41 (0.25)	1.43 (0.29)	1.39 (0.23)	1.37 (0.22)
	L2GHQ	1.86 (0.40)	1.98 (0.42)	1.97 (0.38)	2.04 (0.40)
Non-Overlapping Groups	**L2Agg**	1.43 (0.15)	1.45 (0.18)	1.41 (0.15)	1.39 (0.13)
	L2GHQ	1.87 (0.21)	1.87 (0.21)	1.98 (0.21)	2.07 (0.23)
Overlapping Groups	**L2Agg**	0.39 (0.30)	0.45 (0.38)	0.40 (0.32)	0.41 (0.32)
	L2GHQ	0.45 (0.38)	0.60 (0.49)	0.56 (0.45)	0.62 (0.50)

Note. Agg = Aggression; GHQ = Mental ill-health; L2Agg = friends' aggression; L2GHQ = friends' mental ill-health; *M* = mean; *SD* = standard deviation.

Aggression scale scoring: 1 = not true, 2 = sometimes or somewhat true, 3 = very true or often true. Mental ill-health scale scoring: 1 = better than usual, 2 = same as usual, 3 = worse than usual, 4 = much worse than usual.

The overlapping friendship group means are weighted and should not be directly compared to the means of other friendship group conceptualisations.

Correlation Coefficients

Table 2, Table 3, and Table 4 report the correlation coefficients of the study variables for reciprocal friends, non-overlapping and overlapping friendship groups, respectively. In psychology, researchers typically interpret the magnitude of correlation coefficients in line with Cohen's (1988; 1992) guidelines, wherein 0.10, 0.30 and 0.50 indicate small, medium and large effect sizes, respectively. However, these guidelines were arbitrarily chosen (Cohen, 1992) and are considered to be too stringent for use in psychological research (Funder & Ozer, 2019). More recently, Funder and Ozer (2019) have proposed revised guidelines for interpreting effect sizes, based on an empirical review of effect sizes published in psychological literature. Specifically, they propose that very small effect sizes ($r = 0.05$) can have important implications over time. Moreover, correlation coefficients of 0.10, 0.20, 0.30 and 0.40 reflect small, medium, large and very large effect sizes, respectively (Funder & Ozer, 2019).

At the individual level, large to very large positive correlation coefficients were observed for individual aggression between time points (range: .44 and .60), and individual mental ill-health between timepoints (range: .31 to .50), indicating that individual aggression and individual level mental ill-health were both stable over time. In addition, group aggression was found to be stable over time regardless of whether the friendships were conceptualised as being reciprocal friendships (range: .19 to .31; Table 2), non-overlapping groups (range: .28 to .41; Table 3) or overlapping groups (range: .15 to .27; Table 4), as evidenced by correlation coefficients of a medium to large magnitude. In addition, across all friendship group conceptualisations, correlation coefficients of a medium to large magnitude indicated that group mental ill-health was also stable over time (reciprocal range: .13 to .23; non-overlapping groups range: .24 to .37; overlapping groups range: .16 to .28). These correlation coefficients indicate a moderate to high degree of stability in all study variables

and suggest that if an individual or a group scored highly in either aggression or mental ill-health, then they tended to do so across all grades.

Positive correlations, ranging in size from small to very large, were also observed between individual aggression and group aggression for reciprocal friendships (range: .10 to .31: Table 2) and non-overlapping friendship groups (range: .19 to .46; Table 3), indicating that individuals with high levels of aggression were likely to also be in friendship groups with high levels of aggression. In contrast, the overall pattern of the correlation coefficients between individual aggression and group aggression appeared somewhat smaller in magnitude for the overlapping friendship groups, ranging from -.01 to .20 (Table 4), with a number of these correlations not being statistically significant. A similar pattern of results was observed between individual mental ill-health and group mental ill-health, whereby positive correlation coefficients, ranging from small to large, were observed for reciprocal friendships (range: .10 to .31; Table 2) and non-overlapping friendship groups (range: .14 to .39; Table 3) while small coefficients were observed for the overlapping friendship groups (range: -.01 to .12; Table 4). Taken together, these correlation coefficients indicate that associations exist between individual and group aggression, as well as individual and group mental ill-health.

At the individual level, positive medium to large sized correlation coefficients, ranging from .18 to .37, were observed between aggression and mental ill-health, indicating that an individual engaging in higher levels of aggression tended to also suffer from higher levels of mental ill-health. The strongest coefficients tended to be observed between variables within the same time point, for example, the coefficient between individual aggression at Time 1 and individual mental ill-health at Time 1 was stronger than that of individual aggression at Time 1 and individual mental ill-health at Time 2, 3 or 4. Similarly, group aggression and group mental ill-health were also positively correlated with each other for

both reciprocal friendships (range: .04 to .37; Table 2) and non-overlapping friendship groups (range: .03 to .37; Table 3). The coefficients that were very small in magnitude tended to be between different time points, while those that were large or very large tended to be within the same time point, e.g., group aggression at Time 2 and group mental ill-health at Time 2. Taken together, these results suggest that friendship groups with high levels of aggression also tended to have high levels of mental ill-health. However, for the overlapping friendship groups, a number of the correlation coefficients between group aggression and group mental ill-health were very large, ranging from .93 to .97 (Table 4). Correlations of this magnitude likely reflect a gross overestimation of the association between group aggression and group mental ill-health. When calculating group aggression and group mental ill-health scores for the overlapping friendship groups, individual aggression and mental ill-health scores can feature multiple times. For example, if an individual is a member of four friendship groups, then their aggression and mental ill-health scores are included four times, once for each friendship group they are a member of, when calculating group aggression and mental ill-health. As approximately half of the sample is a member of more than one friendship group there are many instances in which individual level data is included multiple times at the friendship group level. Thus, these correlations were likely artificially inflated due to a high degree of repetition in participant scores. Regardless, these large correlation coefficients are evidence of problematic levels of collinearity between group aggression and group mental ill-health. One consequence of high collinearity is that it becomes difficult to disentangle the effects of two independent variables, in this case group aggression and group mental ill-health, and it can generate problems in subsequent analysis and interpretation (Freckleton, 2011; Dormann et al., 2012).

Table 2

Correlation Coefficients Between Individual and Group Aggression and Mental Ill-Health for Reciprocal Friendships Across Four Time Points

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.Agg8	-														
2.Agg9	.59***	-													
3.Agg10	.50***	.60***	-												
4.Agg11	.44***	.53***	.58***	-											
5.GHQ8	.37***	.26***	.23***	.19***	-										
6.GHQ9	.26***	.36***	.20***	.18***	.50***	-									
7.GHQ10	.19***	.22***	.33***	.19***	.39***	.47***	-								
8.GHQ11	.18***	.20***	.21***	.28***	.31***	.41***	.48***	-							
9.L2Agg8	.22***	.17***	.17***	.15***	.09**	.07*	.11***	.06	-						
10.L2Agg9	.21***	.31***	.20***	.21***	.04	.14***	.07*	.05	.25***	-					
11.L2Agg10	.10***	.19***	.20***	.20***	-.01	.10***	.07**	.03	.19***	.31***	-				
12.L2Agg11	.13***	.15***	.14***	.15***	.09*	.04	.07*	.08**	.19***	.30***	.32***	-			
13.L2GHQ8	.09**	.07*	.04	.10**	.11***	.11***	.07*	.09**	.37***	.05	.04	.14***	-		
14.L2GHQ9	.04	.13***	.10***	.13***	.05	.14***	.11***	.13***	.08*	.41***	.12***	.10**	.17***	-	
15.L2GHQ10	.03	.07*	.05*	.12***	.01	.07**	.14***	.10**	.15***	.15***	.33***	.13***	.18***	.23***	-
16.L2GHQ11	.03	.10**	.07*	.08**	.10**	.14***	.15***	.19***	.14***	.17***	.10**	.26***	.13***	.19***	.22***

Notes. Agg8 = aggression in Grade 8; Agg9 = aggression in Grade 9; Agg10 = aggression in Grade 10; Agg11 = aggression in Grade 11; GHQ8 = mental ill-health in Grade 8; GHQ9 = mental ill-health in Grade 9; GHQ10 = mental ill-health in Grade 10; GHQ11 = mental ill-health in Grade 11; L2Agg8 = Friends' aggression in Grade 8; L2Agg9 = friends' aggression in Grade 9; L2Agg10 = friends' aggression in Grade 10; L2Agg11 = friends' aggression in Grade 11; L2GHQ8 = friends' mental ill-health in Grade 8; L2GHQ9 = friends' mental ill-health in Grade 9; L2GHQ10 = friends' mental ill-health in Grade 10; L2GHQ11 = friends' mental ill-health in Grade 11.

$* = p < .05$; $** = p < .01$; $*** = p < .001$

Table 3

Correlation Coefficients Between Individual and Group Aggression and Mental Ill-Health for Non-Overlapping Friendship Groups Across Four Time Points

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.Agg8	-														
2.Agg9	.59***	-													
3.Agg10	.50***	.60***	-												
4.Agg11	.44***	.53***	.58***	-											
5.GHQ8	.37***	.26***	.23***	.19***	-										
6.GHQ9	.26***	.36***	.20***	.18***	.50***	-									
7.GHQ10	.19***	.22***	.33***	.19***	.39***	.47***	-								
8.GHQ11	.18***	.20***	.21***	.28***	.31***	.41***	.48***	-							
9.L2Agg8	.42***	.26***	.20***	.24***	.14***	.07**	.12***	.06*	-						
10.L2Agg9	.22***	.46***	.27***	.22***	.07*	.14***	.09***	.07*	.36***	-					
11.L2Agg10	.19***	.31***	.43***	.27***	.04	.10***	.14***	.07**	.28***	.41***	-				
12.L2Agg11	.20***	.26***	.25***	.38***	.13***	.12***	.10***	.14***	.34***	.35***	.39***	-			
13.L2GHQ8	.16***	.07**	.07**	.13***	.39***	.20***	.20***	.19***	.36***	.07**	.03	.18***	-		
14.L2GHQ9	.09***	.17***	.09***	.13***	.19***	.36***	.22***	.18***	.14***	.37***	.13***	.16***	.31***	-	
15.L2GHQ10	.08**	.12***	.15***	.12***	.14***	.21***	.39***	.19***	.20***	.21***	.35***	.18***	.24***	.37***	-
16.L2GHQ11	.07**	.12***	.11***	.13***	.17***	.22***	.22***	.39***	.09***	.15***	.13***	.35***	.24***	.29***	.37***

Notes. Agg8 = aggression in Grade 8; Agg9 = aggression in Grade 9; Agg10 = aggression in Grade 10; Agg11 = aggression in Grade 11; GHQ8 = mental ill-health in Grade 8; GHQ9 = mental ill-health in Grade 9; GHQ10 = mental ill-health in Grade 10; GHQ11 = mental ill-health in Grade 11; L2Agg8 = Friends' aggression in Grade 8; L2Agg9 = friends' aggression in Grade 9; L2Agg10 = friends' aggression in Grade 10; L2Agg11 = friends' aggression in Grade 11; L2GHQ8 = friends' mental ill-health in Grade 8; L2GHQ9 = friends' mental ill-health in Grade 9; L2GHQ10 = friends' mental ill-health in Grade 10; L2GHQ11 = friends' mental ill-health in Grade 11.

$* = p < .05$; $** = p < .01$; $*** = p < .001$

Table 4

Correlation Coefficients Between Individual and Group Aggression and Mental Ill-Health for Overlapping Friendship Groups Across Four Time Points

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.Agg8	-														
2.Agg9	.59***	-													
3.Agg10	.50***	.60***	-												
4.Agg11	.44***	.53***	.58***	-											
5.GHQ8	.37***	.26***	.23***	0.19***	-										
6.GHQ9	.26***	.36***	.20***	0.18***	.50***	-									
7.GHQ10	.19***	.22***	.33***	0.19***	.39***	.47***	-								
8.GHQ11	.18***	.20***	.21***	0.28***	.31***	.41***	.48***	-							
9.L2Agg8	.04	.07*	.03	0.03	-.00	.04	.01	.01	-						
10.L2Agg9	.08**	.20***	.09***	0.13***	-.04	.06*	.03	.05	.24***	-					
11.L2Agg10	.09***	.04	.12***	0.11***	-.02	.02	.05*	-.01	.24***	.25***	-				
12.L2Agg11	.00	-.01	-.01	0.08**	.04	.045	.01	.05	.27***	.15***	.23***	-			
13.L2GHQ8	-.03	.01	.00	0.01	.06*	.08**	.05	.05	.93***	.19***	.23***	.28***	-		
14.L2GHQ9	.03	.11***	.05	0.09**	-.01	.12***	.06*	.08**	.24***	.96***	.27***	.17***	.21***	-	
15.L2GHQ10	.06*	.00	.06*	0.07*	.01	.04	.12***	.01	.24***	.25***	.97***	.23***	.24***	.28***	-
16.L2GHQ11	-.03	-.05	-.05	0.01	.05	.07**	.04	.12***	.25***	.13***	.18***	.97***	.28***	.16***	.20***

Notes. Agg8 = aggression in Grade 8; Agg9 = aggression in Grade 9; Agg10 = aggression in Grade 10; Agg11 = aggression in Grade 11; GHQ8 = mental ill-health in Grade 8; GHQ9 = mental ill-health in Grade 9; GHQ10 = mental ill-health in Grade 10; GHQ11 = mental ill-health in Grade 11; L2Agg8 = Friends' aggression in Grade 8; L2Agg9 = friends' aggression in Grade 9; L2Agg10 = friends' aggression in Grade 10; L2Agg11 = friends' aggression in Grade 11; L2GHQ8 = friends' mental ill-health in Grade 8; L2GHQ9 = friends' mental ill-health in Grade 9; L2GHQ10 = friends' mental ill-health in Grade 10; L2GHQ11 = friends' mental ill-health in Grade 11.

$* = p < .05$; $** = p < .01$; $*** = p < .001$

Multilevel Models

To address the research questions of this study, I estimated three sets of four multilevel models for the reciprocal friendships data, the non-overlapping friendship groups data, and the overlapping friendship groups data, the results for which are presented in Tables 5, 6, and 7, respectively. Lagged scores for individual aggression, individual mental ill-health, friendship group aggression, and friendship group mental ill-health were included as predictors. The outcome in each model differed: the outcome in Model 1 was individual aggression; the outcome in Model 2 was individual mental ill-health; the outcome in Model 3 was friendship group aggression; and the outcome in the final model, Model 4, was friendship group mental ill-health. Any effect of a lagged predictor score on the outcome variable would indicate the effect of the predictor at Time t on the outcome at t+1, accounting for the other effects in the model. Because individual and group level variables are covaried in the same model, the estimated effects represent the unique effect of the individual and the group level variables on outcomes. In each model, varying intercepts were used for students and time to account for the hierarchical nature of the data. Including students as a varying intercept in the model also prevents individual data being counted twice, once at the individual level and once at the group level, and thus, issues due to dependency do not arise. In addition, gender and school were both controlled for to account for exogenous effects. I chose to use fixed effects for schools because fixed effects do not assume a normal distribution across schools (Gelman & Hill, 2006). However, I also ran the same multilevel models with varying intercepts for school, instead of controlling for schools. The results for these models did not differ substantially depending on how the school variable was included in the model (see Supplementary Materials S7). Thus, I chose to report the results from the parsimonious models, wherein school was controlled for, in the following sections.

It is also important to note that in the results reported subsequently, mental ill-health results are consistently reported in a 'negative' direction, e.g., worse mental ill-health at the individual level is associated with worse mental ill-health at the group level. This decision was based on the literature that shows that mental ill-health and well-being are distinct constructs, as evidenced by weak correlations and the identification of a substantial number of individuals who experience good well-being and poor mental ill-health simultaneously (Sharpe et al., 2016; Kinderman et al., 2015; Patalay & Fitzsimons, 2016). Thus, low mental ill-health is not necessarily indicative of high well-being. Therefore, to avoid suggesting that lower levels of mental ill-health are reflective of a positive mental state, mental ill-health results are interpreted in a 'negative' direction in this thesis.

Stability of Study Variables

The autoregressive effects, i.e., the effect of a construct on itself measured at a later time, describe the stability of the study variables from one time point to the next. Regardless of how the friendship group was conceptualised, both individual aggression and individual mental ill-health were stable over time, as evidenced by positive autoregressive estimates and confidence intervals that did not include zero. For reciprocal (Table 5, Model 3), non-overlapping (Table 6, Model 3), and overlapping (Table 7, Model 3) friendships, group aggression was also stable over time. Thus, if a group engaged in high levels of aggressive behaviours, they tended to do so across all time points. Finally, friendship group mental ill-health was stable over time in reciprocal friendships (Table 5, Model 4) and non-overlapping friendship groups (Table 6, Model 4). However, as evidenced by a confidence interval that included zero, group mental ill-health was not stable over time in overlapping friendship groups (Table 7, Model 4). In sum, the study variables showed good stability over time irrespective of the friendship group conceptualisation, with the exception of group mental ill-health in overlapping friendship groups.

It is possible that smaller and sometimes non-significant autoregressive estimates in the overlapping friendship group models may be indicative of greater movement of individuals between friendship groups, which negatively impacts the stability of a group's aggression and mental ill-health levels. Alternatively, the stability estimates of the overlapping friendship groups, which differ from those of reciprocal friendships and non-overlapping groups, may be a consequence of the collinearity issues mentioned above.

Comparing the autoregressive estimates of the study variables also revealed some interesting patterns. Across all friendship conceptualisations, individual aggression was consistently found to be more stable than individual mental ill-health, as evidenced by larger estimates. The same pattern was also observed for group aggression and group mental ill-health, whereby the group aggression estimates tended to be larger than those of group mental ill-health. In addition, individual aggression tended to have higher levels of stability compared to group aggression, with the effect sizes for individual aggression being roughly double that of the effect sizes for group aggression for all friendship conceptualisations. Similarly, the effect sizes for individual mental ill-health were consistently larger than the effect sizes of friendship group mental ill-health in reciprocal, non-overlapping, and overlapping friendships. Thus, taken together, aggression appeared to be more stable than mental ill-health, and individual characteristics appeared to be more stable than group characteristics.

Aggression

For reciprocal and non-overlapping friendship conceptualisations, individual aggression predicted subsequent group aggression, as evidenced by a positive effect size and a confidence interval that did not include zero (see Table 5, Model 3, and Table 6, Model 3 for reciprocal friends, and non-overlapping groups respectively). This suggests that if an individual is more aggressive than usual, compared to their typical year (random intercept),

then their friends will be unusually aggressive a year later. In contrast, individual aggression was not found to predict subsequent group aggression in overlapping friendship groups, as evidenced by a confidence interval that included zero (Table 7, Model 3).

Notably, lagged group aggression was not found to predict future individual aggression in reciprocated friendships (Table 5, Model 1), non-overlapping friendships (Table 6, Model 1), or overlapping friendship groups (Table 7, Model 1). Thus, regardless of how the friendship groups were conceptualised, hypothesis 1, which postulated that higher than usual levels of group aggression would positively influence subsequent individual aggression levels, was not supported. Specifically, while there was an association between individual and group aggression, it was not in the hypothesised direction. Instead, the results suggest that if an individual engages in higher than usual levels of aggressive behaviours, then their friendship group will also engage in more aggressive behaviours one year later.

Mental Ill-Health

Regarding mental ill-health, the results differed depending on the way friendships were conceptualised. For reciprocated friendships, no associations were observed between individual mental ill-health and group mental ill-health. More specifically, individual mental ill-health did not predict subsequent group mental ill-health (Table 5, Model 4) and group mental ill-health did not predict subsequent individual mental ill-health (Table 5, Model 2), as evidenced by confidence intervals that included zero.

For non-overlapping friendship groups, individual mental ill-health predicted subsequent group mental ill-health (Table 6, Model 4), whereby if an individual had worse mental ill-health than usual, then their group would develop worse mental ill-health than usual a year later. However, the converse of this relation was not found. In other words, group mental ill-health did not predict future individual mental ill-health (Table 6, Model 2) in non-overlapping friendship groups.

In overlapping friendship groups, lagged group mental ill-health was found to negatively predict subsequent individual mental ill-health (Table 7, Model 2), whereby if a friendship group had higher levels of mental ill-health than usual, then the individual would experience lower levels of subsequent mental ill-health one year later. No evidence was found for the converse of this relation, namely individual mental ill-health did not predict subsequent group mental ill-health in overlapping friendship groups.

In sum, the second hypothesis, which stated that group mental ill-health would positively predict individual mental ill-health was not supported in the present study. Instead, group mental ill-health was found to negatively predict individual mental ill-health, and individual mental ill-health was found to positively predict group mental ill-health. Moreover, the relation between individual mental ill-health and group mental ill-health appears to differ depending on how friendships are conceptualised, suggesting that different processes of peer influence may be occurring for different friendship conceptualisations.

Links Between Aggression and Mental Ill-Health

One of the key questions of my research was the extent to which aggression and mental ill-health at the individual and group levels influence each other over time. Looking first at individual level aggression and mental ill-health, lagged individual aggression was found to predict subsequent individual mental ill-health, regardless of whether friendships were conceptualised as reciprocal (Table 5 Model 2), non-overlapping (Table 6, Model 2) or non-overlapping (Table 7, Model 2). Thus, if a person experienced unusually high levels of aggression in one year, they tended to experience unusually high levels of mental health problems in subsequent years, supporting the third hypothesis of the present study. Notably, regardless of how friendships were conceptualised, if an individual experienced unusually high levels of mental ill-health, this did not influence their subsequent aggressive behaviours.

Taken together, these results suggest that aggression is a risk factor for subsequent mental ill-health.

At the group level, no relations were observed between group aggression and group mental ill-health for reciprocal friendships (Table 5 Model 3 and Model 4) or for overlapping friendship groups (Table 7 Model 3 and Model 4), as evidenced by confidence intervals that included zero. Thus, hypothesis 4, which posited that higher than usual group aggression would positively predict future higher than usual group mental ill-health, was not supported for reciprocal friendships and overlapping friendship group conceptualisations.

However, for non-overlapping friendship groups, lagged group aggression was found to positively predict group mental ill-health (Table 6, Model 4), supporting the fourth hypothesis of this study. In other words, groups that were unusually aggressive tended to experience unusually high levels of mental health problems a year later. In addition, as can be seen in Table 6, Model 3, a negative association exists between lagged group mental ill-health and group aggression, which suggests that groups that experienced unusually high mental health problems became less aggressive a year later. These results, taken together, suggest that there may be a homeostatic process happening at the non-overlapping group level, whereby aggressive friendship groups develop worse mental health which in turn decreases their levels of aggression.

For all conceptualisations of friendship, no relation was observed between lagged individual aggression and group mental ill-health, nor was any association observed between lagged mental ill-health and future group aggression. In addition, lagged group mental ill-health was not found to predict future individual aggression, with the exception of the reciprocal friendship conceptualisation (Table 5 Model 1). More specifically, if an individual's reciprocated friends experienced unusually high mental ill-health, they were likely to become more aggressive in the future. It is possible that an individual is exposed to

their reciprocated friends' mental ill-health problems to a greater extent than the mental ill-health of their broader friendship group, which increases the influencing capacity of reciprocated friendships' mental ill-health on an individual's subsequent aggressive behaviour. Group aggression was found to positively predict subsequent individual mental ill-health, only when friendships were conceptualised as overlapping groups (Table 7, Model 2). In other words, if an individual was a member of a group with higher than usual levels of aggression, they tended to suffer from worse than usual mental ill-health one year later. Thus, when friendships are conceptualised as overlapping groups, the aggressive behaviours of an individual's group negatively impact their own mental ill-health.

In response to the numerous results outlined above, Table 8 presents a summary of all the findings from the multilevel models presented in this chapter. More specifically, Table 8 summarises the analysis, with a particular focus on how group aggression and group mental ill-health scores are calculated for each friendship conceptualisation. Table 8 also indicates the direction of the associations between the study variables, in addition to indicating which results were statistically significant.

Table 5

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using Reciprocated Friendships

Variables at T	Estimate	SE	Confidence Interval	
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.615**	**0.013**	**0.589**	**0.642**
Individual Mental Ill-Health	0.021	0.016	-0.012	0.054
Group Aggression	0.022	0.018	-0.017	0.061
Group Mental Ill-Health	**0.037**	**0.014**	**0.010**	**0.064**
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.105**	**0.016**	**0.074**	**0.137**
Individual Mental Ill-Health	**0.442**	**0.017**	**0.407**	**0.477**
Group Aggression	-0.030	0.023	-0.080	0.020
Group Mental Ill-Health	0.019	0.015	-0.012	0.050
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.111**	**0.026**	**0.055**	**0.168**
Individual Mental Ill-Health	0.006	0.020	-0.034	0.047
Group Aggression	**0.288**	**0.029**	**0.224**	**0.351**
Group Mental Ill-Health	-0.043	0.028	-0.102	0.016
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.020	0.017	-0.016	0.056
Individual Mental Ill-Health	0.018	0.018	-0.018	0.054
Group Aggression	0.033	0.022	-0.013	0.079
Group Mental Ill-Health	**0.154**	**0.025**	**0.101**	**0.207**

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 6

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the infoMap Non-Overlapping Friendship Groups

Variables at T	Estimate	SE	Confidence Interval	
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.598**	**0.017**	**0.563**	**0.634**
Individual Mental Ill-Health	0.031	0.016	-0.001	0.063
Group Aggression	0.012	0.014	-0.017	0.041
Group Mental Ill-Health	-0.030	0.019	-0.071	0.010
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.104**	**0.014**	**0.076**	**0.133**
Individual Mental Ill-Health	**0.439**	**0.018**	**0.402**	**0.477**
Group Aggression	-0.023	0.016	-0.055	0.009
Group Mental Ill-Health	-0.004	0.017	-0.039	0.031
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.111**	**0.014**	**0.085**	**0.138**
Individual Mental Ill-Health	0.008	0.015	-0.021	0.038
Group Aggression	**0.325**	**0.018**	**0.288**	**0.382**
Group Mental Ill-Health	**-0.062**	**0.020**	**-0.102**	**-0.022**
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.026	0.014	-0.003	0.054
Individual Mental Ill-Health	**0.063**	**0.014**	**0.035**	**0.090**
Group Aggression	**0.035**	**0.014**	**0.007**	**0.062**
Group Mental Ill-health	**0.207**	**0.015**	**0.177**	**0.237**

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 7

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the linkcomm Overlapping Friendship Groups

Variables at T	Estimate	SE	Confidence Interval	
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.606**	**0.023**	**0.556**	**0.656**
Individual Mental Ill-Health	0.041	0.021	-0.005	0.086
Group Aggression	0.065	0.062	-0.065	0.195
Group Mental Ill-Health	-0.053	0.065	-0.200	0.074
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.087**	**0.020**	**0.044**	**0.130**
Individual Mental Ill-Health	**0.466**	**0.021**	**0.421**	**0.511**
Group Aggression	**0.125**	**0.060**	**0.001**	**0.250**
Group Mental Ill-Health	**-0.152**	**0.060**	**-0.276**	**-0.028**
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	0.019	0.021	-0.024	0.061
Individual Mental Ill-Health	-0.034	0.025	-0.087	0.019
Group Aggression	**0.215**	**0.090**	**0.023**	**0.407**
Group Mental Ill-Health	-0.016	0.097	-0.224	0.191
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	-0.025	0.020	-0.067	0.017
Individual Mental Ill-Health	-0.004	0.024	-0.055	0.046
Group Aggression	0.049	0.082	-0.126	0.223
Group Mental Ill-Health	0.155	0.090	-0.036	0.346

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 8

Summary table of the multilevel model results from Study 1

	Variables at T	Variables at T+1			
		Agg	GHQ	L2Agg	L2GHQ
Reciprocal friendships: L2Agg and L2GHQ scores computed as the average self-reported aggression and mental ill-health scores, respectively, across all reciprocated friends of each participant.	Agg	+	+	+	+
	GHQ	+	+	+	+
	L2Agg	+	-	+	+
	L2GHQ	+	+	-	+
Non-overlapping groups: L2Agg and L2GHQ computed as the average of the aggression and mental ill-health scores across all members in an individual's non-overlapping friendship group.	Agg	+	+	+	+
	GHQ	+	+	+	+
	L2Agg	+	-	+	+
	L2GHQ	-	-	-	+
Overlapping groups: L2Agg and L2GHQ scores were computed as the average aggression and mental ill-health scores, respectively, across the multiple groups an individual belongs to, weighted by the size of each group.	Agg	+	+	+	-
	GHQ	+	+	-	-
	L2Agg	+	+	+	+
	L2GHQ	-	-	-	+

Notes. T= time; Agg = Aggression; GHQ = mental ill-health; L2Agg = friends' aggression;

L2GHQ = friends' mental ill-health; + = a positive estimate; - = a negative estimate

Dark shaded boxes are those for which there was a significant estimate between the variables.

<center>**Discussion**</center>

The primary aim of the present study was to examine the relations between aggression and mental ill-health over time in the context of friendship groups. More specifically, I investigated the associations between individual and friendship group levels of aggression and mental ill-health over time in a large longitudinal sample of Australian youth. I also compared the consequences of using different friendship conceptualisations on clarifying the substantive questions in relation to individual and group aggression and mental ill-health. The results of the present study uniquely contribute to the literature in both substantive and methodological ways, as discussed below.

Aggression

A positive relation was found between individual aggression and group aggression when the friendships were conceptualised as being either reciprocal or non-overlapping. More specifically, if an individual's level of aggression was higher than usual, then their friendship group tended to subsequently engage in higher than usual levels of aggression, controlling for prior levels of group aggression. Notably, when the overlapping friendship group conceptualisation was used, individual aggression did not predict subsequent group aggression, nor did group aggression predict subsequent individual aggression. Thus, the first hypothesis of this study, which stated that group aggression would positively predict individual aggression, was not supported. Instead, individual aggression was found to positively predict group aggression for some, but not all, friendship group conceptualisations. This finding contrasts with past literature, which consistently reports that friendship group aggression predicts subsequent individual aggression (e.g., Espelage et al., 2003; Low et al., 2013; Werner & Crick, 2004; Werner & Hill, 2010). However, many of the studies that have investigated peer influence processes for aggression have only examined the predictors of individual aggressive behaviours, and not the predictors of a group's aggressive behaviours

(e.g., Low et al., 2013; Werner & Hill, 2010). For example, Espelage et al. (2003) only measured group aggression at Time 1 to be used as a predictor of individual aggression at Time 2. Thus, whether individual aggression influences group aggression over time has not been adequately investigated in the literature. This study provides preliminary evidence that levels of individual aggression can influence subsequent group levels of aggression.

Mental Ill-Health

The associations between individual mental ill-health and group mental ill-health differed depending on how the friendship groups were conceptualised, suggesting that peer influence processes for mental ill-health may operate differently across different conceptualisations of friendships. When reciprocal friendships were used to calculate group mental ill-health scores, individual mental ill-health did not predict subsequent group mental ill-health, nor did group mental ill-health predict individual mental ill-health.

In contrast, for non-overlapping friendship groups, if an individual had higher than usual levels of mental ill-health, then their group was likely to suffer from higher than usual levels of mental ill-health one year later. Although most studies report that group mental ill-health is a predictor of future individual mental ill-health, (e.g., Giletta et al., 2011; Prinstein, 2007), there are some studies that have also found evidence of individual mental ill-health influencing group mental ill-health over time (e.g., Goodwin et al., 2012).

For the overlapping friendship group conceptualisation, if an individual's group experienced higher levels of mental ill-health, then the individual tended to have lower levels of mental ill-health one year later. Thus, the second hypothesis, which stated that group mental ill-health would positively predict individual mental ill-health, was not supported in this study. Instead, for overlapping groups, group mental ill-health predicted subsequent lower levels of individual mental ill-health.

Aggression and Mental Ill-Health

At the individual level, aggression was found to positively predict subsequent mental ill-health one year later. More specifically, if an individual engaged in more aggressive behaviours than usual, then they would experience higher levels of subsequent mental ill-health than usual. Moreover, individual mental ill-health was not found to predict future individual aggression. Thus, the third hypothesis of the present study, which predicted that aggression was a risk factor for future mental ill-health, was supported in this study. These results support the failure model (Capaldi, 1992; Patterson & Capaldi, 1990; Patterson & Stoolmiller, 1991), which argues that mental ill-health is a consequence of engaging in aggressive behaviours, as well as numerous empirical studies that also found aggression to be a risk factor for mental ill-health (e.g., Crick et al., 2006; Moilanen et al., 2010).

At the group level, no associations were observed between group aggression and group mental ill-health when these variables were calculated using the reciprocal friendships or the overlapping friendship groups. However, when non-overlapping friendship groups were examined, group aggression was found to predict group mental ill-health, supporting the fourth hypothesis of this study. More specifically, groups who engaged in unusually high levels of aggression tended to suffer from worse than usual levels of mental ill-health one year later. Thus, the process by which aggression causes mental ill-health at the individual level may also be present at the group level for non-overlapping friendship groups. Moreover, another novel association was observed at the group level, whereby higher than usual levels of group mental ill-health predicted lower than usual levels of group aggression at subsequent time points in non-overlapping friendship groups. These results, taken together, suggest that a homeostatic process may be happening at the non-overlapping group level, whereby aggressive friendship groups develop worse mental health which in turn decreases their levels of aggression.

Friendship Groups

I have presented the results based on three conceptualisations of friendships. One might wonder which one of these is the 'true' friendship conceptualisation. However, that kind of thinking assumes that there is only one 'real' friendship group conceptualisation. One of the insights from my thesis is that it is useful to consider different operationalisations of friendship groups. Some psychological processes may be operating at friendship groups of one kind but not the other. This means that all three conceptualisations are 'true'. Thus, it is informative to compare the results of reciprocal friendships, non-overlapping friendship groups, and overlapping friendship groups to better inform the literature. Interestingly, the results differed depending on how the friendship groups were conceptualised, in terms of both effect sizes and the directions of the associations. Thus, these results support the fifth hypothesis of the present study, which stated that the results would differ depending on how the friendships were conceptualised. In addition, these results also provide preliminary evidence for what the differences between conceptualisations might be. However, it is also important to note that the potential for Type I errors, whereby the null hypothesis is incorrectly rejected, increases for results not based on an a priori hypothesis, as was the case for this hypothesis (Keselman et al., 2002; Ruxton & Beauchamp, 2008).

Taking a closer look, the reciprocal friendship conceptualisation yielded fewer statistically significant group effects. With the exception of individual aggression predicting subsequent group aggression, no associations were found between individual mental ill-health and group mental ill-health, or between group aggression and group mental ill-health. In contrast, when non-overlapping friendship groups were considered, group level effects were found between individual and group aggression, individual and group mental ill-health and also between group aggression and group mental ill-health. Perhaps the broader group

structures captured by the non-overlapping friendship groups play a role in the associations with group level variables, beyond the influence of reciprocated friendships.

While few group effects were observed for the overlapping group conceptualisation, some concerning results indicate that further research is needed to understand the cause. More specifically, large correlation coefficients, indicative of problematic levels of collinearity, were observed between group aggression and group mental ill-health (Mason & Perreault, 1991). One consequence of collinearity is that theoretically 'important' variables may have insignificant coefficients when analysed (Dormann et al., 2013; Freckleton, 2011; Mason & Perreault, 1991). This is particularly relevant to this study, as group mental ill-health was not found to be stable over time for the overlapping friendship groups. This finding is in contrast to past literature suggesting group mental ill-health should be stable over time (e.g., Giletta et al., 2011; Goodwin et al., 2012) and also contrasts with the results from the well-established reciprocal friendship dyad and non-overlapping friendship group conceptualisations. Taken together, these concerns led me to explore, in the next study, alternative ways of conceptualising overlapping friendship groups.

Chapter Summary

In this fourth chapter, I investigated the relations between individual and group aggression and mental ill-health over time. In this study, individual aggression and individual mental ill-health were found to predict subsequent group aggression and group mental ill-health, respectively. Thus, peer influences processes, whereby the individual was influencing their peers, were occurring for both aggression and mental ill-health. In addition, I found support for the failure model which states that aggression is a risk factor for subsequent mental ill-health. Of particular interest was a novel homeostatic process that was observed at the group level in the non-overlapping friendship groups, whereby groups who engaged in

higher than usual levels of aggression suffered worse than usual mental ill-health one year later, which subsequently resulted in the group engaging in fewer aggressive behaviours.

Moreover, this study aimed to make a methodological contribution to the literature by comparing the consequences of using reciprocal, non-overlapping, and overlapping friendship conceptualisations on the relations between aggression and mental ill-health. Interestingly, the associations between individual and group aggression and mental ill-health differed depending on which friendship group conceptualisation was used, indicating that peer influence processes may operate differently depending on how friendships are conceptualised. Compared to reciprocal friendships, the results from the non-overlapping friendship group conceptualisation yielded more group level relations. Perhaps additional group norms, rules, or structures were captured at the group level that had a unique influence on aggression and mental ill-health. High levels of collinearity between group aggression and group mental ill-health were observed for the overlapping friendship groups, calling into question their validity as a friendship group conceptualisation. Thus, further investigation was warranted, which will be the focus of the second study of this thesis.

Chapter 5: Study 2

Exploring Problematic Levels of Collinearity in the Overlapping Friendship Groups

Introduction

Thus far, this thesis has contributed to the literature both substantively and methodologically. Substantively, the results of Study 1 (presented in Chapter 4) demonstrated associations between individual and group aggression and mental ill-health in the context of friendship groups. Specifically, individuals who engaged in higher than usual levels of aggression tended to be a member of a friendship group with higher than usual levels of aggression one year later. Similar results were observed for mental ill-health, whereby if an individual suffered from higher than usual levels of mental ill-health, this positively predicted their friendship group suffering from worse mental ill-health one year later. Thus, as expected, peer influence processes were occurring for both aggression and mental ill-health. Moreover, at the individual level, engaging in aggressive behaviours predicted higher levels of mental ill-health one year later, supporting the literature arguing that aggression is a risk factor for mental ill-health. A similar process was observed, for the first time, at the group level, whereby groups that engaged in more aggressive behaviours than usual suffered worse mental ill-health than usual one year later. Interestingly, higher than usual levels of group mental ill-health predicted lower than usual levels of group aggression at subsequent time points. These friendship group level results indicate that there may be a homeostatic process happening, whereby aggressive friendship groups develop worse mental health which in turn decreases their levels of aggression over time.

However, the above results were not observed across all friendship group conceptualisations. For example, the homeostatic process between group aggression and group mental ill-health was only found for non-overlapping friendship groups. In addition, individual mental ill-health did not predict subsequent group mental ill-health when

friendships were conceptualised as being reciprocated. Thus, methodologically, Chapter 4 shed light on the consequences of using different friendship conceptualisations. Specifically, in the context of aggression and mental ill-health, different peer influence processes appear to be operating across different friendship group conceptualisations.

Regarding the differing results between friendship conceptualisations, some unexpected findings for the overlapping friendship groups were of particular interest. First, there was evidence of collinearity, in the form of very large correlation coefficients (range: .93 to .97), between the group aggression and group mental ill-health variables. Second, the group mental ill-health autoregressive estimate was insignificant, indicating that group mental ill-health was not stable over time, a finding which is inconsistent with past literature (e.g., Goodwin et al., 2012) and the other well-established friendship conceptualisations (Chapter 4). It may be that mental ill-health stability at the group level is an example of a peer influence process occurring in some friendship conceptualisations and not others. However, given the high levels of collinearity observed, and that collinearity can consequently result in theoretically 'important' estimates being statistically non-significant, this finding warrants further examination. Taken together, these concerns call into question the validity of the results for the overlapping friendship group conceptualisation. Thus, the main aim of this chapter is to further explore the results of the overlapping friendship groups.

Collinearity

Collinearity refers to non-independence between predictor variables (Alin, 2010; Mason & Perreault, 1991). Some degree of collinearity is almost always present between predictor variables and, thus, one has to determine the point at which the degree of collinearity becomes problematic. Cut-offs of .80 or .90 for correlation coefficients are commonly used as indicators of problematic collinearity (Mason & Perreault, 1991). As reported in Chapter 4, for the overlapping friendship groups, very large correlation

coefficients, ranging from .93 to .97 were observed between group aggression and group

mental ill-health within the same time point, i.e., group aggression at Time 2 and group

mental ill-health at Time 2. Thus, a near perfect linear association was observed between

group aggression and group mental ill-health, indicating problematic levels of collinearity.

Collinearity must be addressed when data are analysed, particularly when using general linear

modelling methods, including multilevel modelling methods used in Chapter 4. This is

because it has the potential to cause a number of undesirable consequences. For example, if

two highly collinear variables are both correlated with the outcome variable, it is not

possible, without further information, to determine which is the true predictor of the outcome.

In addition, parameter estimates may change dramatically despite negligible changes to the

size or characteristics of the sample. Moreover, parameter estimates can have signs that are

theoretically incorrect and estimates for theoretically 'important' variables may be

statistically non-significant (Dormann et al., 2013; Freckleton, 2011; Mason & Perreault,

1991).

  Of particular relevance to the present thesis is the potential for theoretically

'important' variables to have non-significant coefficients when collinearity is an issue

(Dormann et al., 2013; Freckleton, 2011; Mason & Perreault, 1991). More specifically, for

the overlapping friendship groups, the stability estimate for group mental ill-health was found

to be statistically non-significant in Study 1 (Chapter 4), a finding that is inconsistent with

past research. For example, Goodwin et al. (2012) analysed the stability of friends'

depressive symptoms in a series of cross-lagged models. Positive and statistically significant

autoregressive paths were observed between Grade 7 and Grade 8 and also between Grade 9

and Grade 10, indicating that friends' depression levels were stable over time between some

grades. Mental ill-health has also been found to be stable at the individual level during

adolescence (e.g., Charman, 1994; Patalay & Fitzsimons, 2018). For example, Holsen et al.

(2000) found that over the course of six years, there was a tendency for adolescent's levels of depressed mood to remain stable. Moreover, Prenoveau et al. (2011) found both anxiety and depression to be stable over time in an adolescent sample. Thus, if friendship groups levels of mental ill-health are stable over time, and the mental ill-health of the individuals within those groups is stable over time, then mental ill-health of the friendship group should also be stable over time in this thesis. Finally, group mental ill-health was found to be stable in both the reciprocal friendships and the non-overlapping friendship group conceptualisations in Study 1 (Chapter 4). Both of these friendship conceptualisation methods are well-established in the literature (e.g., Newcomb & Bagwell, 1995; Newman & Girvan, 2004; Sales-Pardo et al., 2007), compared to overlapping friendship group methods which are comparatively newer, thus lending greater support for group mental ill-health being stable over time. Consequently, further research is needed to address the collinearity issues observed in the overlapping friendship group conceptualisation.

Weighting the Overlapping Friendship Groups

As problematic collinearity was only observed in the overlapping friendship groups, it suggests that it may be a product of the weighting procedure used, a procedure that neither the reciprocal friendships nor non-overlapping friendship group conceptualisations underwent. There are two aspects of the weighting procedure which may be causing the collinearity issues, both of which will be tested in the present study. The first is the metric that is being used to weight the groups, and the second is the weighting procedure itself. Both the weighting metric and the weighting procedure will be discussed below, with alternative approaches being outlined for both.

Weighting Metric

In Chapter 4, for the overlapping friendship groups, I created aggregated group aggression and group mental ill-health scores by weighting the overlapping groups an

individual was a member of by size (see Methods section in Chapter 4 for a more detailed description). Larger weights were attributed to the group aggression and group mental ill-health scores of bigger groups. This method was first used by Sahdra et al. (2020) to investigate the levels of felt discrimination in adolescent friendship groups. I chose this method as it has been used in past research by Sahdra et al. (2020) and is, thus, already established in the literature. Moreover, it has the added benefit of using all available data from the multiple groups an individual is a member of.

When weighting friendship groups by size, it is assumed that groups do not exert an equal influence on an individual. Specifically, size-weighting assumes that the more people in a group, the more influence the group will exert on the individual. However, there does not appear to be a clear link between group size and degree of influence. There is evidence to suggest that as friendship groups get larger, they become less cohesive (Değirmencioğlu et al., 1998). Therefore, it may be that an individual within a larger group interacts with some group members infrequently, thus reducing said group members' capacity to influence the individual. Moreover, it has been reported that in larger friendship groups, the level of intimacy between group members decreases (Roberts et al., 2009; Brewer & Webster, 2000; Sokolovska et al., 2016). Intimate friends (e.g., best friendships) have been found to exert a greater degree of influence on an individual, compared with less intimate friends (e.g., peer group members; Brown et al., 1997; Epstein & Karweit, 1983; Hussong, 2002). Thus, if larger friendship groups are composed of less intimate group members, it may not be the case that larger groups are more influential than smaller groups. In conclusion, attributing a greater weight to larger groups may not be the most theoretically appropriate method for investigating peer influence in the context of aggression and mental ill-health.

Instead, it may be more suitable to weight the groups based on a more reliable measure of the degree to which they are likely to influence individual levels of aggression

and mental ill-health. It is widely reported that youth are significantly influenced by peers who they themselves have nominated as being their friends, regardless of whether those friendships are reciprocated (Aloise-Young et al., 1994; Faris & Ennett, 2012). Given that youth are influenced by the behaviours of those whom they identify as being their friends, by extension, an influential group could be defined as one wherein an adolescent has identified a number of the group members as friends. Arguably, the more friends an adolescent nominates within a group, the more influence that group may have on that individual. Thus, in the present study, I will further examine the overlapping friendship group conceptualisation by weighting individuals' friendship groups by the number of friends they have nominated in the groups, a metric known as outdegree in the social network literature. More specifically, bigger weights will be attributed to groups for which an individual has a larger outdegree score.

Weighting Procedure

Alternatively, it may be that the weighting procedure itself is the cause of the collinearity issues. By nature of the overlapping groups, individual data can feature multiple times when calculating group aggression and group mental ill-health scores, which is likely to inflate the correlation coefficients. For example, if an individual is a member of four friendship groups, then their aggression and mental ill-health scores are included four times, once for each friendship group they are a member of, thus resulting in repetition in participant scores at the group level. Moreover, as approximately half of the sample is a member of more than one friendship group, there are many instances in which individual level data is included multiple times at the friendship group level. Also, from a theoretical perspective, it may not be appropriate to include all of the friendship groups of a participant when calculating group level variables for them. Perhaps, when examining multiple overlapping friendship groups, some groups are quite tangential to the young person's life

and are, therefore, not particularly influential. As a result, including non-influential friendship groups in the study of peer influence may be diluting the effects of the influential friendship groups in the analysis.

Thus, in order to address potential collinearity issues, as well as remove tangential groups from the analysis, I focused on each individual's 'best' group. As it currently remains unclear whether group size or number of nominated friends, i.e., outdegree, is a more appropriate metric by which to examine overlapping friendship groups, I define the 'best' group in two different ways: first as an individual's biggest group in terms of size; and second as an individual's most influential group based on the number of friends they nominated in the group, i.e., outdegree.

The Present Study

The main aim of this study is to address problematic levels of collinearity observed between group aggression and group mental ill-health when the overlapping friendship groups are weighted by size in Chapter 4. Specifically, three additional friendship group conceptualisations are explored in this chapter: overlapping friendship groups weighted by outdegree; biggest groups in terms of size; and most influential groups in terms of outdegree.

Research Questions and Hypotheses

In addition to testing the substantive hypotheses regarding the links between individual and group aggression and mental ill-health, presented in Chapter 4, in the current study I will also investigate two additional research questions, which are described in detail below.

Research Question 1

Will the collinearity issues be resolved when the overlapping friendship groups are weighted by influence, i.e., outdegree, instead of size?

Hypothesis 1

Theoretically, weighting the overlapping friendship groups by size may not be appropriate for the purposes of investigating peer influence processes (e.g., Değirmencioğlu et al., 1998; Hussong, 2002; Sokolocska et al., 2016). A more appropriate metric by which to weight the groups may be the extent to which they influence the individual (Aloise-Young et al., 1994; Faris & Ennett, 2012), which can be conceptualised using the outdegree metric. Thus, I hypothesised that weighting the overlapping friendship groups by outdegree would resolve the problematic levels of collinearity between group aggression and group mental ill-health.

Research Question 2

Will the collinearity issues be resolved when friendship groups are conceptualised as the biggest groups or as the most influential groups?

Hypothesis 2

The large correlation coefficients observed between group aggression and group mental ill-health in Chapter 4 may be a consequence of the repetition of individual scores when calculating group variable scores. To address this repetition, I focused on each individual's single 'best' group, defined in two ways: first as the biggest group an individual was a member of; and second as an individual's most influential group. I hypothesised that the collinearity issues would be resolved by conceptualising overlapping friendship groups as an individual's biggest group and also as an individual's most influential group.

Method

Participants

The present study used the same sample of participants as Chapter 4. Briefly, the sample consisted of 2,865 students (50.4% female), from 17 Catholic high schools in Australia. The sample was broadly representative in terms of geographical location and

socioeconomic status. Participants completed measures of aggression, mental ill-health, and friendship nominations in Grade 8, Grade 9, Grade 10 and Grade 11. More detailed information about the participants and the procedure is reported in the Method section of Chapter 4.

Instruments

Aggression

Aggression was measured using the 16-item aggression subscale of Achenbach's (1991) Youth Self-Report Inventory. A more detailed description of the aggression scale can be found in the Methods section of Chapter 4.

Mental Ill-Health

As with Study 1, mental ill-health was measured using the 12-item General Health Questionnaire (GHQ-12; Goldberg & Hillier, 1979). A more detailed description of the GHQ-12 can be found in Chapter 4.

Friendship Nominations

Friendship nominations were collected using a modified version of Coie et al.'s (1982) nomination procedure whereby participants were asked to nominate five of their closest male and female friends. A more detailed account of the nomination procedure is provided in Chapter 4.

Weighting the Overlapping Friendship Groups

The overlapping friendship groups identified using the linkcomm algorithm (Kalinka & Tomancak, 2011) in Chapter 4 were also used in the present study. Chapter 4 provides a detailed description of the data preparation process, as well as the linkcomm algorithm itself. Moreover, Chapter 4 contains detailed descriptive statistics for the number of groups found by the linkcomm algorithm as well as the degree of overlap (see also section S6 in the Supplementary Materials). Briefly, the linkcomm algorithm produced 498 groups in Grade 8,

576 groups in Grade 9, 543 groups in Grade 10, and 510 groups in Grade 11. Just under half of all students who were identified as being a member of a friendship group (Grade 8 = 49.4%; Grade 9 = 49.4%; Grade 10 = 47.5%; and Grade 11 = 50.4%) belonged to more than one friendship group, with the majority of students being a member of between one and four groups.

Using this friendship group data, three friendship conceptualisations were then derived for the present study: (i) groups weighted by outdegree; (ii) biggest groups; and (iii) most influential groups. For the first friendship group conceptualisation, group aggression and group mental ill-health scores were calculated as the average aggression and mental ill-health scores, respectively, of the multiple groups an individual belonged to, weighted by the number of friendship nominations an individual made in each of their groups, i.e., outdegree. Larger weights were attributed to groups for which the individual had a higher outdegree score. In other words, larger weights were given to the most influential groups. For the second friendship group conceptualisation, of all the groups an individual was a member of, only the largest group was selected, and the average aggression and mental ill-health scores of that group's members were used for subsequent analyses. A similar process was used for the final group conceptualisation, whereby only an individual's most influential group, i.e., the group for which the individual has the highest outdegree score, was selected. Group aggression and group mental ill-health scores were then calculated as the average of that group's members' aggression and mental ill-health scores, which were then used for subsequent analyses.

Once group aggression and group mental ill-health scores were recalculated using the different weighting metric and different weighting procedure, the rest of the analysis followed the same method as that of Study 1. Briefly, I assessed the presence of collinearity by examining the correlation coefficients between the study variables. For the reasons

outlined in the methods section of Chapter 4 and so the results could be compared to those in Study 1 (Chapter 4), I applied multilevel modelling methods to investigate the substantive research questions about the relations between aggression and mental ill-health at both the individual and group levels. Multiple imputation methods were also used to produce unbiased estimates of the missing data. A detailed description of both the multilevel modelling methods and the multiple imputation methods are presented in the Methods section of Chapter 4.

<div align="center">**Results**</div>

Descriptive Statistics

Means and Standard Deviations

The means and standard deviations for individual aggression and individual mental ill-health are presented in Table 9. Table 9 also contains the means and standard deviations for group aggression and group mental ill-health for the friendship groups weighted by outdegree, the biggest groups, and the most influential groups i.e., the highest outdegree groups. At the individual level, a mean of approximately 1.4 for individual aggression indicates that, on average, participants viewed the aggressive statements as being between somewhat or sometimes true, and very true or often true. Moreover, a mean of approximately 2 for individual mental ill-health indicates that, on average, participants were not suffering worse mental ill-health than normal.

At the group level, the means and standard deviations for group aggression and group mental ill-health were similar for both the biggest groups and the most influential groups. In addition, they were also comparable to those of individual aggression and individual mental ill-health respectively, indicating that the individuals and the groups were reporting similar levels of aggression and mental ill-health. Notably, the means and standard deviations were lower for group aggression and group mental ill-health when the groups were weighted by

outdegree, as a consequence of the weighting procedure. However, the means for the groups

weighted by outdegree were comparable to those of the groups weighted by size, from

Chapter 4, which underwent a similar weighting procedure.

Table 9

Means and Standard Deviations for all Study Variables

	Grade 8 M(SD)	Grade 9 M(SD)	Grade 10 M(SD)	Grade 11 M(SD)
Individual level				
Agg	1.42 (0.35)	1.45 (0.40)	1.41 (0.35)	1.39 (0.33)
GHQ	1.87 (0.53)	1.98 (0.55)	1.98 (0.55)	2.07 (0.58)
Weighted by outdegree				
L2Agg	0.43 (0.48)	0.47 (0.52)	0.44 (0.50)	0.45 (0.48)
L2GHQ	0.49 (0.58)	0.65 (0.71)	0.61 (0.70)	0.68 (0,74)
Biggest group				
L2Agg	1.41 (0.17)	1.44 (0.22)	1.40 (0.17)	1.37 (0.15)
L2GHQ	1.86 (0.23)	1.97 (0.26)	1.98 (0.25)	2.06 (0.26)
Biggest outdegree group				
L2Agg	1.40 (0.16)	1.44 (0.23)	1.40 (0.18)	1.37 (0.15)
L2GHQ	1.85 (0.23)	2.00 (0.27)	1.98 (0.27)	2.10 (0.28)

Note. Agg = Aggression; GHQ = Mental ill-health; L2Agg = friendship group aggression;

L2GHQ = friendship group mental ill-health; M = mean; SD = standard deviation.

Aggression scale scoring: 1 = not true, 2 = sometimes or somewhat true, 3 = very true or often

true. Mental ill-health scale scoring: 1 = better than usual, 2 = same as usual, 3 = worse than

usual, 4 = much worse than usual.

Correlation Coefficients

Tables 10, 11 and 12 present the correlation coefficients between the study variables for groups weighted by outdegree, the biggest groups, and the most influential groups i.e., highest outdegree group, respectively. As with Chapter 4, the correlation coefficients were interpreted in line with Funder and Ozer's (2019) guidelines for interpreting effect sizes, wherein 0.05, 0.10, 0.20, 0.30 and 0.40 indicate very small, small, medium, large, and very large effect sizes respectively.

Of particular interest to the present study were correlations with group aggression and group mental ill-health, as these variables differed to those from Chapter 4 as a consequence of the different weighting procedures. First, positive correlation coefficients, ranging from medium to very large in magnitude, indicated that group aggression and group mental ill-health were stable over time, regardless of whether the groups were weighted by outdegree (group aggression range: .16 to .24; group mental ill-health range: .17 to .22; Table 10), the biggest groups (group aggression range: .22 to .50; group mental ill-health range: .24 to .41; Table 11), or the most influential groups (group aggression range: .22 to .51; group mental ill-health range: .23 to .44; Table 12). Notably, group aggression and group mental ill-health appeared to be most stable for the biggest groups and the most influential groups, as evidenced by larger correlation coefficients. Moreover, the correlation coefficients observed in the present study are in line with those observed for reciprocal friendships, non-overlapping friendship groups, and overlapping friendship groups (see Tables 2, 3, and 4 respectively in Chapter 4). Thus, the stability of group aggression and group mental ill-health was comparable across all friendship group conceptualisations and also to reciprocal and non-overlapping conceptualisations in Chapter 4.

When the groups were weighted by outdegree, very small to medium, and often insignificant, correlation coefficients were observed between individual aggression and group

aggression (range: -.02 to .18; Table 10), and between individual mental ill-health and group mental ill-health (range: .00 to .19; Table 10). The coefficients within the same time point tended to be the largest in magnitude and statistically significant. For example, individual aggression at Time 1 was positively correlated with group aggression at Time 1, but not at Time 2, 3, or 4. When the biggest groups (Table 11) and the most influential groups (Table 12) were examined, positive correlation coefficients, ranging in size from medium to very large, were observed between individual aggression and group aggression (biggest group range: .23 to .55; most influential group range: .23 to .57) and between individual mental ill-health and group mental ill-health (largest group range: .16 to .48; most influential groups range: .17 to .49). In other words, if an individual reported higher levels of aggression, they also tended to be a member of a group with high levels of aggression. In addition, if an individual suffered from high levels of mental ill-health, their group also tended to suffer from worse mental ill-health. While the largest correlations tended to be within the same time point, correlations of a medium magnitude were also observed between time points (e.g., individual aggression at Time 1 and group aggression at Time 2). In sum, the largest associations between individual and group aggression and mental ill-health were observed when the largest and most influential groups were considered.

The correlations between group aggression and group mental ill-health are particularly worthy of mention. In Study 1, when the overlapping friendship groups were weighted by size, very large correlation coefficients were observed between group aggression and group mental ill-health, ranging from .93 to .97 (see Table 4 in Chapter 4). Similarly, in the present study, when the groups were weighted by outdegree, very large correlation coefficients, ranging from .88 to .97 (see Table 10), were still observed between group aggression and group mental ill-health within the same time point, e.g., between group aggression at Time 1 and group mental ill-health at Time 1. Therefore, weighting the groups

using a different metric, i.e., outdegree instead of size, did not address the collinearity issues.

Thus, the first hypothesis of the present study, which hypothesised that collinearity issues would be resolved by using a different weighting metric, was not supported. The inflated correlation coefficients, therefore, are likely the result of the weighting procedure itself whereby individual data is included multiple times at the group level when creating aggregated group level scores. As roughly half of the sample are members of at least two friendship groups, there are many instances where individual data is repeated at the group level.

When the repetition of individual data at the group level was addressed by focusing on a single group per participant, problematic levels of collinearity were no longer observed between group aggression and group mental ill-health. More specifically, positive correlation coefficients were observed between group aggression and group mental ill-health for the biggest friendship groups (range: .07 to .41; Table 11) and for the most influential groups (range: .06 to .41; Table 12), such that groups who engaged in high levels of aggression also tended to suffer from high levels of mental ill-health. Thus, the second hypothesis of the present study, which hypothesised that the collinearity issues would be resolved by conceptualising overlapping friendship groups as an individual's biggest group or as an individual's most influential group, was supported in the present study. Moreover, these correlations between group aggression and group mental ill-health for the biggest and most influential groups are of comparable magnitude (ranging from being small to very large) to those for the reciprocal friendships (range: .04 to .41) and the non-overlapping friendship groups (range: .03 to .37; Table 3) from Chapter 4.

Taken together, collinearity issues remain when the overlapping friendship groups are weighted by outdegree. As a consequence, it is difficult to disentangle the effects of group aggression and group mental ill-health, which can cause problems for subsequent analyses

and interpretations (Freckleton, 2011; Dormann et al., 2012). In contrast, high levels of collinearity were not observed when the largest and most influential groups were considered. Moreover, the pattern of correlation coefficients for both the largest and most influential groups were comparable to those of the reciprocal and non-overlapping friendship conceptualisations reported in Chapter 4, adding strength to the validity of these associations.

Table 10

Correlation Coefficients Between Individual and Group Aggression and Mental Ill-Health for Overlapping Friendship Groups Weighted by Outdegree Across

Four Time Points

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.Agg8	-														
2.Agg9	.59***	-													
3.Agg10	.49***	.60***	-												
4.Agg11	.44***	.53***	.58***	-											
5.GHQ8	.37***	.26***	.23***	.19***	-										
6.GHQ9	.26***	.36***	.20***	.18***	.50***	-									
7.GHQ10	.19***	.22***	.33***	.19***	.39***	.47***	-								
8.GHQ11	.18***	.19***	.21***	.28***	.31***	.41***	.48***	-							
9.L2Agg8	.10***	.07*	.06*	.01	.01	.04	.00	-.03	-						
10.L2Agg9	.11***	.18****	.07*	.07*	-.04	.10***	.01	.01	.24***	-					
11.L2Agg10	.07*	-.01	.14***	.10***	.00	-.01	.04	-.03	.21***	.22***	-				
12.L2Agg11	.04	.00	.05	.11***	.01	.03	.02	.08*	.20***	.16***	.22****	-			
13.L2GHQ8	.03	.02	.03	-.02	.10***	.08*	.03	.00	.88***	.21***	.19***	.21***	-		
14.L2GHQ9	.07*	.08*	.03	.04	.01	.19***	.05	.06*	.23***	.94***	.20***	.17***	.22***	-	
15.L2GHQ10	.03	-.04	.07*	.06*	.01	.02	.12***	.00	.20***	.19***	.97***	.23***	.19***	.20***	-
16.L2GHQ11	.02	-.02	.03	.06*	.03	.06	.06*	.17***	.18***	.14***	.19***	.96***	.21***	.17***	.20***

Notes. Agg8 = aggression in Grade 8; Agg9 = aggression in Grade 9; Agg10 = aggression in Grade 10; Agg11 = aggression in Grade 11; GHQ8 = mental ill-health in Grade 8; GHQ9 = mental ill-health in Grade 9; GHQ10 = mental ill-health in Grade 10; GHQ11 = mental ill-health in Grade 11; L2Agg8 = Friends' aggression in Grade 8; L2Agg9 = friends' aggression in Grade 9; L2Agg10 = friends' aggression in Grade 10; L2Agg11 = friends' aggression in Grade 11; L2GHQ8 = friends' mental ill-health in Grade 8; L2GHQ9 = friends' mental ill-health in Grade 9; L2GHQ10 = friends' mental ill-health in Grade 10; L2GHQ11 = friends' mental ill-health in Grade 11.

* = $p < .05$; ** = $p < .01$; *** = $p < .001$

Table 11

Correlation Coefficients Between Individual and Group Aggression and Mental Ill-Health for the Biggest Friendship Groups Across Four Time Points

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.Agg8	-														
2.Agg9	.59***	-													
3.Agg10	.49***	.60***	-												
4.Agg11	.44***	.53***	.58***	-											
5.GHQ8	.37***	.26***	.23***	.19***	-										
6.GHQ9	.26***	.36***	.20***	.18***	.50***	-									
7.GHQ10	.19***	.22***	.33***	.19***	.39***	.47***	-								
8.GHQ11	.18***	.19***	.21***	.28***	.31***	.41***	.48***	-							
9.L2Agg8	.49***	.31***	.26***	.24***	.16***	0.12***	.07*	.06	-						
10.L2Agg9	.34***	.55***	.35***	.32***	.13***	0.20***	.13***	.11**	.39***	-					
11.L2Agg10	.24***	.37***	.52***	.36***	.04	0.10***	.20***	.12***	.22***	.46***	-				
12.L2Agg11	.23***	.30***	.33***	.46***	.11**	0.12***	.12***	.16***	.31***	.39***	.50***	-			
13.L2GHQ8	.18***	.14***	.09**	.11**	.47***	0.27***	.20***	.18***	.35***	.15***	.06	.15***	-		
14.L2GHQ9	.13***	.24***	.16***	.15***	.33***	0.48***	.29***	.28***	.15***	.41***	.16***	.10**	.41***	-	
15.L2GHQ10	.11***	.15***	.19***	.15***	.16***	0.21***	.46***	.26***	.18***	.23***	.39***	.27***	.27***	.34***	-
16.L2GHQ11	.09**	.11***	.10**	.16***	.17***	0.24***	.25***	.45***	.11**	.19***	.17***	.30***	.24***	.35***	.40***

Notes. Agg8 = aggression in Grade 8; Agg9 = aggression in Grade 9; Agg10 = aggression in Grade 10; Agg11 = aggression in Grade 11; GHQ8 = mental ill-health in Grade 8; GHQ9 = mental ill-health in Grade 9; GHQ10 = mental ill-health in Grade 10; GHQ11 = mental ill-health in Grade 11; L2Agg8 = Friends' aggression in Grade 8; L2Agg9 = friends' aggression in Grade 9; L2Agg10 = friends' aggression in Grade 10; L2Agg11 = friends' aggression in Grade 11; L2GHQ8 = friends' mental ill-health in Grade 8; L2GHQ9 = friends' mental ill-health in Grade 9; L2GHQ10 = friends' mental ill-health in Grade 10; L2GHQ11 = friends' mental ill-health in Grade 11.

$* = p < .05; ** = p < .01; *** = p < .001$

Table 12

Correlation Coefficients Between Individual and Group Aggression and Mental Ill-Health for the Most Influential Friendship Groups Across Four Time Points

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.Agg8	-														
2.Agg9	.59***	-													
3.Agg10	.50***	.60***	-												
4.Agg11	.44***	.53***	.58***	-											
5.GHQ8	.37***	.26***	.24***	.19***	-										
6.GHQ9	.26***	.36***	.21***	.18***	.51***	-									
7.GHQ10	.19***	.22***	.33***	.19***	.40***	.48***	-								
8.GHQ11	.18***	.19***	.21***	.28***	.31***	.41***	.48***	-							
9.L2Agg8	.47***	.33***	.27***	.24***	.17***	.12***	.08*	0.05	-						
10.L2Agg9	.35***	.57***	.36***	.32***	.12***	.20***	.13***	.12***	.40***	-					
11.L2Agg10	.23***	.34***	.53***	.35***	.10***	.14***	.21***	.11***	.22***	.43***	-				
12.L2Agg11	.23***	.33***	.35***	.48***	.11***	.11***	.11***	.16***	.30***	.39***	.51***	-			
13.L2GHQ8	.18***	.15***	.11***	.13***	.48***	.29***	.21***	.21***	.34***	.16***	.05	.14***	-		
14.L2GHQ9	.14***	.25***	.16***	.14***	.32***	.49***	.30***	.26***	.16***	.41***	.15***	0.07	.44***	-	
15.L2GHQ10	.11***	.14***	.19***	.15***	.17***	.21***	.48***	.26***	.15***	.23***	.37***	.26***	.25***	.34***	-
16.L2GHQ11	.08*	.13***	.11***	.16***	.17***	.24***	.26***	.47***	.09*	.18***	.13***	.30***	.23***	.34***	.37***

Notes. Agg8 = aggression in Grade 8; Agg9 = aggression in Grade 9; Agg10 = aggression in Grade 10; Agg11 = aggression in Grade 11; GHQ8 = mental ill-health in Grade 8; GHQ9 = mental ill-health in Grade 9; GHQ10 = mental ill-health in Grade 10; GHQ11 = mental ill-health in Grade 11; L2Agg8 = Friends' aggression in Grade 8; L2Agg9 = friends' aggression in Grade 9; L2Agg10 = friends' aggression in Grade 10; L2Agg11 = friends' aggression in Grade 11; L2GHQ8 = friends' mental ill-health in Grade 8; L2GHQ9 = friends' mental ill-health in Grade 9; L2GHQ10 = friends' mental ill-health in Grade 10; L2GHQ11 = friends' mental ill-health in Grade 11.

* = $p < .05$; ** = $p < .01$; *** = $p < .001$

Multilevel Models

I estimated three sets of four multilevel models for the groups weighted by outdegree, the biggest groups, and the most influential group, the results for which are presented in Tables 13, 14 and 15, respectively. In order to compare results from this study with those from the previous study, the multilevel models were structured in the same way as those in Chapter 4. More specifically, lagged scores of all study variables, namely individual aggression, individual mental ill-health, group aggression, and group mental ill-health, were included as predictors in all models. Each model then had a different outcome variable: the outcome in Model 1 was individual aggression; the outcome in Model 2 was individual mental ill-health; the outcome in Model 3 was group aggression; and the outcome in Model 4 was group mental ill-health. Any effect of a lagged score on the outcome variable would indicate the effect of the predictor at Time t on the outcome at t+1, accounting for all other effects in the model. As individual and group level variables were covaried in the same model, the estimated effects represent the unique effect of the individual and the group on the outcome variables. In each model, varying intercepts were used for participants and time, to account for the hierarchical nature of the data. Including students as a varying intercept in the model also prevents issues due to dependency from arising. In addition, gender and school were both controlled for to account for exogenous effects (Gellman & Hill, 2006). Moreover, I standardised all study variables to facilitate the interpretation of the effect sizes. As with Study 1, I compared models that included school as a varying intercept, instead of controlling for school. The results for these models are presented in Supplementary Materials S8. Notably, the results did not differ substantially depending on how the school variable was included in the model.

Stability of Study Variables

First, I examined the autoregressive estimates, which describe how stable the study variables are over time. Individual aggression, individual mental ill-health, and group aggression were all stable over time for the groups weighted by outdegree (Table 13, Model 1, 2, and 3), for the biggest groups (Table 14, Model 1, 2, and 3), and also for the most influential groups (Table 15, Model 1, 2, and 3), as evidenced by positive effect sizes and confidence intervals that did not include zero. Moreover, the effect sizes were all of a comparable magnitude to those reported for the reciprocal friendships, non-overlapping groups, and overlapping groups in Chapter 4. Group mental ill-health was also stable over time in the biggest groups (Table 14 Model 4) and the most influential groups (Table 15 Model 4), but not when the groups were weighted by outdegree (Table 13 Model 4), as evidenced by a small effect size and a confidence interval that included zero. A statistically non-significant group mental ill-health estimate was also observed when the friendship groups were weighted by size in Chapter 4. Taken together, the results of this study show that stability was observed in all variables, with the exception of group mental ill-health in the groups weighted by outdegree.

As was the case in Study 1 (Chapter 4), regardless of the weighting procedure used for the overlapping friendship groups, aggression was consistently found to be more stable than mental ill-health. More specifically, individual aggression was more stable than individual mental ill-health, and group aggression was consistently found to be more stable than group mental ill-health, as evidenced by larger effect sizes for the aggression variables compared to those for mental ill-health. Moreover, individual aggression was more stable than group aggression, whereby the effect sizes for individual aggression were approximately double that of the effect sizes for group aggression. A similar pattern of results was observed for individual and group mental ill-health, although the difference between them was not as

great as that of individual and group aggression. In sum, aggression was consistently more stable than mental ill-health at both the individual and the group level, and individual characteristics were considerably more stable than group characteristics.

Aggression

Regardless of how the friendship groups were conceptualised, group aggression did not predict subsequent individual aggression, as evidenced by confidence intervals that included zero. Moreover, individual aggression was not found to predict subsequent group aggression when the friendship groups were weighted by outdegree, as evidenced by a small estimate and a confidence interval that included zero. In contrast, individual aggression predicted subsequent group aggression for both the biggest groups (Table 14, Model 3) and the most influential groups (Table 15, Model 3), as evidenced by positive estimates and confidence intervals that did not include zero. Taken together, if a group was engaging in higher than usual levels of aggression, this did not predict subsequent higher than usual levels of aggression at the individual level. However, if an individual engaged in more aggressive behaviours than usual, then their friendship group would likely experience higher than usual levels of aggression one year later, except for groups weighted by outdegree. Thus, the associations between individual and group aggression appeared to differ depending on how the friendship groups were conceptualised.

Mental Ill-Health

When friendship groups were weighted by outdegree, group mental ill-health was found to negatively predict subsequent individual mental ill-health (Table 13, Model 2) as evidenced by a confidence interval that did not include zero. In other words, when an individual's group was suffering from higher than usual levels of mental ill-health, then that individual tended to experience lower levels of mental ill-health one year later. In contrast, individual mental ill-health was found to positively predict group mental ill-health when the

friendship groups were conceptualised as the biggest groups (Table 14, Model 4) and the most influential groups (Table 15 Model 4). More specifically, if an individual suffered from worse mental ill-health than usual, then their group would subsequently experience worse than usual mental ill-health a year later. Taken together, the results indicate that the manner in which the group is conceptualised appears to impact the observed associations between individual and group mental ill-health.

Links Between Aggression and Mental Ill-Health

Regardless of how the friendship groups were conceptualised, lagged individual aggression was found to positively predict subsequent individual mental ill-health (Table 13, Model 2; Table 14, Model 2; Table 15, Model 2). Thus, if an individual experienced unusually high levels of aggression in one year, they tended to suffer from worse than usual mental ill-health in subsequent years. Notably, lagged individual mental ill-health was not found to predict subsequent individual aggression in any of the friendship group conceptualisations, as evidenced by confidence intervals that included zero. Thus, the association between individual aggression and individual mental ill-health is not reciprocal.

At the group level, lagged group aggression positively predicted subsequent group mental ill-health in groups weighted by outdegree (Table 13, Model 4), the biggest groups (Table 14, Model 4), and the most influential groups (Table 15, Model 4). In other words, if groups engaged in unusually high levels of aggression, they were more likely to experience unusually high levels of mental ill-health one year later. For the most influential groups, the converse of this association was also observed, whereby group mental ill-health negatively predicted subsequent group aggression (Table 15, Model 3). Taken together, these results indicate the presence of a homeostatic process in the most influential groups, whereby aggressive friendship groups develop worse mental ill-health which in turn decreases their levels of subsequent aggressive behaviour. Notably, a negative estimate was also observed

for the groups weighted by outdegree (Table 13, Model 3); however, the confidence interval

included zero. Thus, we cannot interpret this estimate with confidence.

When friendship groups were weighted by outdegree, group aggression positively

predicted individual mental ill-health (Table 13, Model 2) and individual mental ill-health

negatively predicted subsequent group aggression (Table 13, Model 3). In other words, if a

group engaged in higher levels of aggressive behaviours then the individual was likely to

suffer from higher than usual mental ill-health subsequently. Then, when an individual was

suffering from higher than usual mental ill-health, their group would subsequently become

less aggressive a year later. Taken together, these results provide evidence for another

homeostatic process, this time between individual mental ill-health and group aggression. No

associations were found between individual mental ill-health and group aggression for either

the biggest groups or the most influential groups. As this effect was only observed when the

friendship groups were weighted by outdegree, caution is needed when interpreting this

result, as collinearity was observed for group aggression and group mental ill-health.

To aid with the interpretation of the multilevel model results, Table 16 summarises

how group aggression and group mental ill-health scores were calculated for each of the

friendship conceptualisations for this study. In addition, Table 16 indicates the direction of

the associations as well as those which are statistically significant.

Table 13

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the linkcomm Overlapping Friendship Groups, Weighted by

Outdegree

Variables at T	Estimate	SE	Confidence Interval Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.617**	**0.018**	**0.579**	**0.654**
Individual Mental Ill-Health	0.029	0.017	-0.007	0.064
Group Aggression	0.021	0.070	-0.131	0.173
Group Mental Ill-Health	-0.017	0.063	-0.154	0.119
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.088**	**0.015**	**0.058**	**0.117**
Individual Mental Ill-Health	**0.463**	**0.019**	**0.423**	**0.503**
Group Aggression	**0.147**	**0.048**	**0.047**	**0.246**
Group Mental Ill-Health	**-0.165**	**0.049**	**-0.266**	**-0.064**
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	0.030	0.019	-0.009	0.069
Individual Mental Ill-Health	**-0.020**	**0.020**	**0.061**	**0.021**
Group Aggression	**0.247**	**0.073**	**0.091**	**0.404**
Group Mental Ill-Health	-0.031	0.076	-0.193	0.131
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	-0.016	0.017	-0.051	0.018
Individual Mental Ill-Health	0.029	0.019	-0.010	0.068
Group Aggression	**0.162**	**0.060**	**0.037**	**0.290**
Group Mental Ill-Health	0.039	0.064	-0.095	0.173

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 14

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the Biggest Friendship Groups

Variables at T	Estimate	SE	Confidence Interval Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.611**	**0.017**	**0577**	**0.646**
Individual Mental Ill-Health	0.019	0.016	-0.015	0.052
Group Aggression	0.020	0.017	-0.016	0.056
Group Mental Ill-Health	0.021	0.020	-0.021	0.063
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.100**	**0.017**	**0.064**	**0.134**
Individual Mental Ill-Health	**0.428**	**0.016**	**0.397**	**0.459**
Group Aggression	-0.006	0.021	-0.050	0.039
Group Mental Ill-Health	0.042	0.027	-0.015	0.100
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.171**	**0.024**	**0.121**	**0.221**
Individual Mental Ill-Health	-0.007	0.020	-0.049	0.034
Group Aggression	**0.355**	**0.023**	**0.307**	**0.403**
Group Mental Ill-Health	0.021	0.025	-0.030	0.073
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.013	0.016	-0.019	0.044
Individual Mental Ill-Health	**0.082**	**0.023**	**0.033**	**0.131**
Group Aggression	**0.046**	**0.018**	**0.009**	**0.083**
Group Mental Ill-Health	**0.309**	**0.029**	**0.248**	**0.370**

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 15

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the Most Influential Friendship Groups

Variables at T	Estimate	SE	Confidence Interval Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.604**	**0.017**	**0.568**	**0.640**
Individual Mental Ill-Health	0.026	0.014	-0.003	0.054
Group Aggression	0.019	0.015	-0.012	0.050
Group Mental Ill-Health	-0.024	0.017	-0.059	0.010
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.101**	**0.019**	**0.062**	**0.140**
Individual Mental Ill-Health	**0.453**	**0.016**	**0.419**	**0.486**
Group Aggression	-0.014	0.018	-0.052	0.023
Group Mental Ill-Health	-0.004	0.018	-0.041	0.033
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.105**	**0.016**	**0.073**	**0.137**
Individual Mental Ill-Health	0.007	0.015	-0.023	0.037
Group Aggression	**0.348**	**0.024**	**0.298**	**0.398**
Group Mental Ill-Health	**-0.063**	**0.020**	**-0.103**	**-0.022**
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.022	0.012	-0.002	0.046
Individual Mental Ill-Health	**0.067**	**0.014**	**0.039**	**0.094**
Group Aggression	**0.042**	**0.015**	**0.013**	**0.072**
Group Mental Ill-Health	**0.228**	**0.016**	**0.197**	**0.260**

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 16

Summary table of the multilevel model results from Study 2

	Variables at T	Variables at T+1			
		Agg	GHQ	L2Agg	L2GHQ
Overlapping groups: L2Agg and L2GHQ scores were computed as the average aggression and mental ill-health scores, respectively, across the multiple groups an individual belongs to, weighted by the number of friendship nominations an individual made in each of their groups (i.e., outdegree)	Agg	+	+	+	-
	GHQ	+	+	-	+
	L2Agg	+	+	+	+
	L2GHQ	-	-	-	+
Overlapping groups: L2Agg and L2GHQ were computed as the average of the aggression and mental ill-health scores across all members in an individual's largest friendship group.	Agg	+	+	+	+
	GHQ	+	+	-	+
	L2Agg	+	-	+	+
	L2GHQ	+	+	+	+
Overlapping groups: L2Agg and L2GHQ were computed as the average of the aggression and mental ill-health scores across all members in the group in which an individual had nominated the most people (i.e., outdegree).	Agg	+	+	+	+
	GHQ	+	+	+	+
	L2Agg	+	-	+	+
	L2GHQ	-	-	-	+

Notes. T= time; Agg = Aggression; GHQ = mental ill-health; L2Agg = friends' aggression;

L2GHQ = friends' mental ill-health; + = a positive estimate; - = a negative estimate

Dark shaded boxes are those for which there was a significant estimate between the variables.

Discussion

The primary aim of the present study was to address high levels of collinearity found between group aggression and group mental ill-health in the overlapping friendship groups when weighted by size. More specifically, group aggression and group mental ill-health were highly collinear, with correlation coefficients ranging from .93 to .97, when the overlapping friendship groups were weighted by size (see Chapter 4, Table 4). Collinearity can cause theoretically 'important' estimates to have statistically non-significant coefficients (Dormann et al., 2013; Freckleton, 2011; Mason & Perreault, 1991). I argued that this may have been the reason why group mental ill-health was not found to be stable over time in the overlapping friendship groups despite literature suggesting it should be (e.g., Fleming et al., 2014; Goodwin et al., 2012; Patalay & Fitzsimons, 2018), and despite being stable when friendships were conceptualised as being reciprocated friendships or non-overlapping groups in Chapter 4. I proposed that collinearity was the consequence of the weighting method used, as it was a procedure unique to the overlapping friendship group conceptualisation

In attempting to resolve the collinearity issues, I investigated both the weighting metric (whereby groups were weighted by outdegree instead of size) as well as the weighting procedure itself (by removing repetition of individual data at the group level and examining an individual's biggest group and their most influential group). The results of the present study, discussed in more detail below, built on those of Chapter 4 while also contributing uniquely to the literature on aggression and mental ill-health in friendship groups by comparing the consequences of using three additional overlapping friendship group conceptualisations.

Weighting the Overlapping Friendship Groups

In attempting to resolve collinearity issues between group aggression and group mental ill-health, I first explored the impact of weighting the friendship groups by influence,

i.e., outdegree, instead of by size, as was done in Chapter 4. When group aggression and group mental ill-health were calculated from overlapping friendship groups that were weighted by outdegree, large correlation coefficients were still observed between group aggression and group mental ill-health within the same time point. In addition, group mental ill-health was still found to be unstable over time. Therefore, the first hypothesis of the present study, wherein I hypothesised that collinearity issues would be resolved by weighting the overlapping friendship groups by outdegree, was not supported in the present study. Thus, problematic levels of collinearity between group aggression and group mental ill-health does not appear to be a consequence of the metric used to weight overlapping friendship groups.

In contrast, when group aggression and group mental ill-health were calculated from an individual's biggest or most influential group, the correlation coefficients between these variables were no longer inflated and, instead, coefficients of a moderate to large magnitude were observed. Moreover, these correlation coefficients were of a comparable magnitude to those reported by the reciprocal friendships and the non-overlapping friendship groups in Chapter 4. Thus, the second hypothesis of the present study, where I hypothesised that the collinearity issues were caused by the weighting procedure, was supported. A consequence of problematic collinearity can be that theoretically relevant variables may have insignificant coefficients (Dormann et al., 2013; Freckleton, 2011; Mason & Perreault, 1991). Thus, as group mental ill-health was also found to be stable when the biggest and most influential friendship groups were examined, this lends further support to the collinearity issues being resolved. These results make a unique methodological contribution to the literature by comparing the consequences of using different weighting procedures for overlapping friendship groups, which has not, to the best of my knowledge, been explored in previous literature.

In comparing the biggest and most influential friendship group conceptualisations, the most influential group conceptualisation is particularly helpful in clarifying the associations between aggression and mental ill-health at the individual and friendship group levels. Specifically, I was interested primarily in the ability of individuals and groups to influence each other, and size of groups may be a poor proxy for influence (e.g., Değirmencioğlu et al., 1998; Hussong, 2002; Sokolocska et al., 2016). Methodologically, the results from the most influential group conceptualisations align with those from the non-overlapping friendship groups presented in Chapter 4. As non-overlapping friendship groups identified using the infoMap algorithm have been identified in the literature as being the most accurate method of disjoint community detection available (Newman & Girvan, 2004; Sales-Pardo et al., 2007), this lends further support for the validity of the results using the most influential friendship groups. Therefore, based on both theoretical and methodological considerations, I conclude that an individual's most influential group is a particularly helpful operationalisation of the overlapping friendship groups for the research aims of this thesis, and I will use the most influential group conceptualisation for subsequent analyses in the next chapter.

Associations Between Individual and Group Level Aggression and Mental Ill-Health

This study also contributed to the literature by investigating the consequences of using three additional overlapping friendship group conceptualisations, namely groups weighted by outdegree, biggest groups, and most influential groups, on the associations between aggression and mental ill-health. These results are discussed below, and are also compared with the friendship conceptualisations used in Chapter 4.

Aggression

Looking first at the links between aggression and mental ill-health, when friendship groups were weighted by outdegree, group aggression was found to predict subsequent individual aggression. In other words, if an individual was a member of a friendship group

with high levels of aggression, then they were likely to engage in more aggressive behaviours than usual one year later. Notably, this finding is in line with a number of empirical studies that also found the aggressive behaviours of friends to influence subsequent individual aggression behaviour (e.g., Espelage et al., 2003; Werner & Crick, 2004; Werner & Hill, 2010). However, it should be noted that, in the present thesis, group aggression was only found to predict individual aggression when the overlapping groups were weighted by either size (Chapter 4) or by outdegree, both of which suffer from collinearity concerns.

For both the biggest group and the most influential group conceptualisations, individual aggression positively predicted group aggression, whereby if an individual engaged in higher than usual levels of aggression, then the group an individual was part of one year later was likely to engage in higher than usual levels of aggression. This finding is in line with the results from the reciprocal friendships and the non-overlapping friendship groups reported in Chapter 4. This lends further validity to this temporal association as it has now been replicated in multiple friendship group conceptualisations.

Mental Ill-Health

When the overlapping friendship groups were weighted by outdegree, if an individual's group experienced higher than usual levels of group mental ill-health, then that individual was likely to experience worse mental ill-health one year later. As with aggression, this association was only observed for the overlapping friendship groups weighted by size in Chapter 4, and not in any of the other friendship conceptualisations examined in this thesis. Given the collinearity concerns observed in both of these friendship conceptualisations, as well as the lack of group mental ill-health stability, it is unclear whether this weighting procedure is a valid method to use when conceptualising friendship groups, and thus, these results should be interpreted with caution.

In contrast, for both the biggest groups and the most influential groups, individual mental ill-health predicted group mental ill-health, whereby higher levels of mental ill-health at the individual level resulted in higher than usual levels of group mental ill-health one year later. This finding was also observed in Chapter 4 for the well-established reciprocal and non-overlapping friendship conceptualisations. Thus, in this thesis, the majority of friendship conceptualisations provide support for individual mental ill-health predicting subsequent group mental ill-health.

Aggression and Mental Ill-Health

Individual aggression predicted subsequent individual mental ill-health regardless of how the friendship groups were conceptualised. This result is in line with numerous empirical studies that also report a temporal association whereby aggression predicts subsequent mental ill-health (Card et al., 2008; Murray-Close et al., 2007; Slemming et al., 2010), and with the results presented in Chapter 4. Moreover, this finding also supports the theoretical literature, which argues that engaging in aggressive behaviours can negatively impact an individual's mental ill-health (Capaldi, 1992; Patterson & Capaldi, 1990; Patterson & Stoolmiller, 1991;Ryan & Deci, 2017; Coyne, 1976).

At the group level, regardless of how the friendship groups were conceptualised, group aggression positively predicted group mental ill-health, whereby groups who engaged in more aggressive behaviours tended to suffer from worse mental ill-health than usual one year later. Moreover, when the most influential friendship groups were examined, group mental ill-health also predicted group aggression, such that friendship groups who experienced worse mental ill-health than usual tended to engage in fewer than usual aggressive behaviours one year later. The same homeostatic process was also observed in Chapter 4 for the non-overlapping friendship groups. This lends credibility to the existence of this process, as it has been found in multiple friendship group conceptualisations.

Interestingly, another novel homeostatic process was observed when the groups were weighted by outdegree. When an individual's groups engaged in higher levels of aggressive behaviours, the individual tended to suffer from higher than usual mental ill-health one year later. Moreover, when an individual suffered from higher than usual mental ill-health, then their group would subsequently become less aggressive a year later. As this homeostatic process was only observed when the friendship groups were weighted by outdegree, caution is needed when interpreting this result, as collinearity was observed for group aggression and group mental ill-health. Thus, it can be difficult to disentangle the effects of these variables which, in turn, can cause issues with later analysis and interpretation (Dormann et al., 2013; Freckleton, 2011; Mason & Perreault, 1991). For this reason, the existence of this homeostatic process requires further clarification in future studies.

Chapter Summary

In this fifth chapter, I sought to resolve the problematic levels of collinearity between group aggression and group mental ill-health reported for the overlapping friendship groups in Chapter 4. By examining an alternative weighting metric (i.e., weighting the friendship groups by outdegree) and other weighting procedures (i.e., selecting an individual's biggest or their most influential friendship group), I found that the weighting procedure was likely the cause of the problematic levels of collinearity. In comparing the biggest and the most influential groups, I argue that the most influential friendship group conceptualisation is particularly suitable for achieving the research aims of this thesis, and thus, will be used in subsequent analyses.

Moreover, I also compared the consequences of using three additional friendship group conceptualisations on the substantive hypotheses regarding aggression and mental ill-health. Notably, when the biggest and the most influential friendship group conceptualisations were examined, the results were comparable to those of the reciprocal

friendships and non-overlapping friendship groups in Chapter 4. Specifically, individual aggression predicted group aggression; individual mental ill-health predicted group mental ill-health; individual aggression predicted individual mental ill-health; and group aggression and group mental ill-health predicted each other. However, when the groups were weighted by outdegree, a number of novel associations were observed. Most notable was a new homeostatic process that emerged between individual mental ill-health and group aggression whereby when an individual's group engaged in higher levels of aggressive behaviours, the individual tended to suffer from worse mental ill-health, which subsequently caused their friendship group to become less aggressive one year later. However, this novel homeostatic process, observed for the overlapping friendship groups weighted by outdegree, should be interpreted with caution due to problematic collinearity between group aggression and group mental ill-health which call into question the validity of weighting overlapping friendship groups by outdegree in the present study.

Chapter 6: Study 3

Untangling Selection and Socialisation Effects for Aggression and Mental Ill-Health

Introduction

In Study 2, described in the previous chapter, I sought to address the problematic collinearity found in Study 1 (Chapter 4) between group aggression and group mental ill-health when the overlapping friendship groups were considered. Upon investigating both the weighting procedure and the weighting metric used, I found the weighting procedure itself was the cause of the observed collinearity. Moreover, given that different peer influence processes operated across different friendship conceptualisations, I argued that it is important to select a theoretically driven method when conceptualising overlapping friendship groups. I concluded that the most relevant metric to achieve the research aims of this thesis was to select an individual's most influential friendship group from their multiple overlapping groups. When the most influential groups were examined, the causal links between aggression and mental ill-health were found to be similar to those using the non-overlapping friendship groups in Study 1 (Chapter 4). Together, the results of Studies 1 and 2 (Chapters 4 and 5, respectively) demonstrate novel associations between individual and group aggression and mental ill-health in the context of three different friendship conceptualisations: reciprocal friendships; non-overlapping friendship groups; and most influential friendship groups.

Of particular relevance to the present study are the observed associations between individual aggression and group aggression, and between individual mental ill-health and group mental ill-health. It is unclear at this point the extent to which individual aggression and mental ill-health are influencing group aggression and mental ill-health via selection or socialisation processes. When interpreting the longitudinal associations between individual aggression and group aggression, for example, it would be interesting to know whether the friends have adopted the individual's aggressive behaviours (i.e., socialisation), or whether

the individual has moved to another friendship group that engages in more aggressive behaviours where their aggression would be more accepted (i.e., selection). Thus, the primary aim of this study is to investigate whether selection or socialisation processes account for the observed associations between individual aggression and group aggression, and between individual mental ill-health and group mental ill-health.

Measuring Selection and Socialisation Effects

Stochastic Actor-Based Methods

Numerous studies have examined the influence of both selection and socialisation processes for different behaviours. Such studies tend to use stochastic actor-based modelling (Kiuru et al., 2012; Sijtsema et al., 2010; Van Zalk et al., 2011), which is often carried out using the SIENA program (Simulation Investigation for Empirical Network Analyses; Snijders, 2001; Snijders et al., 2007). SIENA simultaneously estimates changes in the network structure and in the characteristics of individuals that comprise the network. The effects of individual characteristics on changes to the network indicate selection effects (Dijkstra et al., 2011; Snijders et al., 2007). For example, if aggressive individuals terminated existing friendships or made new ones, this would indicate the presence of selection processes. Conversely, the effects of the network on changes in individual characteristics indicate socialisation effects (Dijkstra et al., 2011; for an overview see Snijders et al., 2010; Veenstra & Steglich, 2012). For example, if individuals are friends with others in the network and consequently become more aggressive, this indicates the presence of socialisation processes.

However stochastic actor-based modelling, and in particular SIENA, is limited in being actor-oriented and deriving estimates from a simulation of how individuals change their behaviour and their friendships. Thus, this modelling procedure does not allow for the conceptualisation of friendship groups, or the measurement of group norms (Cheadle &

Goosby, 2012; Conway et al., 2011; Ragan et al., 2019). Consequently, use of SIENA-type modelling is not suitable for the analysis in this thesis, and in particular for this study where I aim to examine selection and socialisation processes within friendship groups. I would also like to note that, prior to commencing with the studies outlined in this thesis, the data used in this thesis was subjected to SIENA modelling. However, the models consistently failed to converge, a consequence of too much missingness in the network data. Thus, the data was deemed unsuited to SIENA modelling methods.

Other researchers have argued for the utility of longitudinal regression modelling to investigate selection and socialisation processes (Guan & Kamo, 2016). Separate models are utilised for stable and unstable friendships because the effects for stable friendships are thought to reflect socialisation influences while the effects for unstable friendships are attributed to selection influences (e.g., Engels et al., 2004). In this study, I will use this method, whereby I compare stable and unstable friendships to explore the influence of selection and socialisation on aggression and mental ill-health in the context of reciprocal friendships, non-overlapping friendship groups, and most influential friendships groups.

Friendship Stability and Instability

Stability is defined as the maintenance of a friendship over a period of time, while instability refers to both the termination as well as the formation of new relationships (Poulin & Chan, 2010). Poulin and Chan (2010), in a review of the literature on stability, concluded that approximately fifty percent of children and adolescents' friendships are stable over time. In a more recent meta-analysis, Meter et al. (2015) examined fifty-seven effect sizes and also found that about half of all friendships were stable over time. Moreover, these rates of friendship stability were found to be consistent throughout childhood and adolescence (Meter et al., 2015). Given that roughly half of all friendships are stable over time, the other half of an individual's friendships are characterised by instability. Indeed, instability is a common

phenomenon, particularly during adolescence (Poulin & Chan, 2010). It is important to note that friendship instability is not inherently negative nor is it necessarily indicative of poor social functioning.

Friendship stability, compared to friendship instability, has been studied to a greater extent in the literature. Stability is generally measured by identification of friends across two waves of measurement, i.e., friends who are present at both Time 1 and Time 2 of data collection (Poulin & Chan, 2010). Once the stable friendships are identified, they can be used for subsequent analyses. Most studies have assessed friendship stability by collecting friendship information at two separate time points, most often twice over the course of a school year (e.g., Aboud et al., 2003; Berndt & Hoyle, 1985; Bowker, 2004; Bowker et al., 2006; Değirmencioğlu et al., 1998; Rubin et al., 2006). There are fewer studies where stability has been measured using three (e.g., Berndt et al., 1999; Lee et al., 2007) or more (e.g., Chan & Poulin, 2007; Hardy et al., 2002) waves of friendship data. Importantly, the studies with more than two waves of data collection still tend to be collected over the course of one school year.

When studying stability, best friendships i.e., reciprocated relations between individuals, are the most frequently examined friendship conceptualisation (e.g., Bowker, 2004; Branje et al., 2007; Lee et al., 2007; Rubin et al., 2006), with friendship groups receiving substantially less focus in the literature (e.g., Değirmencioğlu et al., 1998; Ennett & Bauman, 1996). However, there is evidence to suggest that different definitions of friendship do not produce different stability estimates. Specifically, Meter et al. (2015) found similar levels of stability between reciprocated and non-reciprocated friendships, and between reciprocal and all friendships. Notably however, friendship groups more broadly were not included in these comparisons.

The Present Study

The primary aim of this study is to provide further insight into the substantive findings of the investigations already presented in this thesis. Specifically, I will examine the role of both selection and socialisation processes on the associations between individual aggression and group aggression, and between individual mental ill-health and group mental ill-health. To do this, I will identify an individual's stable and unstable friendships within each friendship conceptualisation and use these friends for subsequent analyses. Performing separate analyses for the stable and unstable friendships will enable me to untangle selection and socialisation processes, whereby it is argued that the effects for stable friendships reflect socialisation processes whereas the effects for unstable friendships reflect selection processes.

Research Questions and Hypotheses

Of particular interest to the present study are the following findings: individual aggression was found to predict group aggression; and individual mental ill-health was found to predict group mental ill-health. While the emergence of additional associations will be discussed in this study, the research questions and hypotheses will centre on these associations that have already been established in Studies 1 and 2 (Chapters 4 and 5, respectively). Thus, the research questions and hypotheses presented below focus on (i) individual and group aggression, and on (ii) individual and group mental ill-health and present hypotheses as to the involvement of selection and socialisation processes.

Research Question 1

Will the longitudinal association between individual aggression and group aggression be attributable to selection or socialisation processes?

Hypothesis 1

Aggression is one of the most widely studied behaviours in the context of both selection and socialisation (e.g., Low et al., 2013; Sijtsema, 2016). Longitudinally, youth have been found to select friends who engage in levels of aggression similar to their own (Dijkstra et al., 2011). There are also many studies that report socialisation effects for aggression (e.g., Espelage et al., 2003; Sijtsema et al., 2010; Werner & Hill, 2010). Notably, in Study 1 and Study 2 of this thesis (Chapters 4 and 5, respectively), I found that individual aggression predicts subsequent group aggression. In contrast, in the literature, studies tend to report that group aggression predicts subsequent individual aggression (e.g., Espelage et al., 2003; Low et al., 2013; Werner & Hill, 2010). However, given the methodological limitation of many of these studies (i.e., that group aggression is not examined as an outcome variable), and that those who theorise about socialisation processes refer to friends influencing each other (Kandel, 1978), it is, reasonable to assume that an individual's aggressive behaviours might also influence the group levels of aggression via socialisation processes. Moreover, there is evidence to suggest that selection and socialisation processes occur simultaneously such that an individual is simultaneously both selecting aggressive friends and becoming more like their aggressive friends (Dijkstra et al., 2011; Mrug et al., 2004; Werner & Crick, 2004). Therefore, in this study, I hypothesise that both selection and socialisation processes will play a role in the association between individual and group aggression. In other words, I expect individual aggression to predict subsequent group aggression when both stable friendships and unstable friendships are investigated.

Research Question 2

Will the longitudinal association between individual mental ill-health and group mental ill-health be attributable to selection or socialisation processes?

Hypothesis 2

There is evidence to support the presence of selection processes for mental ill-health. For example, youth with similar levels of mental ill-health tend to become friends (e.g., Cheadle & Goosby, 2012; Hogue & Steinberg, 1995; Schaefer et al., 2011). Moreover, numerous empirical studies have also found evidence of socialisation processes, with some studies reporting friends' levels of mental ill-health predicts increases in an adolescent's own mental ill-health over time (Giletta et al., 2011; Van Zalk et al., 2010), and others reporting that individual mental ill-health influences subsequent group mental ill-health (e.g., Goodwin et al., 2012). Thus, I hypothesise that selection and socialisation processes both play a role in the association between individual mental ill-health and group mental ill-health. Specifically, I expect individual mental ill-health to predict a subsequent worsening of group mental ill-health when both stable and unstable friendships are considered.

Method

Participants

The present study used the same sample of participants as was used as in Study 1 and Study 2 (Chapter 4 and 5, respectively). The sample consisted of 2,865 students (50.4% female), from 17 high schools located in New South Wales and Queensland, Australia. The sample was representative of secondary schools in Australia with regard to socioeconomic status, and regional and rural settings. As part of a larger battery of questionnaires, participants completed aggression, mental ill-health, and friendship nominations in Grade 8, Grade 9, Grade 10, and Grade 11. A more detailed description of the participants and the procedure is presented in Chapter 4 (Study 1).

Instruments

Aggression

Aggression was measured using the 16-item aggression subscale of Achenbach (1991) Youth Self-Report Inventory. A more detailed description of the aggression scale can be found in the Methods section of Chapter 4 (Study 1).

Mental Ill-Health

As with Studies 1 and 2 (reported in Chapters 4 and 5, respectively), the 12-item General Health Questionnaire (GHQ-12; Goldberg & Hillier, 1979) was used to measure mental ill-health. A more detailed description of the GHQ is presented in Chapter 4.

Friendship Nominations

Friendship nominations were collected using a modified version of the nomination procedure reported by Coie et al. (1982) whereby participants were asked to nominate five of their closest male and female friends. A more detailed account of the nomination procedure is presented in Chapter 4 (Study 1).

Analysis Plan

In this study, I re-calculated the group aggression and group mental ill-health variables that are used in the subsequent analyses in this chapter. I first identified individuals' stable and unstable friendships for each year. Consistent with the reported literature (Poulin & Chan, 2010), stable friends were identified as those that existed across two waves of measurement, i.e., friends present at both Time 1 and Time 2 of data collection. While unstable friendships can reflect both friendship termination and friendship formation, the present study focused on friendship formation. More specifically, unstable friendships were identified as those individuals who were not friends in the previous time point, i.e., a friendship existed at Time 2 but not at Time 1. Stable and unstable (i.e., new) friendships were identified for reciprocal friendships, non-overlapping friendship groups, and most

influential friendship groups. For non-overlapping friendship groups, for example, stable friendships were those who were members of an individual's most influential friendship group at Time 1 and Time 2, while unstable friends were members who were group members at Time 2 but not at Time 1.

Group aggression and group mental ill-health scores were then calculated. For stable friendships, both group aggression and group mental ill-health scores were calculated as the average aggression and mental ill-health scores, respectively, of an individual's stable friends. Similarly, for unstable friendships, group aggression and group mental ill-health were calculated as the average aggression and mental ill-health scores, respectively, of an individual's unstable friendships. It is important to note that it was possible only to calculate group aggression and group mental ill-health scores for stable and unstable friendships for Grades 9, 10, and 11. Since the data for Grade 7 was unavailable, it was not possible to identify an individual's stable or unstable friendships for Grade 8. Thus, this study focuses only on the Grade 9, Grade 10, and Grade 11 time points.

Once group aggression and group mental ill-health were recalculated based on an individual's stable and unstable friendships, the rest of the analysis followed the same method as that of Study 1 and Study 2 (Chapters 4 and 5, respectively), albeit using only three waves of data instead of the four waves used in the previous studies. As with studies 1 and 2 (Chapters 4 and 5, respectively), I applied multilevel modelling methods to investigate the substantive research questions about the relations between aggression and mental ill-health at both the individual and group levels. Multiple imputation methods were also used to produce unbiased estimates of the missing data. A detailed description of both the multilevel modelling methods and the multiple imputation methods are presented in the Methods section of Study 1 in Chapter 4.

Results

Descriptive Statistics

Stability

Table 17 presents means, standard deviations, and median values for both the stable and unstable friendships that were calculated from each friendship group conceptualisation i.e., reciprocal, non-overlapping and most influential. For the reciprocal friendships, the youth in this sample had, on average, 1.5 stable friends and just over 2 unstable friends. In contrast, when friendships were conceptualised as non-overlapping groups, participants had, on average, 10 stable friendships although the median value was lower, ranging from 5 to 7 stable friendships. Moreover, the mean for the unstable friendships was greater, with the average number ranging from 10.64 to 20.10 across grades, with 8 being the most common number of unstable friendships. Finally, for the most influential friendship groups, the average number of stable and unstable friendships fell between the values for the reciprocal friendships and the non-overlapping friendship groups. Specifically, participants had, on average, 5 stable friendships and close to 7 unstable friendships when friendships were conceptualised using the most influential friendship groups. In sum, the descriptive statistics, i.e., means, standard deviations, and median values, are not comparable across reciprocal, non-overlapping and most influential friendship conceptualisations. However, regardless of how the friendship groups were conceptualised, participants tended to have a higher number of unstable friendships than they did stable friendships.

Table 17

Means, Standard Deviations and Median Values for Stable and Unstable Friendships for the Reciprocal Friendships, Non-Overlapping Groups and Most Influential Groups Across Grades

	Stable Friends			Unstable Friends		
	Grade 9	**Grade 10**	**Grade 11**	**Grade 9**	**Grade 10**	**Grade 11**
Reciprocal Friendships						
M (SD)	1.54(0.88)	1.78(1.04)	1.72(0.91)	2.37(1.43)	2.29(1.31)	2.05(1.18)
Median	1	1	1	2	2	2
Non-Overlapping Friendship Groups						
M (SD)	8.69(10.49)	9.97(10.48)	10.40(9.34)	15.70(20.14)	10.64(10.77)	20.10(33.61)
Median	5	5	7	8	8	8
Most Influential Friendship Groups						
M (SD)	4.82(4.73)	5.12(4.84)	4.37(3.26)	6.83(6.23)	6.74(6.59)	6.53(5.95)
Median	3	4	3	5	4	5

Note. M = mean number of stable/unstable friendships; SD = standard deviation.

Means and Standard Deviations

The means and standard deviations for individual aggression and individual mental ill-health are presented in Table 18. Notably, the individual level descriptive statistics are the same regardless of whether stable or unstable friendships are considered. As discussed in the results section of Chapter 4, means of approximately 1.4 suggest that, on average, participants viewed the aggressive statements as being somewhat or sometimes true, and very true or often true. In addition, means of approximately 2 suggests that the participants were not experiencing more mental ill-health concerns than normal.

Also presented in Table 18 are the mean scores and standard deviations, for group aggression and group mental ill-health for the three different friendship group conceptualisations when (i) only stable friendships were considered and (ii) when only unstable friendships were considered. Regardless of the friendship conceptualisation examined, the overall pattern of the mean scores for group aggression and group mental ill-health were comparable across stable and unstable friendships. This finding was observed for all grades. Average group aggression and group mental ill-health scores were also comparable to individual aggression and individual mental ill-health scores, indicating that individuals and groups reported similar levels of aggression and mental ill-health. Moreover, for each friendship group conceptualisation, the mean scores and standard deviations for group aggression and group mental ill-health observed in this study were similar to those reported in the previous studies of this thesis (see Chapter 4 for reciprocal and non-overlapping group means and standard deviations; see Chapter 5 for most influential friendship groups means and standard deviations).

Table 18

Means and Standard Deviations for all Study Variables Where Group Aggression and Group Mental Ill-Health Were Calculated Using Data from Both Stable and Unstable Friendships for Each Friendship Conceptualisation

	Stable Friendships			Unstable Friendships		
	Grade 9 *M(SD)*	Grade 10 *M(SD)*	Grade 11 *M(SD)*	Grade 9 *M(SD)*	Grade 10 *M(SD)*	Grade 11 *M(SD)*
Individual						
Agg	1.45(0.40)	1.41(0.35)	1.39(0.33)	1.45 (0.40)	1.41 (0.35)	1.39 (0.33)
GHQ	1.96(0.57)	1.98(0.55)	2.06(0.58)	1.96 (0.57)	1.98 (0.55)	2.06 (0.58)
Reciprocal						
L2Agg	1.42(0.34)	1.36(0.26)	1.35(0.25)	1.44(0.31)	1.39(0.24)	1.39(0.26)
L2GHQ	1.96(0.48)	1.98(0.48)	2.02(0.46)	1.99(0.46)	1.98(0.42)	2.06(0.47)
Non-Overlapping						
L2Agg	1.44(0.26)	1.40(0.21)	1.38(0.19)	1.44(0.23)	1.42(0.22)	1.39(0.20)
L2GHQ	1.98(0.37)	1.97(0.33)	2.05(0.31)	1.97(0.28)	2.00(0.33)	2.10(0.37)
Most Influential						
L2Agg	1.45(0.30)	1.38(0.22)	1.36(0.21)	1.43(0.25)	1.41(0.22)	1.39(0.20)
L2GHQ	1.96(0.39)	1.96(0.34)	2.05(0.38)	1.98(0.36)	1.98(0.32)	2.06(0.36)

Note. Agg = aggression; GHQ = mental ill-health; L2Agg = friendship group aggression; L2GHQ = friendship group mental ill-health; M = mean; SD = standard deviation. Aggression scale scoring: 1 = not true, 2 = sometimes or somewhat true, 3 = very true or often true. Mental ill-health scale scoring: 1 = better than usual, 2 = same as usual, 3 = worse than usual, 4 = much worse than usual.

Correlation Coefficients

Tables 19, 20, and 21 present the correlation coefficients between the study variables for the reciprocal friendships, non-overlapping friendship groups, and most influential friendship groups respectively. In each table, the lower triangle of the correlation table presents the coefficients for the stable friendships while the upper triangle presents the coefficients for the unstable friendships. As was done in Study 1 and Study 2 (Chapters 4 and 5, respectively), the correlation coefficients were interpreted in line with Funder and Ozer's (2019) guidelines for interpreting effect sizes, wherein 0.05, 0.10, 0.20, 0.30 and 0.40 indicate very small, small, medium, large, and very large effect sizes respectively. Here, there is a particular focus on how both group aggression and group mental ill-health correlate with other study variables, as these variables differ from those of previous studies as they were calculated using either stable or unstable friendships only.

When calculated using stable friendships, group aggression was found to be stable over time, as indicated by large to very large positive correlation coefficients for the reciprocal friendships (range: .33 to .43, Table 19), the non-overlapping groups (range: .24 to .36; Table 2018) and the most influential groups (range: .32 to .44, Table 21) friendship groups. In other words, if a group engaged in high levels of aggressive behaviours, they tended to do so across all time points. Moreover, group mental ill-health, calculated using stable friendships, was also found to be stable over time, as indicated by coefficients that ranged from small to large in size: from .17 to .30 for the reciprocal friendships (Table 19); from .10 to .28 for the non-overlapping groups (Table 20), and from .20 to .37 for the most influential groups (Table 21). Group aggression and group mental ill-health both showed lower levels of stability for the unstable friendships, across all friendship conceptualisations, when compared to the stable friendships. Specifically, smaller and sometimes statistically non-significant correlation coefficients were observed for group aggression for the reciprocal

friendships (range: -.01 to .27; Table 19); non-overlapping groups (range: 0 to .16; Table 20) and most influential groups (range: .18 to .29; Table 21) friendship groups. Similarly, lower levels of stability were observed for group mental ill-health, as evidenced by positive correlation coefficients ranging from .01 to .14 for the reciprocal friendships (Table 19); from 0 to .16 for the non-overlapping friendship groups (Table 20); and from .10 to .16 for the most influential friendship groups (Table 21). When taken together, group aggression and group mental ill-health were stable over time across all friendship conceptualisations when stable friendships were examined. As expected, lower levels of stability were observed for group aggression and group mental ill-health when unstable friendships were considered, regardless of the friendship group conceptualisations.

Regardless of whether stable or unstable friendships were considered, individual aggression was positively correlated with group aggression across all friendship conceptualisations. Correlation coefficients were small to large in magnitude, ranging from .13 to .22 for the stable reciprocal friendships, and from .04 to .31 for the unstable friendships (see Tables 19, 20 and 21). Therefore, if an individual engaged in higher levels of aggressive behaviours, they tended to be a member of a friendship group that also had higher levels of aggression, regardless of how the friendship group was conceptualised. Similarly, for both stable and unstable friendships, individual mental ill-health was positively correlated with group mental ill-health, such that individuals who suffered from higher levels of mental ill-health also tended to be members of friendship groups with high mental ill-health. This association was observed for the reciprocal friendships (stable friends range: .05 to .17; unstable friends range: .02 to .14; Table 19); non-overlapping friendship groups (stable friends range: .05 to .13; unstable friends range: .08 to .13; Table 20); and most influential friendship groups (stable friends range: .05 to .13; unstable friends range: .02 to .14; Table 21).

When stable friendships were considered, positive correlation coefficients were observed between group aggression and group mental ill-health for the reciprocal friendships (range: .17 to .44; Table 19), the non-overlapping friendship groups (range: .06 to .35; Table 20), and the most influential friendship groups (range: .16 to .38; Table 21). Thus, friendship groups with high levels of aggression tended to also have high levels of mental ill-health, regardless of how the friendship groups were conceptualised. When unstable friendships were considered, a number of the correlation coefficients between group aggression and group mental ill-health were of a small magnitude and statistically non-significant (reciprocal friendships range: -.05 to .43, Table 19; non-overlapping groups range: -.03 to .45 Table 20; most influential groups range: -.05 to .36, Table 21). Notably, however, correlation coefficients of a large or even very large magnitude tended to be observed between group aggression and group mental ill-health within the same time point. For example, group aggression in Grade 9 was positively correlated with group mental ill-health in Grade 9 and correlated to a lesser extent with group mental ill-health in Grades 10 or 11.

Table 19

Correlation Coefficients Between Individual and Group Aggression and Mental Ill-Health Across Three Time Points for the Reciprocated

Friendships, Where Group Aggression and Group Mental Ill-Health Were Calculated from Stable Friends (Lower Triangle) and Unstable

Friends (Upper Triangle)

	1	2	3	4	5	6	7	8	9	10	11	12
1.Agg9	-	.60***	.53***	.36***	.22***	.19***	.31***	.17***	.13**	.11**	.07*	.11**
2.Agg10	.60***	-	.58***	.20***	.33***	.21***	.18***	.17***	.14***	.07	.03	.07
3.Agg11	.53***	.58***	-	.18***	.19***	.28***	.18***	.16***	.11**	.10*	.11**	.10**
4.GHQ9	.36***	.20***	.18***	-	.47***	.41***	.11**	.09**	.02	.09*	.08*	.10*
5.GHQ10	.22***	.33***	.19***	.47***	-	.48***	.09*	.05	.06	.12**	.09**	.10**
6.GHQ11	.19***	.21***	.28***	.41***	.48***	-	.09*	.04	.05	.13**	.08*	.13***
7.L2Agg9	.22***	.18***	.19***	.12**	.09*	.05	-	.14***	.15**	.45***	.03	.04
8.L2Agg10	.15***	.20***	.16***	.07	.11**	.04	.42***	-	.13**	.10*	.28***	.06
9.L2Agg11	.13**	.13**	.18***	.06	.09*	.05	.33***	.43***	-	-.03	.07	.31***
10.L2GHQ9	.13**	.14**	.13**	.13**	.10*	.15**	.44***	.21***	.18**	-	.16***	.00
11.L2GHQ10	.05	.11**	.12**	.05	.14***	.11*	.17**	.38***	.26***	.24***	-	.04
12.L2GHQ11	.04	.07	.04	.17***	.13***	.22***	.23***	.20***	.17***	.17**	.30***	-

Notes. Agg9 = aggression in Grade 9; Agg10 = aggression in Grade 10; Agg11 = aggression in Grade 11; GHQ9 = mental ill-health in

Grade 9; GHQ10 = mental ill-health in Grade 10; GHQ11 = mental ill-health in Grade 11; L2Agg9 = friends' aggression in Grade 9;

L2Agg10 = friends' aggression in Grade 10; L2Agg11 = friends' aggression in Grade 11; L2GHQ9 = friends' mental ill-health in Grade 9;

L2GHQ10 = friends' mental ill-health in Grade 10; L2GHQ11 = friends' mental ill-health in Grade 11.

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

Table 20

Correlation Coefficients Between Individual and Group Aggression and Mental Ill-Health Across Three Time Points for Non-Overlapping

Friendship Groups, Where Group Aggression and Group Mental Ill-Health Were Calculated from Stable Friends (Lower Triangle) and

Unstable Friends (Upper Triangle)

	1	2	3	4	5	6	7	8	9	10	11	12
1.Agg9	-	.60***	.53***	.36***	.22***	.19***	.22***	.16***	.05	.11***	.05	.01
2.Agg10	.60***	-	.58***	.20***	.33***	.21***	.14***	.13***	.04	.06*	.01	.01
3.Agg11	.53***	.58***	-	.18***	.19***	.28***	.07**	.13***	.04	.10***	.03	.03
4.GHQ9	.36***	.20***	.18***	-	.47***	.41***	.05*	.06*	.09***	.05*	.06*	.14***
5.GHQ10	.22***	.33***	.19***	.47***	-	.48***	.04	.03	.05	.09***	.03	.11***
6.GHQ11	.19***	.21***	.28***	.41***	.48***	-	.02	.03	.05	.02	.03	.11***
7.L2Agg9	.22***	.17***	.14***	.05	.06*	.02	-	.27***	.11***	.35***	.06*	-.05
8.L2Agg10	.17***	.20***	.12***	.04	.06*	.07*	.36***	-	-.01	.11***	.33***	-.03
9.L2Agg11	.11***	.12***	.17***	.02	.06*	.04	.24***	.34***	-	.03	.03	.43***
10.L2GHQ9	.05*	.08**	.08**	.08**	.08**	.05	.35***	.13***	.06*	-	.14***	.03
11.L2GHQ10	.04	.06*	.05	.07**	.13***	.07*	.20***	.34***	.10***	.24***	-	.01
12.L2GHQ11	.05	.05	.04	.11***	.13***	.13***	.12***	.11***	.25***	.10***	.28***	-

Notes. Agg9 = aggression in Grade 9; Agg10 = aggression in Grade 10; Agg11 = aggression in Grade 11; GHQ9 = mental ill-health in

Grade 9; GHQ10 = mental ill-health in Grade 10; GHQ11 = mental ill-health in Grade 11; L2Agg9 = friends' aggression in Grade 9;

L2Agg10 = friends' aggression in Grade 10; L2Agg11 = friends' aggression in Grade 11; L2GHQ9 = friends' mental ill-health in Grade 9;

L2GHQ10 = friends' mental ill-health in Grade 10; L2GHQ11 = friends' mental ill-health in Grade 11.

* = $p < .05$; ** = $p < .01$; *** = $p < .001$

Table 21

Correlation Coefficients Between Individual and Group Aggression and Mental Ill-Health Across Three Time Points for the Most

Influential Friendship Groups, Where Group Aggression and Group Mental Ill-Health Were Calculated from Stable Friends (Lower

Triangle) and Unstable Friends (Upper Triangle)

	1	2	3	4	5	6	7	8	9	10	11	12
1.Agg9	-	.60***	.53***	.36***	.22***	.19***	.29***	.17***	.12***	.13***	.08*	.00
2.Agg10	.60***	-	.58***	.20***	.33***	.21***	.20***	.19***	.07*	.10***	.07**	.00
3.Agg11	.53***	.58***	-	.18***	.19***	.28***	.16***	.14***	.11***	.09**	.07*	.04
4.GHQ9	.36***	.20***	.18***	-	.47***	.41***	.11***	.03	.07*	.14***	.02	.09**
5.GHQ10	.22***	.33***	.19***	.47***	-	.48***	.09**	.07**	.03	.12***	.10***	.09**
6.GHQ11	.19***	.21***	.28***	.41***	.48***	-	.09**	.04	.05	.10**	.05	.11***
7.L2Agg9	.21***	.13**	.12**	.05	.04	.00	-	.29***	.18***	.28***	.16***	.02
8.L2Agg10	.16***	.17***	.13**	.06	.07*	.06	.44***	-	.20***	.05	.36***	-.01
9.L2Agg11	.09*	.17***	.14***	.01	.07	.06	.32***	.42***	-	-.05	.15***	.23***
10.L2GHQ9	.13***	.05	.09*	.10**	.13**	.09	.38***	.26***	.17**	-	.15***	.16***
11.L2GHQ10	.04	.05	.09*	.05	.13***	.11**	.16**	.37***	.16**	.28***	-	.10*
12.L2GHQ11	.10*	.12**	.11**	.08*	.10**	.05	.16**	.23***	.28***	.20**	.37***	-

Notes. Agg9 = aggression in Grade 9; Agg10 = aggression in Grade 10; Agg11 = aggression in Grade 11; GHQ9 = mental ill-health in

Grade 9; GHQ10 = mental ill-health in Grade 10; GHQ11 = mental ill-health in Grade 11; L2Agg9 = friends' aggression in Grade 9;

L2Agg10 = friends' aggression in Grade 10; L2Agg11 = friends' aggression in Grade 11; L2GHQ9 = friends' mental ill-health in Grade 9;

L2GHQ10 = friends' mental ill-health in Grade 10; L2GHQ11 = friends' mental ill-health in Grade 11.

$* = p < .05$; $** = p < .01$; $*** = p < .001$

Multilevel Models

To investigate selection processes, I used the data from unstable friendships, and I estimated three sets of four multilevel models, that is, a set for each of the friendship conceptualisations being examined in this study, i.e., reciprocal friendships, non-overlapping groups, and most influential groups. The results are presented in Tables 22, 23, and 24, respectively. In addition, to investigate socialisation processes, I used the data from stable friendships and estimated a second group of three sets of four multilevel models for the reciprocal friendships, non-overlapping groups, and most influential groups. The results are presented in Tables, 25, 26, and 27, respectively.

The models in the present study included three waves of data (Grade 9, Grade 10, and Grade 11) compared to the four waves of data included in models in Studies 1 and 2. The models were similarly structured in all other respects. Lagged scores of all study variables: namely (i) individual aggression; (ii) individual mental ill-health; (iii) group aggression and (iv) group mental ill-health, were included as predictors in all models. Each model had a different outcome variable: the outcome in Model 1 was individual aggression; the outcome in Model 2 was individual mental ill-health; the outcome in Model 3 was group aggression; and the outcome in Model 4 was group mental ill-health. Any effect of a lagged score on the outcome variable would indicate the effect of the predictor at Time 't' on the outcome at 't+1', accounting for all other effects in the model. As individual and group level variables were covaried in the same model, the estimated effects represent the unique effect of the individual and the group on the outcome variables. In each model, varying intercepts were used for participants and time, to account for the hierarchical nature of the data. Including students as a varying intercept in the model also prevents issues due to dependency from arising. In addition, gender and school were both controlled for to account for exogenous

effects (Gellman & Hill, 2006). As with the studies reported in Chapters 4 and 5, all study variables were standardised to facilitate the interpretation of the effect sizes.

Stability of Study Variables

When stable friendships were considered, individual aggression, individual mental ill-health, group aggression, and group mental ill-health were all stable over time for the reciprocal friendships (Table 22 Models 1, 2, 3, and 4), the non-overlapping friendship groups (Table 23, Models 1, 2, 3, and 4) and the most influential friendship groups (Table 24, Models 1, 2, 3, and 4). Thus, if, for example, a group experiences higher than usual levels of aggression, they tend to do so across all time points. When unstable friendships were examined, individual aggression, individual mental ill-health, and group aggression were also stable for the reciprocal friendships (Table 25, Models 1, 2 and 3), the non-overlapping friendship groups (Table 26, Models 1, 2 and 3), and the most influential friendship groups (Table 27, Models 1, 2 and 3). However, group mental ill-health was only found to be stable for the most influential friendship group conceptualisation (Table 27, Model 4). Taken together, analysing either stable or unstable friendships did not impact the stability of the study variables, with the exception of group mental ill-health, which did not demonstrate stability over time for the reciprocal friendships or the non-overlapping friendship groups when unstable friendships were considered.

Consistent with the results in Chapter 4 and Chapter 5, individual aggression was consistently found to be more stable over time than individual mental ill-health, with the autoregressive estimates for aggression being approximately twice as large as those for individual mental ill-health. A similar pattern was also observed at the group level, with estimates for group aggression being larger than those for group mental ill-health. In addition, the effect sizes for the individual variables were consistently larger than the effect sizes of the group level variables. Taken together, aggression was consistently more stable than mental

ill-health, at both the individual and the group level, while individual characteristics were more stable than the group characteristics.

Aggression

Regardless of how the friendship groups were conceptualised, and whether stable or unstable friends were examined, group aggression did not predict subsequent individual aggression, as shown by confidence intervals that included zero. When examining the unstable friendships, individual aggression was found to predict subsequent group aggression across all friendship conceptualisations (Table 25, Model 3; Table 26; Model 3; Table 27; Model 3). In other words, higher than usual levels of individual aggression predicted higher than usual levels of group aggression one year later. As this effect was observed for the unstable friendships, this finding indicates the presence of selection effects, whereby individuals with higher than usual levels of aggression are becoming members of friendship groups who also engage in higher levels of aggression.

When examining the stable friendships, individual aggression was also found to predict subsequent group aggression one year later for the non-overlapping groups (Table 23, Model 3) and the most influential groups (Table 24; Model 3). As this effect was observed for the stable friendships, it indicates the presence of socialisation effects for aggression, whereby the behaviour of the individual is influencing the behaviour of their stable friends over time. Notably, individual aggression did not predict future group aggression when stable reciprocated friendships were examined (Table 22, Model 3).

Taken together, these results support the first hypothesis of the present study, which stated that the association between individual and group aggression could be explained by both selection and socialisation processes. For the reciprocal friendships, only selection effects were observed. However, for both the non-overlapping and the most influential

friendship groups, evidence for both selection and socialisation effects were found, suggesting that both processes may be occurring simultaneously.

Mental Ill-Health

When unstable friendships were examined, individual mental ill-health was not found to predict subsequent group mental ill-health, as evidenced by confidence intervals that included zero. In addition, group mental ill-health was not found to predict subsequent individual mental ill-health for either the non-overlapping (Table 26, Model 2) or the most influential friendship groups (Table 27, Model 2). However, for the reciprocal friendships, group mental ill-health positively predicted individual mental ill-health. In other words, when an individual's group suffered from worse than usual mental ill-health, then they themselves tended to suffer from worse mental ill-health one year later.

In contrast, when the stable friendships were considered, group mental ill-health was not predictive of individual mental ill-health for any of the friendship group conceptualisations. Moreover, individual mental ill-health was not associated with subsequent group mental ill-health one year later for the reciprocal friendships (Table 22 Model 4) or the most influential friendship groups (Table 24, Model 4). However, individual mental ill-health was found to predict future group mental ill-health for the non-overlapping friendship groups (Table 23, Model 4). In other words, when an individual suffered from worse than usual mental ill-health, their friendship group tended to also suffer from worse than usual levels of mental ill-health one year later. This result indicates that socialisation processes may be occurring, whereby an individual suffering from worse mental ill-health influences their friendship group such that its members experience worse mental ill-health subsequently.

Thus, the second hypothesis of this study, which postulated that individual mental ill-health would predict future group mental ill-health in both stable and unstable friendship

analyses, was not supported as this effect was only observed for the stable friendships. In other words, socialisation processes, but not selection processes were observed for mental ill-health. Moreover, a novel association was found for the reciprocal friendships when the unstable friendships were examined: higher than usual levels of group mental ill-health predicted higher than usual levels of individual mental ill-health one year later.

Aggression and Mental Ill-Health

Regardless of how the friendship groups were conceptualised, lagged individual aggression was found to positively predict subsequent individual mental ill-health when stable (Table 22 Model 2; Table 23, Model 2; Table 24, Model2) and unstable (Table 25, Model 2; Table 26, Model 2; Table 27, Model 2) friendships were considered. Thus, if an individual reported higher than usual levels of aggression, they were likely to experience higher than usual levels of mental ill-health one year later. Notably, regardless of how friendship groups were conceptualised, lagged individual mental ill-health was not found to predict subsequent individual aggression, when either stable or unstable friendships were considered.

At the group level, lagged group aggression was found to positively predict group mental ill-health one year later when stable non-overlapping friendship groups (Table 23, Model 4) and unstable most influential friendship groups (Table 27, Model 4) were considered. In other words, if a group was engaging in higher than usual levels of aggressive behaviours, then they would likely suffer from worse mental ill-health one year later. Notably, no other associations were found between group aggression and group mental ill-health, regardless of whether stable or unstable friendships were considered, and regardless of how the friendship groups were conceptualised.

Table 28 summarises the multilevel model results presented in this chapter. More specifically, Table 28 contains a summary of how group aggression and group mental ill-

health scores were calculated for each of the friendship conceptualisations, for both the stable

and the unstable friendships. Table 28 also indicates the direction of the associations between

the study variables, in addition to indicating which results were statistically significant.

Table 22

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the Stable Reciprocal Friends

Variables at T	Estimate	SE	Confidence Interval	
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.620**	**0.019**	**0.582**	**0.659**
Individual Mental Ill-Health	0.005	0.015	-0.026	0.036
Group Aggression	0.027	0.037	-0.054	0.108
Group Mental Ill-Health	0.040	0.028	-0.020	0.100
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.086**	**0.018**	**0.050**	**0.122**
Individual Mental Ill-Health	**0.430**	**0.019**	**0.391**	**0.470**
Group Aggression	0.002	0.024	-0.049	0.053
Group Mental Ill-Health	0.014	0.030	-0.049	0.077
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	0.063	0.058	-0.066	0.193
Individual Mental Ill-Health	-0.007	0.043	-0.103	0.089
Group Aggression	**0.429**	**0.036**	**0.349**	**0.509**
Group Mental Ill-Health	0.076	0.047	-0.027	0.180
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.014	0.048	-0.092	0.120
Individual Mental Ill-Health	0.007	0.029	-0.055	0.069
Group Aggression	0.104	0.053	-0.012	0.221
Group Mental Ill-Health	**0.224**	**0.053**	**0.106**	**0.343**

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 23

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the Stable Non-Overlapping Group Friends

			Confidence Interval	
Variables at T	Estimate	SE	Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.628**	**0.016**	**0.595**	**0.662**
Individual Mental Ill-Health	0.007	0.016	-0.027	0.040
Group Aggression	0.029	0.019	-0.012	0.069
Group Mental Ill-Health	0.020	0.018	-0.017	0.057
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.096**	**0.024**	**0.045**	**0.147**
Individual Mental Ill-Health	**0.428**	**0.022**	**0.382**	**0.474**
Group Aggression	0.021	0.021	-0.022	0.064
Group Mental Ill-Health	0.004	0.018	-0.034	0.041
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.070**	**0.023**	**0.021**	**0.119**
Individual Mental Ill-Health	0.011	0.019	-0.028	0.048
Group Aggression	**0.357**	**0.026**	**0.301**	**0.413**
Group Mental Ill-Health	-0.007	0.018	-0.042	0.029
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.003	0.020	-0.037	0.043
Individual Mental Ill-Health	**0.035**	**0.016**	**0.002**	**0.067**
Group Aggression	**0.072**	**0.032**	**0.002**	**0.141**
Group Mental Ill-Health	**0.204**	**0.022**	**0.158**	**0.251**

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 24

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the Stable Most Influential Group Friends

Variables at T	Estimate	SE	Confidence Interval	
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.629**	**0.021**	**0.585**	**0.673**
Individual Mental Ill-Health	0.009	0.018	-0.029	0.046
Group Aggression	0.014	0.024	-0.036	0.065
Group Mental Ill-Health	0.016	0.022	-0.031	0.062
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.097**	**0.020**	**0.055**	**0.139**
Individual Mental Ill-Health	**0.424**	**0.017**	**0.390**	**0.459**
Group Aggression	-0.011	0.046	-0.111	0.090
Group Mental Ill-Health	0.030	0.028	-0.030	0.089
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.086**	**0.028**	**0.025**	**0.147**
Individual Mental Ill-Health	0.017	0.028	-0.043	0.077
Group Aggression	**0.471**	**0.050**	**0.261**	**0.582**
Group Mental Ill-Health	0.037	0.034	-0.037	0.011
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.058	0.028	-0.001	0.116
Individual Mental Ill-Health	0.005	0.027	-0.053	0.062
Group Aggression	0.086	0.061	-0.051	0.223
Group Mental Ill-Health	**0.291**	**0.058**	**0.161**	**0.420**

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 25

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the Unstable Reciprocal Friends

Variables at T	Estimate	SE	Confidence Interval Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.623**	**0.017**	**0.588**	**0.658**
Individual Mental Ill-Health	0.002	0.018	-0.034	0.039
Group Aggression	0.035	0.022	-0.012	0.081
Group Mental Ill-Health	0.031	0.020	-0.010	0.072
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.097**	**0.020**	**0.056**	**0.138**
Individual Mental Ill-Health	**0.422**	**0.021**	**0.378**	**0.466**
Group Aggression	-0.002	0.026	-0.056	0.052
Group Mental Ill-Health	**0.036**	**0.018**	**0.000**	**0.072**
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.165**	**0.025**	**0.114**	**0.217**
Individual Mental Ill-Health	0.013	0.028	-0.046	0.072
Group Aggression	**0.103**	**0.038**	**0.021**	**0.185**
Group Mental Ill-Health	0.058	0.034	-0.015	0.130
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.059	0.026	0.005	0.112
Individual Mental Ill-Health	0.046	0.021	0.004	0.088
Group Aggression	-0.012	0.034	-0.086	0.061
Group Mental Ill-Health	0.098	0.031	0.031	0.164

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 26

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the Unstable Non-Overlapping Group Friends

Variables at T	Estimate	SE	Confidence Interval	
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.623**	**0.023**	**0.575**	**0.671**
Individual Mental Ill-Health	0.004	0.016	-0.028	0.036
Group Aggression	0.027	0.027	-0.007	0.061
Group Mental Ill-Health	-0.000	0.017	-0.035	0.035
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.097**	**0.017**	**0.062**	**0.131**
Individual Mental Ill-Health	**0.421**	**0.015**	**0.392**	**0.037**
Group Aggression	-0.006	0.021	-0.048	0.037
Group Mental Ill-Health	0.007	0.017	-0.027	0.041
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.090**	**0.023**	**0.043**	**0.137**
Individual Mental Ill-Health	0.006	0.020	-0.034	0.046
Group Aggression	**0.130**	**0.031**	**0.063**	**0.198**
Group Mental Ill-Health	-0.011	0.021	-0.053	0.032
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.010	0.016	-0.022	0.043
Individual Mental Ill-Health	0.030	0.017	-0.004	0.065
Group Aggression	-0.005	0.021	-0.048	0.038
Group Mental Ill-Health	-0.005	0.020	-0.047	0.0361

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 27

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the Unstable Most Influential Group Friends

Variables at T	Estimate	SE	Confidence Interval	
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.614**	**0.019**	**0.574**	**0.654**
Individual Mental Ill-Health	0.004	0.023	-0.045	0.052
Group Aggression	0.028	0.017	-0.008	0.063
Group Mental Ill-Health	**0.038**	**0.018**	**0.001**	**0.075**
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.096**	**0.021**	**0.051**	**0.140**
Individual Mental Ill-Health	**0.419**	**0.020**	**0.377**	**0.460**
Group Aggression	0.017	0.021	-0.027	0.060
Group Mental Ill-Health	-0.004	0.016	-0.036	0.029
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.111**	**0.028**	**0.051**	**0.171**
Individual Mental Ill-Health	-0.012	0.026	-0.068	0.042
Group Aggression	**0.221**	**0.024**	**0.170**	**0.272**
Group Mental Ill-Health	-0.009	0.021	-0.051	0.034
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.025	0.020	-0.017	0.066
Individual Mental Ill-Health	-0.005	0.030	-0.068	0.058
Group Aggression	**0.053**	**0.022**	**0.008**	**0.098**
Group Mental Ill-Health	**0.050**	**0.021**	**0.006**	**0.093**

Notes. T = Time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table 28

Summary table of the multilevel model results from Study Chapter 3

Variables at T	Variables at T+1			
	Agg	GHQ	L2Agg	L2GHQ
Reciprocal friendships: L2Agg and L2GHQ scores were computed as the average aggression and mental ill-health scores, respectively, of an individual's stable reciprocated friendships.				
Agg	+	+	+	+
GHQ	+	+	-	+
L2Agg	+	+	+	+
L2GHQ	+	+	+	+
Non-overlapping groups: L2Agg and L2GHQ scores were computed as the average aggression and mental ill-health scores, respectively, of an individual's stable friendships in their non-overlapping friendship groups.				
Agg	+	+	+	+
GHQ	+	+	+	+
L2Agg	+	+	+	+
L2GHQ	+	+	-	+
Overlapping groups: L2Agg and L2GHQ scores were computed as the average aggression and mental ill-health scores, respectively, of an individual's stable friendships in their friendship groups in which they nominated most friends (i.e., biggest outdegree group).				
Agg	+	+	+	+
GHQ	+	+	+	+
L2Agg	+	-	+	+
L2GHQ	+	+	+	+
Reciprocal friendships: L2Agg and L2GHQ scores were computed as the average aggression and mental ill-health scores, respectively, of an individual's unstable reciprocated friendships.				
Agg	+	+	+	+
GHQ	+	+	+	+
L2Agg	+	-	+	-
L2GHQ	+	+	+	+
Non-overlapping groups: L2Agg and L2GHQ scores were computed as the average aggression and mental ill-health scores, respectively, of an individual's unstable friendships in their non-overlapping friendship groups.				
Agg	+	+	+	+
GHQ	+	+	+	+
L2Agg	+	-	+	-
L2GHQ	-	+	-	-
Overlapping groups: L2Agg and L2GHQ scores were computed as the average aggression and mental ill-health scores, respectively, of an individual's unstable friendships in their friendship groups in which they nominated most friends (i.e., biggest outdegree group).				
Agg	+	+	+	+
GHQ	+	+	-	-
L2Agg	+	+	+	+
L2GHQ	+	-	-	+

Notes. T= time; Agg = Aggression; GHQ = mental ill-health; L2Agg = friends' aggression;

L2GHQ = friends' mental ill-health; + = a positive estimate; - = a negative estimate

Dark shaded boxes are those for which there was a significant estimate between the variables.

Discussion

The primary aim of this study was to provide further insight into the substantive findings of this thesis. Specifically, this study investigated whether selection and/or socialisation processes accounted for the observed associations between individual aggression and group aggression and between individual mental ill-health and group mental ill-health. To achieve the research aims of this study, I classified individuals' friendships as being either stable or unstable and performed separate analyses for both classifications. Comparing the results of the stable and unstable friendship analyses reveals the individual contribution of selection and socialisation processes, in that effects observed for the stable friendships are a proxy for socialisation processes while effects for the unstable friendships are a proxy for selection processes. The results, discussed in more detail below, build on the substantive results from Study 1 (Chapter 4) while also contributing to our understanding of selection and socialisation processes in the context of aggression and mental ill-health.

Aggression

When stable friendships were examined, individual aggression was found to positively predict subsequent group aggression for the non-overlapping and most influential friendship groups. This finding indicates that an individual engaging in more aggressive behaviours than usual tended to be a member of a friendship group that engaged in more aggressive behaviours than usual one year later. As this effect was observed for stable friendships, this suggests individuals are influencing their friendship group via socialisation processes. That is to say, the behaviour of the individual influences the behaviour of the stable members of their friendship groups.

Moreover, when unstable friendships were investigated, individuals who engaged in more aggressive behaviours than usual tended to subsequently be a member of a friendship group that engaged in high levels of aggressive behaviours. This finding supports the

existence of selection processes for aggressive behaviours. Specifically, individuals engaging in higher levels of aggressive behaviours choose to become members of friendship groups who also engage in higher levels of aggression. It may be that individuals select friendship groups with levels of aggression similar to their own as their own aggressive behaviours are likely to be better accepted among the group members. Thus, as hypothesised, both selection and socialisation processes play a part in the peer influence effects of aggressive behaviours.

Collectively, these results support published empirical research that has found evidence of both selection (e.g., Espelage et al., 2003; Hektner et al., 2000; Laninga-Wijnen et al., 2017) and socialisation (e.g., Sijtsema et al., 2010; Werner & Hill, 2010) processes for aggressive behaviours, as well as those that report the simultaneous occurrence of both selection and socialisation processes (e.g., Dijkstra et al., 2011; Mrug et al., 2004; Werner & Crick, 2004).

Mental Ill-Health

For stable friendships, individual levels of mental ill-health were found to predict future group levels of mental ill-health when the friendship groups were conceptualised as being non-overlapping. Specifically, if an individual suffered worse than usual mental ill-health, then stable members of their friendship group tended to suffer from worse than usual mental ill-health one year later. Thus, socialisation processes may be occurring within the non-overlapping friendship groups, whereby an individual suffering from worse mental ill-health influences their friendship group such that other members subsequently also experience worse mental ill-health. This result is consistent with the results of several empirical studies that have observed socialisation effects for mental ill-health, particularly for depression (e.g., Van Zalk et al., 2010). However, it is important to note that socialisation effects were not observed for mental ill-health for the reciprocal friendships or the most

influential friendship group conceptualisations. Thus, socialisation processes appear to operate differently depending on how the friendship groups are conceptualised.

For unstable friendships, individual mental ill-health was not found to predict subsequent group mental ill-health, regardless of how the friendship groups were conceptualised. Thus, I did not find evidence for selection processes in the context of mental ill-health. Interestingly, for unstable friendships, group mental ill-health was found to positively predict individual mental ill-health when friendships were conceptualised as being reciprocal. Specifically, higher levels of group mental ill-health predicted subsequent worse than usual mental ill-health at the individual level. Notably this observation is an effect unique to this study and was not observed in either Studies 1 or 2 (Chapters 4 and 5, respectively).

Taken together, socialisation of mental ill-health was found in the non-overlapping friendship groups, but not in any other friendship conceptualisation. In addition, regardless of how the friendship groups were conceptualised, there was no evidence to suggest that individuals selected friends based on similarity in mental ill-health. These results contrast with the numerous empirical studies that have reported support for both selection (e.g., Giletta et al., 2011; Hogue & Steinberg, 1995; Mercer & Derosier, 2010) and socialisation (e.g., Van Zalk et al., 2010) processes for mental ill-health. There are two potential explanations for these different conclusions. The first concerns the co-occurrence of aggression and mental ill-health behaviours. Research has consistently found that aggression and mental ill-health tend to co-occur, such that individuals with high levels of aggression also tend to suffer from higher levels of mental ill-health (e.g., Card et al., 2008; Klomek et al., 2007; Meeus et al., 2016). Thus, studies that have observed selection and socialisation processes for mental ill-health may instead be detecting selection and socialisation processes for externalising behaviours such as aggression. Therefore, the limited evidence for selection

and socialisation processes for mental ill-health in this study may be a consequence of aggression being controlled for in all analyses. A second possibility concerns the power of the analysis. In running separate analyses for stable and unstable friendships, the sample size at the group level was reduced by splitting it into two groups. Consequently, there may be insufficient power to detect selection and socialisation effects for mental ill-health. Replication of this study with a larger sample size is required to provide further insight into the validity of these potential explanations.

Chapter Summary

In this chapter, I investigated whether associations between individual aggression and group aggression, and between individual mental ill-health and group mental ill-health could be attributed to selection or socialisation processes. By separately examining stable and unstable friendships, I was able to investigate both selection and socialisation processes in the context of friendship groups. The results support both selection and socialisation processes for aggression across multiple friendship conceptualisations. Therefore, I conclude that individuals are simultaneously selecting friends with levels of aggression similar to their own and also influencing their friends to adopt aggressive behaviours.

Less consistent evidence was found to support selection and socialisation processes for mental ill-health. Two explanations are proposed to account for this finding. The first explanation is that selection and socialisations are not observed for mental ill-health and that empirical studies that report evidence to the contrary are instead reporting on selection and socialisation processes of externalising behaviours such as aggression. The second explanation is methodological, proposing there is insufficient power in the sample size to detect selection and socialisation effects for mental ill-health. The results from this study provide further insight into the substantive findings from both Studies 1 and 2 (Chapters 4

and 5, respectively) while also contributing to our understanding of peer influence processes

as reported in the literature.

Chapter 7: General Discussion

Introduction

This thesis aimed to make both substantive and methodological contributions to the peer influence literature. Substantively, I investigated the longitudinal links between aggression and mental ill-health in the context of friendship groups. Key questions focused on how aggression and mental ill-health were associated with each other over time at both the individual and the friendship group level. Methodologically, I compared the consequences of using different friendship group conceptualisations on clarifying the substantive questions of this thesis.

In Chapter 4, I explored the longitudinal associations between aggression and mental ill-health in the context of three different friendship conceptualisations, namely reciprocal friendships, non-overlapping friendship groups, and overlapping friendship groups. I identified several novel associations which make a unique contribution to the peer influence literature. In Chapter 5, I sought to address problematic levels of collinearity between group aggression and group mental ill-health for the overlapping friendship group conceptualisation. I concluded that collinearity is produced by the weighting procedure used and argued that selecting an individual's most influential friendship group from the multiple groups of which they are members is the most appropriate method to achieve the research aims of this thesis. Thus, in Chapter 6, I used individuals' most influential friendship groups, together with reciprocal friendships and non-overlapping friendship groups, to provide further insight into the substantive findings of this thesis. Specifically, I investigated whether selection and/or socialisation processes account for the associations between individual aggression and group aggression, and between individual mental ill-health and group mental ill-health.

Overall, there were five main findings in this thesis. The first was that individual aggression predicted increases in group aggression over time via both selection and socialisation processes. The second was that individual mental ill-health predicted increases in group mental ill-health one year later, likely as a consequence of socialisation processes. The third was that youth who engaged in high levels of aggressive behaviours tended to subsequently suffer from worse mental ill-health. The fourth was that, at the group level, high levels of aggression also predicted worse mental ill-health over time. In addition, when a group suffered from worse mental ill-health, the group tended to subsequently engage in fewer aggressive behaviours. Thus, there was evidence for a homeostatic process occurring between group aggression and group mental ill-health. The fifth finding was that some peer influence processes were operating at friendship conceptualisations of one kind, but not the other. For example, regardless of friendship conceptualisation, individual aggression predicted subsequent increases in individual mental ill-health and individual aggression predicted subsequent increases in group aggression. In contrast, associations between individual mental ill-health and group mental ill-health, and between group aggression and group mental ill-health were only observed when the friendships were conceptualised as being non-overlapping or most influential friendship groups.

In this chapter, I begin by elaborating on the five main findings described above, while also integrating the results within the broader psychological literature. In addition, I discuss both strengths and weaknesses of the studies reported herein. I then outline several avenues for future research. Finally, I end this chapter with a seminal conclusion for the studies presented in this thesis.

Summary and Interpretation of Key Findings

Aggression

With regard to aggression, individual aggression was found to positively predict group aggression one year later. More specifically, if an individual's level of aggression was higher than usual, then their friendship group tended to show higher than usual levels of aggression one year later. Thus, an association was observed between individual and group aggression. Interestingly, however, group aggression was not found to predict subsequent individual aggression in any studies reported herein. Past literature has consistently reported that it is friendship group aggression that predicts subsequent individual aggression (e.g., Espelage et al., 2003; Low et al., 2013; Sijtsema et al., 2010; Werner & Crick, 2004; Werner & Hill, 2010). However, closer inspection of these studies reveals a limitation in their methodology, whereby the studies only examine predictors of individual aggression, and not the predictors of group aggression. For example, in the study conducted by Espelage et al. (2003), the authors focused on predicting individual aggression at Time 2, with friends' aggression only being measured at Time 1 to be used as a predictor. A similar method was used in a number of other studies that reported that friendship group aggression predicted future individual level aggression (e.g., Low et al., 2013; Werner & Hill, 2010). Thus, whether individual aggression influences group aggression over time has not been adequately investigated in the literature.

To test whether omitting friends' aggression as an outcome from analyses would impact the results in this thesis, I conducted additional multilevel model analyses for the reciprocal friendships, the non-overlapping friendship groups, the biggest friendship groups, and the most influential friendship groups whereby lagged individual aggression and lagged group aggression were included as predictors and individual aggression was included as an outcome. The results of these models can be found in Table S15 of the Supplementary

Materials. Interestingly, group aggression was not found to predict individual aggression, regardless of how the friendship groups were conceptualised. Thus, in the present sample, group aggression did not predict individual aggression in the comprehensive models run in Chapters 4 and 5, nor when models mimicked those most often used in the literature.

Additional strengths of the studies included in this thesis lend further support for the direction of causation observed in this thesis, whereby individual aggression positively predicts subsequent group aggression. While many of the longitudinal studies reported in the literature cover a relatively short period of time, tending to follow participants over the course of 1 year only (e.g., Espelage et al., 2003; Low et al., 2013; Werner & Hill, 2010), the investigations presented here included multiple waves of data, following participants over the course of four years. Thus, the multiple waves of data, combined with group aggression being measured at all time points, and a comprehensive series of models that test individual and group variables as both predictors and outcomes in a theory driven manner, lends further support for the results presented herein.

Moreover, I sought to further contribute to our understanding of how individual aggression predicts group aggression by investigating the roles of selection and socialisation processes. Specifically, I investigated whether an aggressive individual became a member of a friendship group that engaged in more aggressive behaviours (i.e., selection), or whether friends in a group adopted the individual's aggressive behaviours over time (i.e., socialisation). In Chapter 6, I found evidence for both selection and socialisation effects, suggesting that both processes may occur simultaneously in adolescent friendship groups.

Selection effects support the similarity attraction hypothesis, which states that individuals who are more similar to one another will be attracted to one another and, thus, are more likely to become friends (Berger & Calabrese, 1974; Byrne & Nelson, 1965). Specifically, as aggressive adolescents tended to become members of aggressive friendship

groups, this suggests that individuals may be drawn to, and become members of, groups of individuals that display levels of aggression that were similar to their own. Moreover, socialisation effects support the central tenet of social learning theory whereby individuals learn behaviours from those with whom they most frequently associate (Bandura, 1973, 1978). However, the direction of influence for social learning theory and the results of this thesis appear to differ. While social learning theory argues that the individual is influenced by their friends, I found friendship groups to be influenced by the individual.

More recently, attention has been brought to the fact that those doing the influencing are also being influenced, and that the influence processes occurring in peer groups are likely more bidirectional than theories (including social learning theory) would indicate. Thus, this discrepancy between my results and those hypothesised by social learning theory may reflect social learning theory's orientation towards how the individual is influenced. This focus on the individual may have a number of unintended consequences. For example, the longitudinal mechanism proposed, whereby the friends influence the individual, may be steering research towards a focus on this causal direction, to the exclusion of studies that examine the effect of an individual's influences on the group. This issue is particularly prominent in the aggression literature where the vast majority of studies have examined how the aggressive behaviours of an individual's friends influence their own behaviour, without also examining how the individual influences the friends (e.g., Espelage et al., 2003; Low et al., 2013; Werner & Hill, 2010). It is important that, going forward, peer influence processes are viewed more dynamically and that study designs allow for the emergence of peer influence processes where the individual's behaviours influence their friends' behaviours.

Previous research has emphasised a need for intervention and prevention programmes to go beyond the promotion of social influence skills and begin to focus more on the broader social structures of an adolescents' peer network and the peer influence processes that are

occurring within them (Dishion & Owen, 2009; Pearson & West, 2003; Valente et al., 2003).

Thus, knowing whether selection or socialisation mechanisms are responsible for peer influence effects has important implications for prevention and intervention programmes. The presence of selection effects might indicate a need to focus on implementing and developing group norms that are in line with the desired behaviour. In the context of aggression, for example, this may involve establishing group norms where aggressive behaviours are not tolerated. The presence of socialisation effects can aid in identifying the source of a behaviour. For example, in this thesis, I found that aggressive individuals influence the aggressive behaviours of their friends over time. Thus, focusing the resources of an intervention on the most aggressive individual in a group may be an effective way of preventing the development of aggressive behaviours in other group members.

Mental Ill-Health

A longitudinal association was found between individual mental ill-health and group mental ill-health, whereby if an individual suffered from worse than usual mental ill-health, then their friendship group tended also to suffer from worse than usual mental ill-health one year later. Thus, it appears that individual levels of mental ill-health can negatively impact other members of the friendship group. This finding is in line with a study by Goodwin et al. (2012), wherein individuals' levels of depression were found to influence their friends' depression levels over time, although not consistently across all the grades examined. However, the majority of empirical studies propose the converse of this associations, whereby friends' levels of mental ill-health influence individual levels of mental ill-health over time (e.g., Guan & Kamo, 2016; Kiuru et al., 2012; Prinstein, 2007; Stevens & Prinstein, 2005).

Notably, studies that found friends' mental ill-health predicted subsequent individual levels of mental ill-health are limited in their study design in that they rarely examine friends'

mental ill-health as an outcome (e.g., Stevens & Prinstein, 2005). Thus, it is not possible to determine whether individuals are also influencing their friends, a potential limitation of published research. As was done for aggression, to assess whether omitting friends' mental ill-health as an outcome from the analyses would impact the results in this thesis, I conducted additional multilevel models for the reciprocal friendships, the non-overlapping friendship groups, the biggest friendship groups, and the most influential friendship groups whereby lagged individual mental ill-health and lagged group mental ill-health were included as predictors and individual mental ill-health was included as an outcome. The results of these models can be found in Table S16 in the Supplementary Materials. Interestingly, group mental ill-health was not found to predict individual mental ill-health, regardless of how the friendship groups were conceptualised, providing further support for the results observed in this thesis and for those reported by Goodwin et al. (2012). This lends further support to the result observed in this thesis, whereby individual mental ill-health positively predicted group mental ill-health, but group mental ill-health did not predict individual mental ill-health.

Another potential explanation as to why the results in this thesis differed from the majority of empirical studies concerns the type of social network analysis that was done. Studies including, Kiuru et al., 2011, Sijstema et al., 2010, and Van Zalk et al., 2011 all use dynamic social network analysis. In contrast, the methods used in this thesis, namely friendship group conceptualisation combined with multilevel models, constitutes static network analysis. It may be the case that dynamic network methods capture more temporal changes in the network (Farine, 2018), than do the static approach used here, a factor potentially contributing to the conflicting results.

In this thesis, I also sought to further contribute to the peer influence literature by exploring the role of selection and socialisation processes in the association between individual and group mental ill-health. Specifically, I investigated whether an individual with

high levels of mental ill-health chose to become a member of a friendship group that suffered from worse mental ill-health (i.e., selection), or whether friends adopted mental ill-health behaviours from the individual (i.e., socialisation). When the unstable friendships were examined, I did not find evidence that individual levels of mental ill-health predicted subsequent group levels of mental ill-health. Thus, I did not find evidence for selection processes. Although numerous studies have found evidence for selection effects for mental ill-health (e.g., Giletta et al., 2011; Hogue & Steinberg, 1995; Mercer & Derosier, 2010), the lack of selection effects for mental ill-health is not altogether surprising. Mental ill-health tends not to be a readily observable trait in others and may only become apparent once the friendship has developed (Ojanen et al., 2013). Thus, it may be difficult for an individual to identify individuals with mental ill-health levels that are similar to their own. However, it should also be noted that in running separate analyses for stable and unstable friendships, the sample size at the group level was reduced by splitting it into two groups. Consequently, an alternative explanation for not observing selection effects is that the sample size may lack sufficient power to detect them. Future research with larger sample sizes is needed to provide further insight into the validity of this explanation.

When the stable friendships were examined, there was support for socialisation processes regarding individual and group mental ill-health, at least for the non-overlapping friendship groups. This result indicates that the individual is influencing their friendship group, causing the friendship group to suffer from worse mental ill-health over time. The presence of socialisation effects provides partial support for the tenets of social learning theory (Bandura, 1973, 1978). Specifically, while mental ill-health behaviours appeared to be learned or adopted by others, social learning theory would argue that it is the behaviours of friends that influence the individual. However, it is important to note that those doing the influencing are also being influenced, and thus, influence processes are likely more dynamic

than theories, including social learning theory, would indicate. It is important that future theoretical and empirical research captures the dynamic nature of peer influence processes.

Aggression and Mental Ill-Health

Individual aggression was found to predict subsequent individual mental ill-health, such that an individual who engaged in higher than usual levels of aggression tended to suffer from worse than usual mental ill-health one year later. This result is supported by numerous empirical studies that report that individuals who engage in aggressive behaviours suffer mental ill-health consequences (e.g., Cleverley et al., 2012; Crick et al., 2006; Moore et al., 2014). Theoretically, this result supports the failure model (Capaldi, 1992; Patterson & Capaldi, 1990; Patterson & Stoolmiller, 1991) and self-determination theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2017). Both of these theories postulate that, as a consequence of aggressive behaviours, youth are more likely to experience impairments or failures, often in their ability to function optimally in social contexts and to form genuine social connections. Over time, the failures contribute to mental ill-health problems. Notably, the failure model stemmed predominantly from research on conduct disorder and depression (Evans & Fite, 2019). Thus, this result also provides preliminary evidence for the application of the failure model to aggression and mental ill-health. However, as aggression has often been linked to aspects of successful social functioning, including popularity (Bagwell et al., 2000; Cillessen & Borch, 2006; Pouwels et al., 2016), status (Cillessen & Mayeux, 2004; Vaillancourt & Hymel, 2006), and peer acceptance (Cillessen & Borch, 2006; Hawley et al., 2007), further research is needed to determine whether the same failure processes, i.e., failure in social functioning, apply to both conduct disorder and aggression.

Interestingly, in a novel contribution to the literature, associations were also found between aggression and mental ill-health at the group level. Specifically, if a friendship group engaged in higher than usual levels of aggression, then the group would suffer from

subsequent worse mental ill-health, controlling for any individual level influence. Moreover, when a friendship group suffered from higher than usual levels of mental ill-health, their engagement in aggressive behaviours would decrease over time. Thus, there is evidence for a homeostatic process between aggression and mental ill-health at the group level, whereby aggressive friendship groups develop worse mental ill-health which in turn decreases their levels of aggression. Notably, these effects differed in magnitude, with the influence of group mental ill-health on group aggression being almost twice that of group aggression on group mental ill-health. The existence of group level effects for aggression and mental ill-health emphasises the importance of also researching the impact of peer influence processes at the group level.

First, considering that group aggression positively predicts group mental ill-health, it may be that the mechanisms by which aggression predicts mental ill-health at the individual level may also play a role at the group level. According to the failure model, engaging in aggressive behaviours causes failures in various aspects of an individual's life, including their ability to function optimally in a social context. Repeated exposure to such failures, over time, contributes to mental ill-health (Capaldi, 1992; Granic & Patterson, 2006; Patterson & Capaldi, 1990). Similarly, self-determination theory argues that aggressive individuals are more likely to engage in behaviours that undermine connectedness with others, including bullying and manipulation (Hawley et al., 2009; Ziegler, 2014). Thus, such individuals are less likely to form genuine and positive social relations with others with a consequent negative impact on their wellbeing (Ciarrochi et al., 2019). Extrapolation of these theories from the individual level to the group level suggest that when a group engages in aggressive behaviours, they are failing to interact in a positive or genuine manner with others in their social network, whether that be other friendship groups or other individuals within their

social network. Consequently, this has a negative impact on the mental health of the group. Further research is needed to test this assertion.

Secondly, accounting for how high levels of group mental ill-health predict lower levels of group aggression at subsequent time points is less straightforward. The finding that group mental ill-health predicts subsequent reductions in a group aggression initially seems inconsistent with theoretical models typically invoked when examining aggression and mental ill-health, such as the failure model (Capaldi, 1992; Patterson & Capaldi, 1990; Patteron & Stoolmiller, 1991) and the acting-out model (Carlson & Cantwell, 1980; Wolff & Ollendick, 2006). Specifically, these models assume the relations between aggression and mental ill-health are positive, with increases in one being associated with increases in the other. However, the findings of this thesis are consistent with other well-established biological models, such as the fight, flight, or freeze model (Bracha et al., 2004; Maack et al., 2015). According to this model, when threatened, people will respond either defensively (i.e., fight) or in an avoidant manner (i.e., flight or freeze; Maack et al., 2015). Based on parallels drawn between threatening situations and mental ill-health, it is argued that mental ill-health corresponds to flight or freeze responses, both of which are incompatible with the display of externalising behaviours, such as aggression (Morin et al., 2017). Empirically, Morin et al. (2017) found support for this proposition, whereby they found internalising and externalising behaviours to share a mutually suppressing reciprocal association over time in a sample of Australian students assessed annually from Grade 7 to Grade 10. Thus, in the context of the peer group in this thesis, suffering from high levels of mental ill-health may cause the group to engage in flight or freeze responses which are incompatible with subsequent engagement in aggressive behaviours.

Alternatively, the mechanisms by which mental ill-health is associated with aggression at the individual level may not apply to the group level. Instead, reductions in

aggressive behaviours may be a consequence of norms or structures within the group, or even within the broader social network, that influence or moderate the degree to which a group engages in aggressive behaviours. Future research is needed to determine which, if any, of the mechanisms proposed above can account for the homeostatic process between aggression and mental ill-health at the group level.

Friendship Groups

Methodological Issues

Looking first at the overlapping friendship groups, problematic levels of collinearity were observed between group aggression and group mental ill-health when the groups were weighted by size or by outdegree, but not when the biggest or most influential groups were selected. This suggests that collinearity was the result of the weighting procedure used, rather than the metric used to weight the groups. Notably, Sahdra et al. (2020) did not report any collinearity concerns when using overlapping friendship groups that were weighted by size to examine felt discrimination in adolescent friendship groups. Upon closer inspection, the main difference between Sahdra et al.'s (2020) study and the study in this thesis is that Sahdra et al. (2020) investigated only one group level variable, while two, namely group aggression and group mental ill-health, were examined here. As collinearity was only observed between the group level variables, this does not rule out the possibility that collinearity would have also been observed had Sahdra et al. (2020) included a second group level variable. Thus, weighting the overlapping friendship groups, regardless of the metric used, may be an appropriate procedure when investigating one group level variable, but not when two are being examined.

An additional consideration when determining whether the weighting procedure is appropriate for addressing the research aims of a study is the degree of overlap at the group level. In this thesis, half of the sample were members of more than one friendship group, with

most participants being a member of between one and four groups. Thus, the degree of repetition in individual scores at the group level may be greater in the present sample and, consequently, result in greater collinearity issues. This weighting procedure may be more suited to networks that are characterised by low levels of overlap. An example might be an organisational setting whereby most individuals work in non-overlapping teams and only a small number of people move between the groups, perhaps in a supervisory capacity.

Since two group level variables and friendship groups with a high degree of overlap were examined in this thesis, a different operationalisation was needed for the overlapping friendship groups to achieve the research aims of this work. Thus, in Chapter 5, I investigated the associations between aggression and mental ill-health in the context of both an individual's biggest group and an individual's most influential group, i.e., biggest outdegree group. I conclude that, for two reasons, an individual's most influential group is the most appropriate conceptualisation to use to achieve the research aims of this thesis. First, I was particularly interested in peer influence processes in this thesis. Thus, given that larger groups are not necessarily more influential (Değirmencioğlu et al., 1998; Hussong, 2002; Sokolocska et al., 2016), and that individuals appear to be influenced to a greater extent by the behaviours of those whom they identify as being their friend i.e., outdegree nominations (Faris & Ennett, 2012; Meter et al., 2015), I argue that focusing on an individual's most influential group was more suitable in the context of this thesis, compared to an individual's largest friendship group. Secondly, from a methodological perspective, when the results for the most influential groups were examined, they were comparable to those of the non-overlapping friendship groups. The non-overlapping friendship groups were identified using the infoMap group detection algorithm which is considered to be one of the most accurate disjoint group detection methods. Thus, given the alignment of results across these two methods, this lends

weight to the results from the most influential friendship groups. Thus, individuals' most influential friendship groups were used for subsequent analyses in Chapter 6.

In sum, weighting overlapping friendship groups by size, or by another metric such as influence, may not be an appropriate procedure to adopt without closer consideration of the sample and variables of interest. More specifically, this weighting procedure may be best suited to studies that only investigate one variable at the group level and those with levels of overlap lower than those reported in the present sample. In cases where two group level variables are being examined and there is a high degree of overlap in the network, as was the case in the studies reported herein, it might be more appropriate to select one of the individual's multiple groups based on a theoretically driven metric. Based on both theoretical and methodological considerations, I concluded that an individual's most influential group was the most appropriate operationalisation of the overlapping friendship groups for the research aims of this thesis and used the most influential group conceptualisation for subsequent analyses in Chapter 6.

Comparing the Results Across Different Friendship Conceptualisations

This thesis also sought to contribute to the literature through a comparison of the results obtained when different friendship conceptualisations (reciprocal friendships, non-overlapping friendship groups, biggest overlapping friendship groups, and most influential overlapping friendship groups) were used to answer the substantive questions related to the associations between aggression and mental ill-health. It is important to note that there is not one 'true' friendship group conceptualisation. Indeed, one of the insights of my thesis is that it is useful to consider different conceptualisations of friendship groups in the study of peer influence processes.

Looking at the friendship groups first, when the results for non-overlapping groups and the most influential overlapping groups were compared, the results were remarkably

similar, in terms of both the magnitude and direction of effect sizes. Specifically, all study variables were found to be stable over time; individual aggression and individual mental ill-health were found to predict group aggression and group mental ill-health, respectively; individual aggression predicted individual mental ill-health; and both conceptualisations found evidence for a homeostatic process at the group level whereby group aggression predicted increases in group mental ill-health which subsequently predicted lower levels of group aggression. Thus, results and conclusions made from non-overlapping group conceptualisations may be generalisable to most influential group conceptualisations, and vice versa.

Notably, the results for the biggest overlapping groups were also similar to those of the non-overlapping and most influential friendship groups. However, there was one exception: group mental ill-health did not predict subsequent group aggression, meaning the homeostatic process at the group level was not observed for the biggest groups. As discussed in more detail above, this may be a consequence of choosing size as the metric, as the size of a friendship group has a weaker theoretical link to peer influence processes (Değirmencioğlu et al., 1998; Hussong, 2002; Sokolocska et al., 2016), compared to the degree of influence, and thus, may be less likely to detect peer influence processes between these two variables. Thus, this finding highlights the importance of selecting a theoretically driven metric to conceptualise overlapping friendship groups.

When reciprocated friendships were considered, as with the friendship group conceptualisations, all study variables were found to be stable over time, individual aggression predicted individual mental ill-health, and individual aggression also predicted group mental ill-health. However, a number of differences were also observed. Notably, individual mental ill-health was not found to predict group mental ill-health, and no homeostatic process was observed whereby group aggression did not predict group mental

ill-health, nor did group mental ill-health predict group aggression. Moreover, there was a small positive effect for group mental ill-health predicting individual aggression, which was not observed in any other friendship conceptualisations. Taken together, it appears that fewer group level effects are observed for the reciprocated friendship conceptualisation. This supports the argument in the literature that reciprocated friendships may be a narrow or limited view through which to examine peer influence processes. Specifically, isolated dyadic interactions are quite rare, and even best friendship interactions tend to occur within larger friendship groups (Urberg et al., 1995). These larger friendship groups possess additional structures, norms, and rules that are not present in dyadic interactions, that have a unique potential for influence (Adler & Adler, 1998; Corsaro & Eder, 1990; Wasserman & Faust, 1994). Consequently, examining reciprocated friendships, without also considering broader friendship groups, may fail to capture the true nature of peer influence processes.

Taken together, these results indicate that differences exist between the different friendship conceptualisations, particularly between the dyadic level and the friendship group levels. Thus, it appears that peer influence processes operate differently depending on how the friendship group is conceptualised. Thus, researchers should carefully consider what friendship conceptualisation is most appropriate for accomplishing their research goals. Moreover, as the majority of peer influence research has tended to focus on reciprocated friendships, my results also make a unique contribution to the literature by comparing reciprocal friendships with non-overlapping and overlapping friendship group conceptualisations, and highlight a need for more research focused on friendship group conceptualisations when investigating peer influence processes.

Strengths and Limitations

The body of research presented above is strengthened by a number of factors. First, the studies in this thesis used a large sample size of over 2,500 participants. This greatly

exceeds the sample size of 250 participants recommended to obtain stable estimates (Schönbrodt & Perugini, 2013). In addition, large sample sizes also help to accurately reflect the true complexity of adolescent peer interactions (Brechwald & Prinstein, 2011). Moreover, the sample used was representative of secondary schools across Australia with regard to socioeconomic status, lending support for the generalisability of these results across other Australian adolescent populations.

Another is the longitudinal design of the sample. Longitudinal research is particularly important in developmental research as it can follow change and establish a sequence of events over time in individuals within a cohort (Caruana et al., 2015; Rutter, 1988), thus allowing me to determine how aggression and mental ill-health influenced each other over time in this Australian cohort. Moreover, in the peer literature specifically, there has been an overreliance on cross-sectional studies (Prinstein & Dodge, 2008) and there is a continued need for more longitudinal research to further our understanding of developmental changes in adolescence (Brechwald & Prinstein, 2011). Thus, this thesis acknowledges this dearth in the research by examining a longitudinal sample consisting of four waves of data.

Finally, this thesis was strengthened by the use of both multiple imputation and multilevel modelling methods. Multiple imputation enabled the use of all available data, thus preserving the sample size and statistical power of the analyses (McCleary, 2002). In addition, multiple imputation produces unbiased estimates, increasing the validity of observed results (McCleary, 2002). Multilevel modelling methods ensured that the hierarchical nature of the data used in this thesis was accounted for, thereby ensuring the standard errors of the regression coefficients were not underestimated (Gelman & Hill, 2006; Hox, 2017). An additional methodological strength is that I included both aggression and mental ill-health in the same models and was, thus, able to determine unique effects of both variables. More specifically, aggression and mental ill-health tend to co-occur such that

individuals who engage in aggressive behaviours also tend to suffer from mental ill-health (e.g., Card et al., 2008; Meeus et al., 2016; Ng et al., 2012). Thus, previous studies that have investigated peer influence effects of either aggression or mental ill-health may not represent 'true' results as these may have been confounded. Thus, this thesis was able to determine the unique effects of aggression, controlling for mental ill-health, and vice versa.

Along with the numerous methodological and analytical strengths mentioned above, there are also some potential limitations that should be noted. Firstly, it is known that the probability of committing a Type I error, whereby the null hypothesis is incorrectly rejected, increases as the number of analyses conducted increases (Keselman et al., 2002; Ruxton & Beauchamp, 2008). Thus, as this thesis contained numerous multilevel model analyses, there is an increased risk for Type I errors.

Moreover, the use of self-report questionnaires to assess both aggression and mental ill-health constitutes a potential limitation in this thesis. Although self-report measures have a number of advantages in that they are an efficient and inexpensive way to collect large volumes of rich information from participants (Paulhus & Vazire, 2007), they are also susceptible to a number of biases, one of which is socially desirable responding. Socially desirable responding is where respondents overreport socially desirable behaviours and attitudes while underreporting undesirable ones (Barnett, 1998; Tourangeau et al., 2000). It may be that respondents believe the information they are providing is accurate (i.e., self-deception) or they may knowingly respond in a way that conforms to socially acceptable values, avoids criticism, or gains social approval (King & Bruner, 2000). Socially desirable responding can confound associations among the variables of interest by suppressing or obscuring relations among variables or by producing artificial associations between variables (King & Bruner, 2000). Empirical evidence indicates that aggression self-report measures are susceptible to socially desirable responding (e.g., Krumpal, 2013; Vigil-Colet et al., 2012).

For example, participants have been found to report significantly lower levels of aggression for themselves than for others (Gregoski et al., 2005), and youths' estimates of their own aggression was found to be significantly lower than their peers' estimates of their aggression (Österman et al., 1994). Moreover, mental ill-health has also been found to be susceptible to socially desirable responding, whereby individuals, males in particular, are less likely to report symptoms of mental ill-health due to the stigma surrounding mental ill-health and the perception of mental ill-health as a weakness (e.g., Brody & Hall, 2010). In sum, participants tend to under-report both aggressive behaviours and symptoms of mental ill-health. Thus, in this thesis, relations between aggression and mental ill-health may have been suppressed or obscured. On the other hand, this adds validity to the relations that were observed. Moreover, this limitation can be addressed in future research by collecting other-reports of aggression and mental ill-health, such as through peer-report or teacher-report measures. Alternatively, participants can complete measures (e.g., Marlowe Crowne Social Desirability Scale; Crowne & Marlowe, 1960) that assess an individual's likelihood of engaging in socially desirable responding. This can then be considered in subsequent analyses. Additional avenues for future research are discussed in the next section.

Future Directions

Subcomponents of Aggression

In this thesis, I examined general aggression, which encompasses both direct and indirect forms. While there is utility in examining aggression as a general construct since almost half of the variance in direct and indirect aggression overlaps (Card et al., 2008), there is also value in examining direct and indirect aggression separately. Indirectly aggressive behaviours are of particular interest to the research aims of this thesis given how embedded they are in social processes and that they specifically target social relationships (Archer & Coyne, 2005; Coyne et al., 2006; Voulgaridou & Kokkinos, 2015). Thus, it would be

interesting to investigate whether peer influence processes, for example linking individual and group aggression, would be impacted to a greater extent by indirect aggression.

Moreover, research indicates that direct and indirect aggression are differentially associated with mental health outcomes. For example, Van der Wal et al. (2003) found that indirect bullying was associated with maladjustment to a greater degree than direct bullying. Moreover, Card et al. (2008), found direct aggression to be more strongly related to externalising problems, while indirect aggression was more strongly related to internalising problems. Interestingly, youth who engage in both direct and indirect aggression are at greatest risk for subsequent internalising problems (Crick et al., 2006). Thus, future research should investigate whether the associations between aggression and mental ill-health in the context of friendship groups differ depending on whether direct or indirect aggression is examined.

Gender

The results from this thesis would benefit from future examination of gender differences in the associations between aggression and mental ill-health. Importantly, the literature shows that, overall, males and females tend to be more similar than they are different (for a review see Hyde, 2005), and where differences do occur, they tend to be a consequence of social processes, as opposed to biological differences (Hyde, 2005). That being said, aggression is one variable that consistently shows moderate gender differences (Archer, 2004; Hyde, 2005). Gender differences appear to depend on whether direct or indirect aggression is being examined. Gender differences in direct aggression are frequently reported in the literature (e.g., Toldos, 2005; Tomada & Schneider, 1997). Moreover, a number of research syntheses have found these differences to hold across age, country, and measurement type (Archer, 2004; Bettencourt & Miller, 1996; Card et al., 2008). Despite it being a widely held belief that females engage in more indirect aggression than do males, the

research is less conclusive, with some studies finding females to be more indirectly aggressive (e.g., Björkqvist et al., 1992; Crick & Grotpeter, 1995; Lagerspetz et al., 1988; Salmivalli et al., 2000), others reporting that males are more indirectly aggressive (Tomada & Schneider, 1997) and others finding no gender differences (e.g., Galen & Underwood, 1997; Rys & Bear, 1997; Toldos, 2005). More recently, a number of meta-analyses have concluded that the gender differences for indirect aggression are negligible (Card et al., 2008; Hyde, 2005), concluding that males and females engage in comparable levels of indirect aggression. Thus, future research examining gender differences on the relations between aggression and mental ill-health should focus on both direct and indirect forms of aggression.

Gender differences have also been reported for mental ill-health, although the findings are less consistent than those for aggression. For example, Patalay and Fitzsimons (2018) found that girls between the ages of 11 and 14 experienced worse mental ill-health compared to males and also reported lower levels of well-being. Moreover, this gender gap has been found to increase over the course of adolescence (Bradshaw et al., 2013; Cavallo et al., 2006) and has been observed across 73 different countries (Campbell et al., 2021). In contrast, in a comprehensive review of the literature focused on 8- to 16-year-old youth, Twenge and Nolen-Hoeksema (2002) found gender differences in depression to be negligible ($d = 0.02$) and in a review of reviews Hyde (2005) report effect sizes close to zero, or of a small magnitude for mental health. Despite the inconclusive evidence for gender differences in mental health, future research would benefit from exploring whether they exist for aggression and mental ill-health in the context of adolescent friendship groups.

Beyond the School Setting

To date, the vast majority of studies that have investigated adolescent friendships have focused on those within the school setting (Cillessen & Marks, 2017; Poulin & Dishion, 2008). Indeed, youth spend a substantial part of their time at school and are exposed to a

stable peer group (Poulin & Dishion, 2008), and schools also constitute clearly defined reference groups for collecting sociometric data (Cillessen & Marks, 2017). However, the school environment will capture only a proportion of an adolescent's friendships. Research has shown that adolescents have three different groups of friendships: friends in school; friends inside and outside school; and friends outside school, and that roughly one third of an adolescent's friendships are outside school friends (Kerr et al., 2007). Moreover, different peer contexts may be differentially associated with various developmental outcomes. For example, Van Zalk et al. (2010) report that depressive symptoms are more salient in friendships outside of the school context. Moreover, the school setting tends to be more homogeneous in composition with regard to metrics such as socio-economic status, intelligence and ethnicity, than in society in general. Thus, the focus on friendships in schools may neglect other important social contexts and may provide limited insight into adolescent friendships (Van Zalk et al., 2010). Future research should endeavour to go beyond school friendships to the wider society in investigating the associations between aggression and mental ill-health.

Chapter Summary

During adolescence, friends constitute a powerful source of influence on the behaviours, beliefs, and attitudes of adolescents. Research investigating peer influence has tended to focus on either aggression or mental ill-health. Prior to the investigations reported in this thesis, these two lines of research had remained largely separate. In a series of three empirical studies, this thesis presents original research that showed aggression and mental ill-health to be associated with each other over time, at both the individual and the group level. Overall, this thesis contributed five main findings. The first was that individual aggression predicted increases in group aggression over time via both selection and socialisation processes. The second was that individual mental ill-health predicted increases in group

mental ill-health one year later, likely as a consequence of socialisation processes. The third was that youth who engaged in high levels of aggressive behaviours tended to subsequently suffer from worse mental ill-health. The fourth was that, at the group level, high levels of aggression also predicted worse mental ill-health over time. In addition, when a group suffered from worse mental ill-health, the group tended to subsequently engage in fewer aggressive behaviours. Thus, there was evidence for a homeostatic process occurring between group aggression and group mental ill-health. The fifth finding was that some peer influence processes were operating at friendship conceptualisations of one kind, but not the other. Taken together, the studies presented herein have contributed both substantively and methodologically to the developmental psychology literature.

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Supplementary Materials

S1: Aggression Questionnaire

Instructions

Below is a list of items. For each item that describes you now or within the past 6 months, please circle the *2* if the item is *very true or often true* of you. Circle the *1* if the item is *somewhat or sometimes true* of you. If the item is *not true* of you, circle the *0*.

		0	**1**	**2**
1.	I argue a lot			
2.	I destroy things belonging to others			
3.	I destroy my own things			
4.	I disobey at school			
5.	I am mean to others			
6.	I disobey my parents			
7.	I try to get a lot of attention			
8.	I get in many fights			
9.	I physically attach people			
10.	I scream a lot			
11.	My moods or feelings change suddenly			
12.	I tease others a lot			
13.	I threaten to hurt people			
14.	I am suspicious			
15.	I am louder than other kids			
16.	I have a hot temper			

S2: General Health Questionnaire

Instructions

We would like to know if you have had any medical complaints, and how your health has been in general over the past few weeks. Please answer ALL the questions simply by selecting the answer which you think most nearly applies to you.

Have you recently…

1.	…been able to concentrate on what you're doing?	Better than usual	Same as usual	Less than usual	Much less than usual
2.	… lost much sleep over worry?	Not at all	No more than usual	Rather more than usual	Much more than usual
3.	…felt you were playing a useful part in things?	More so than usual	Same as usual	Less useful than usual	Much less useful
4.	… felt capable of making decisions about things?	More so than usual	Same as usual	Less so than usual	Much less capable
5.	… felt constantly under strain?	Not at all	No more than usual	Rather more than usual	Much more than usual
6.	… felt you couldn't overcome difficulties?	Not at all	No more than usual	Rather more than usual	Much more than usual
7.	… been able to enjoy your normal day-to-day activities?	More so than usual	Same as usual	Less so than usual	Much more than usual
8.	… been able to face up to your problems?	More so than usual	Same as usual	Less so than usual	Much less able
9.	… been feeling unhappy and depressed?	Not at all	No more than usual	Rather more than usual	Much more than usual
10.	… been losing confidence in yourself?	Not at all	No more than usual	Rather more than usual	Much more than usual
11.	… been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
12.	… been feeling reasonably happy, all things considered?	More so than usual	About the same as usual	Les so than usual	Much less than usual

S3: Link Community Dendrograms

Figure S1

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

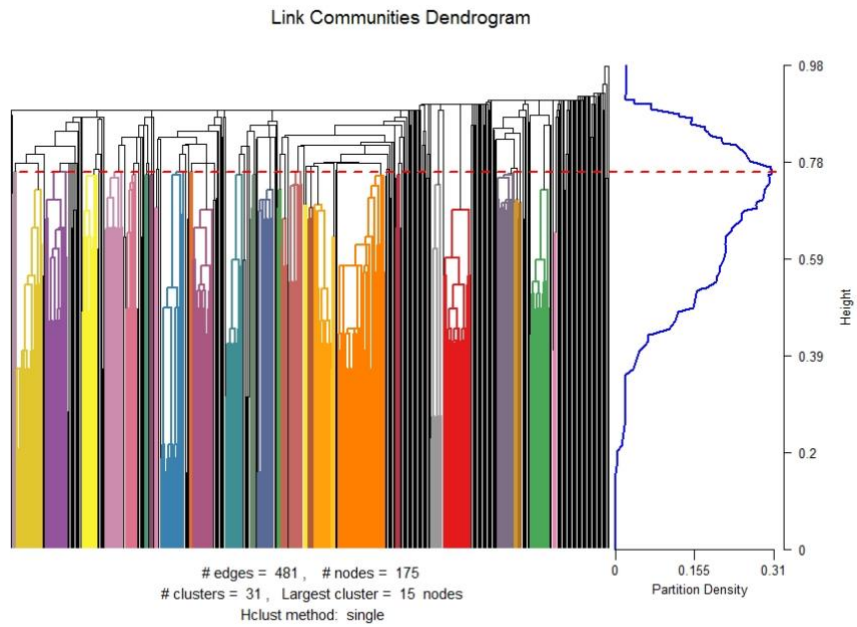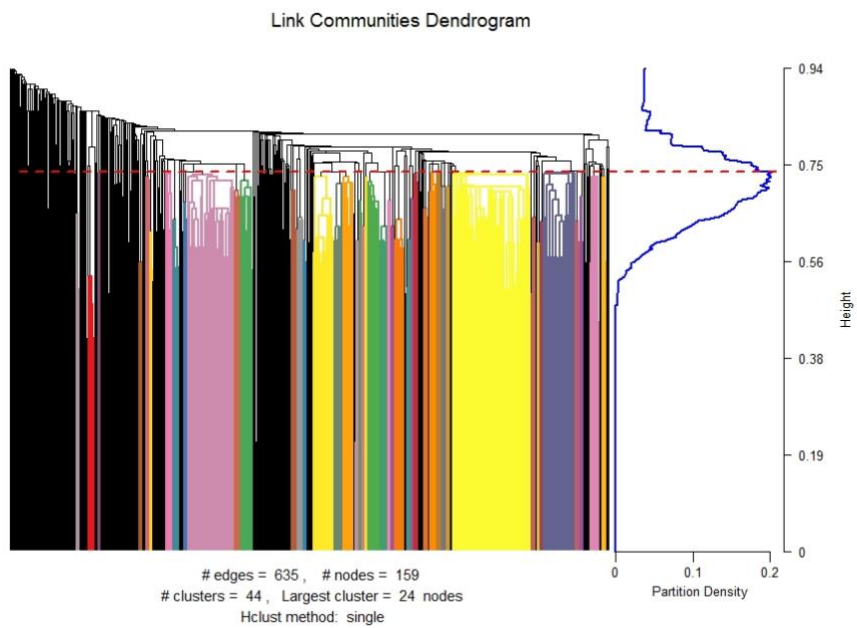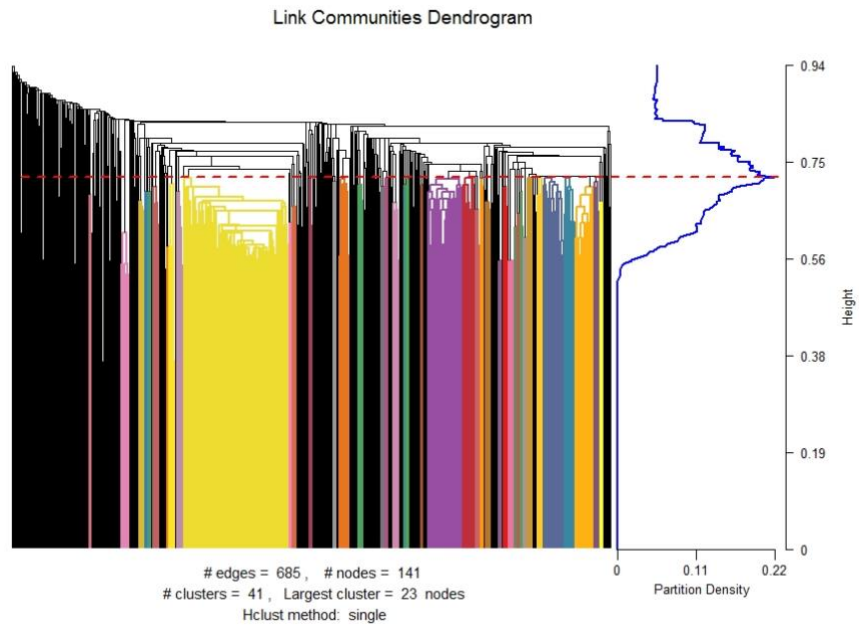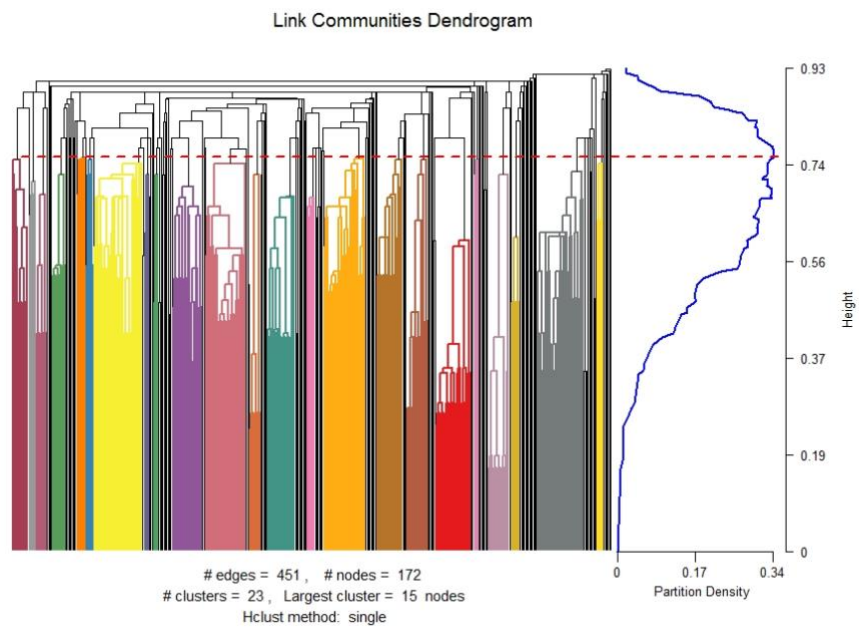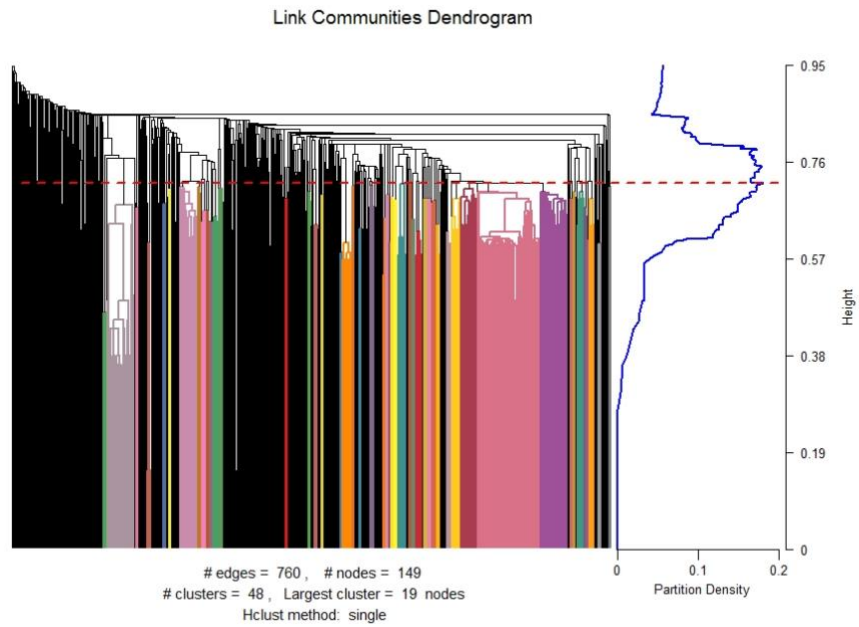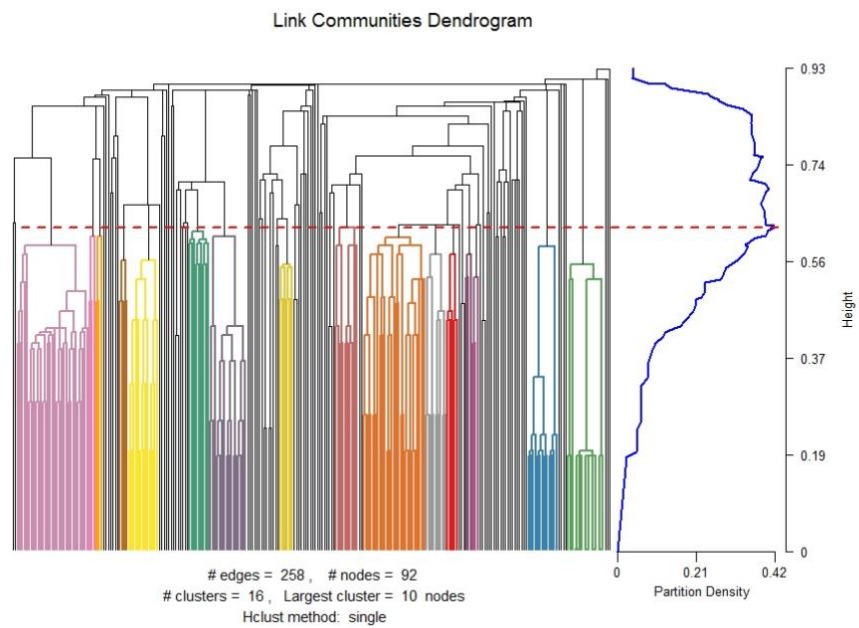*Clusters, and Largest Cluster Size for the Friendship Networks Data of School 1 in Grade 8.*
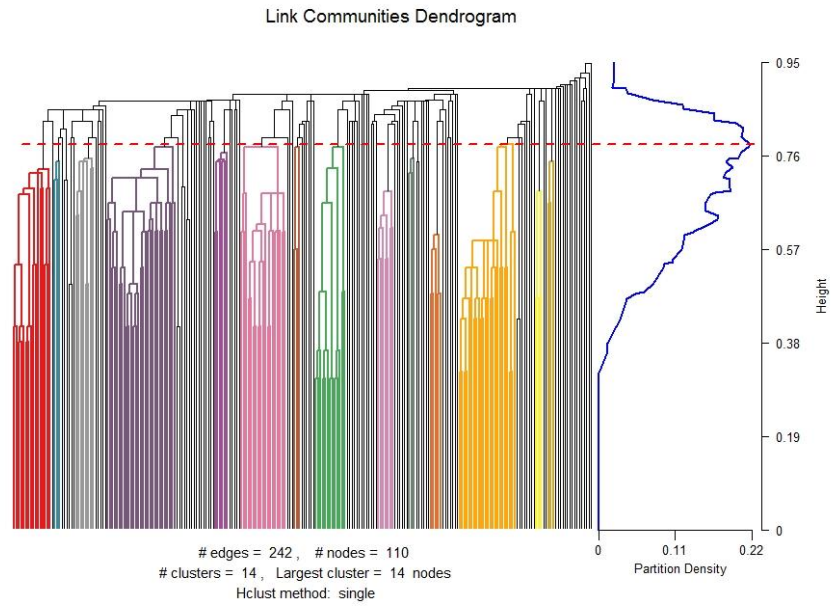
Figure S2

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 2 in Grade 8.
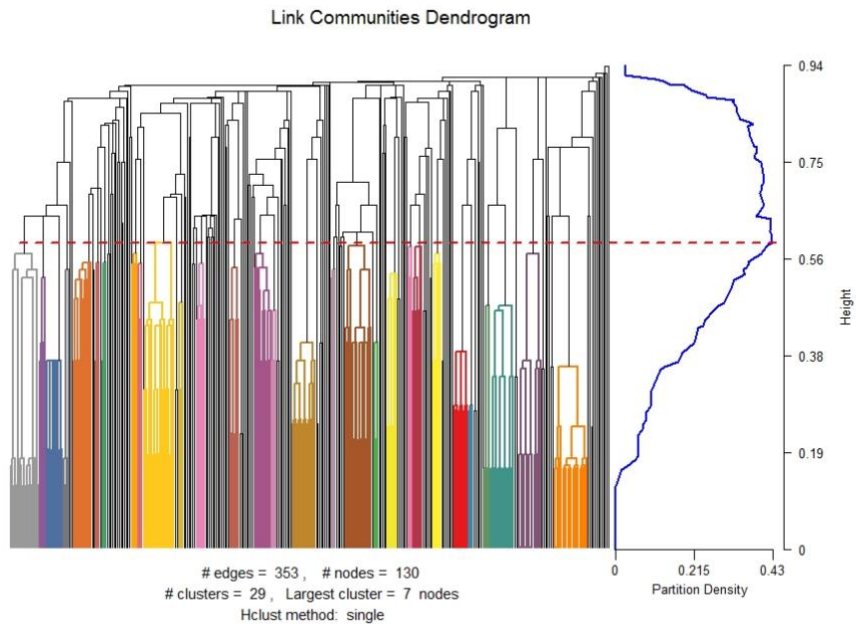

Link Communities Dendrogram

edges = 1022 , # nodes = 208
clusters = 75 , Largest cluster = 18 nodes
Hclust method: single
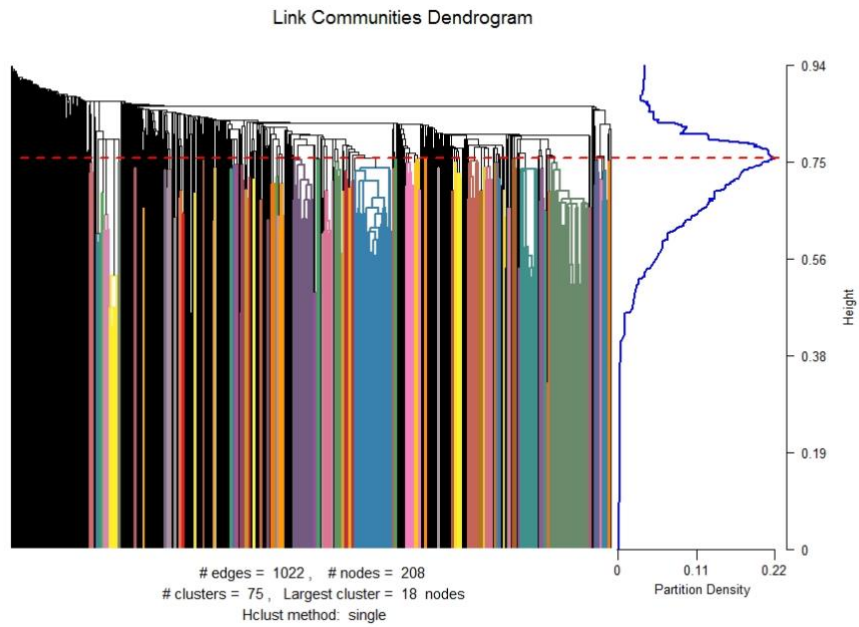
Figure S3

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 3 in Grade 8.
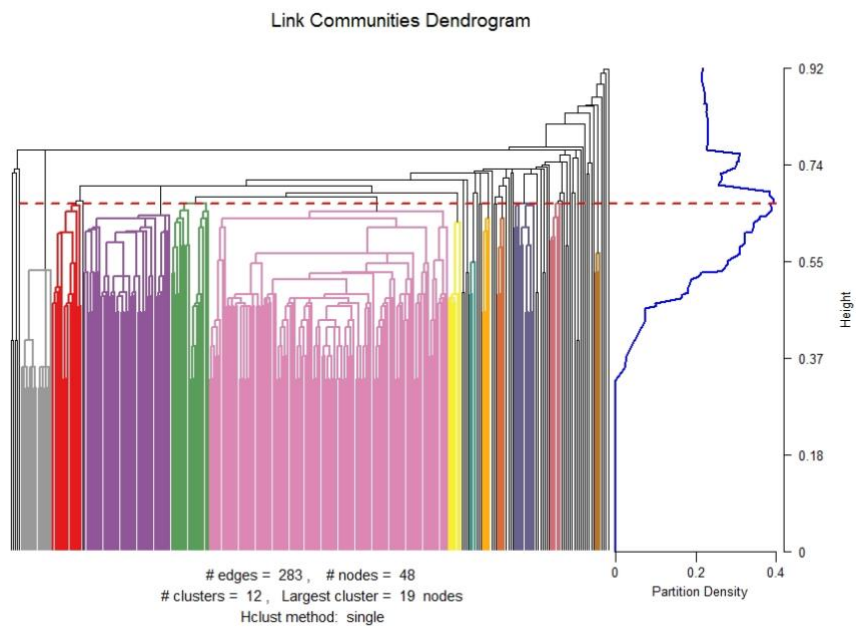

Link Communities Dendrogram

edges = 552 , # nodes = 161
clusters = 24 , Largest cluster = 21 nodes
Hclust method: single

232
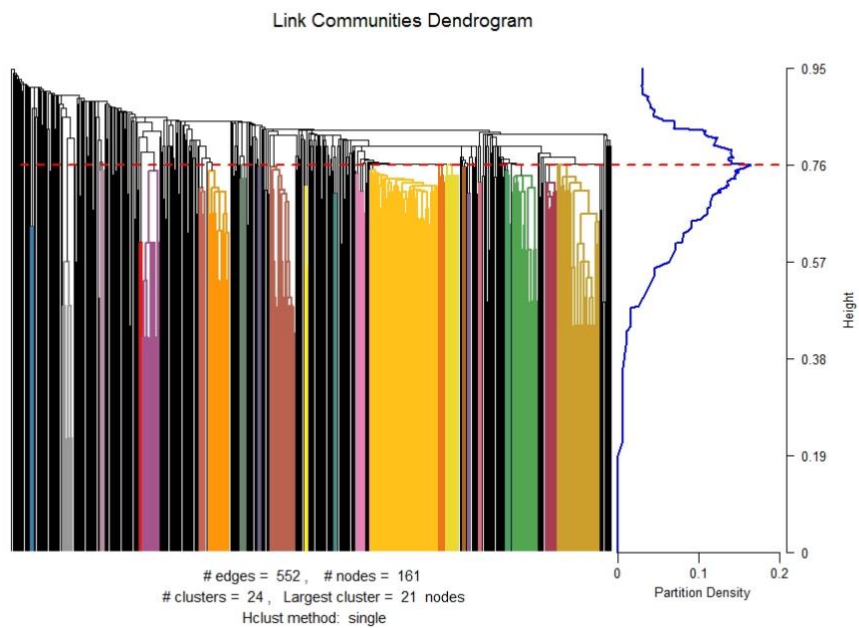
Figure S4

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

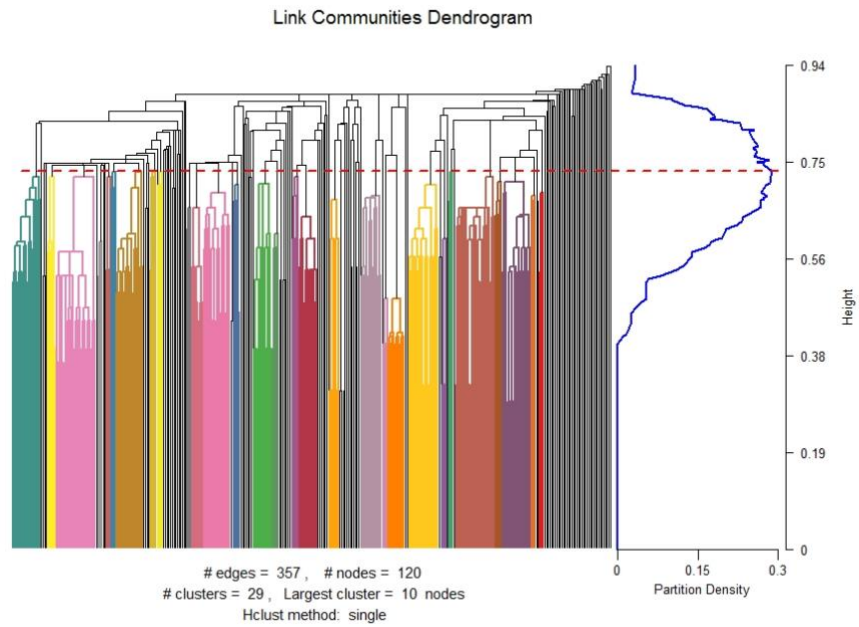*Clusters, and Largest Cluster Size for the Friendship Networks Data of School 4 in Grade 8.*
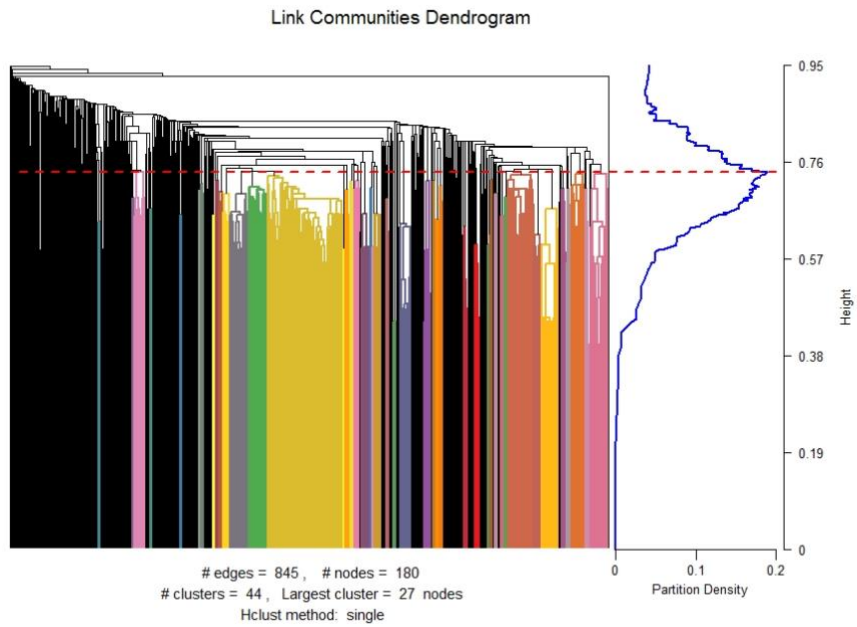
Figure S5

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 5 in Grade 8.
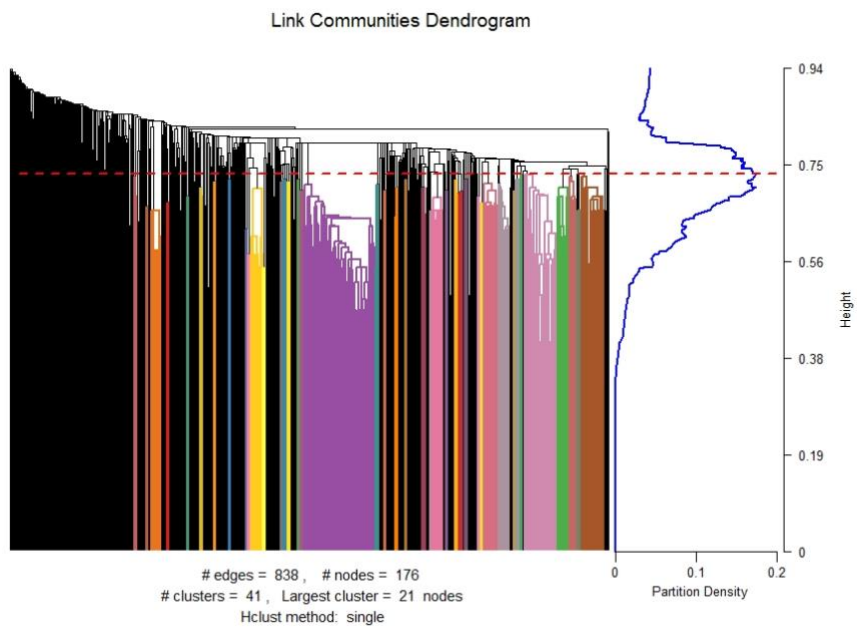
Figure S6

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 6 in Grade 8.
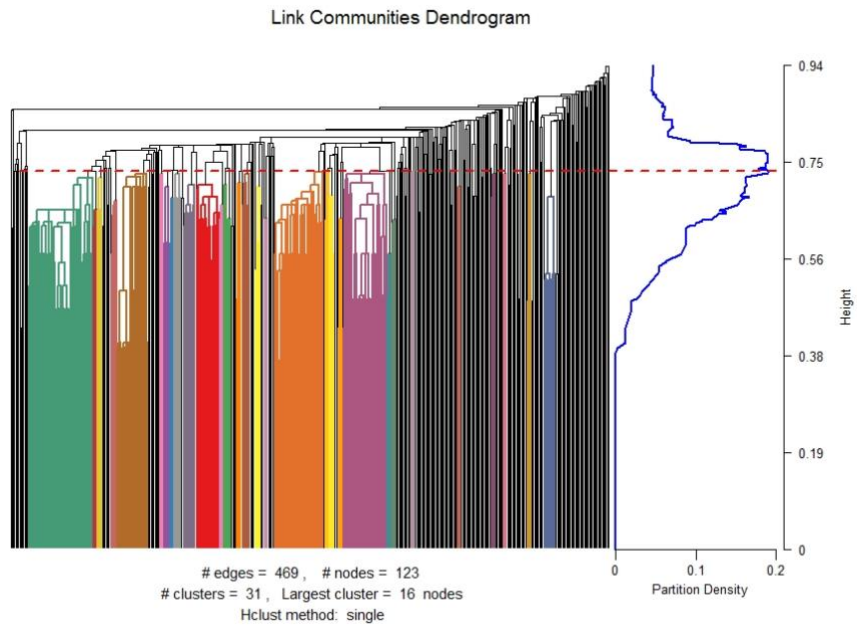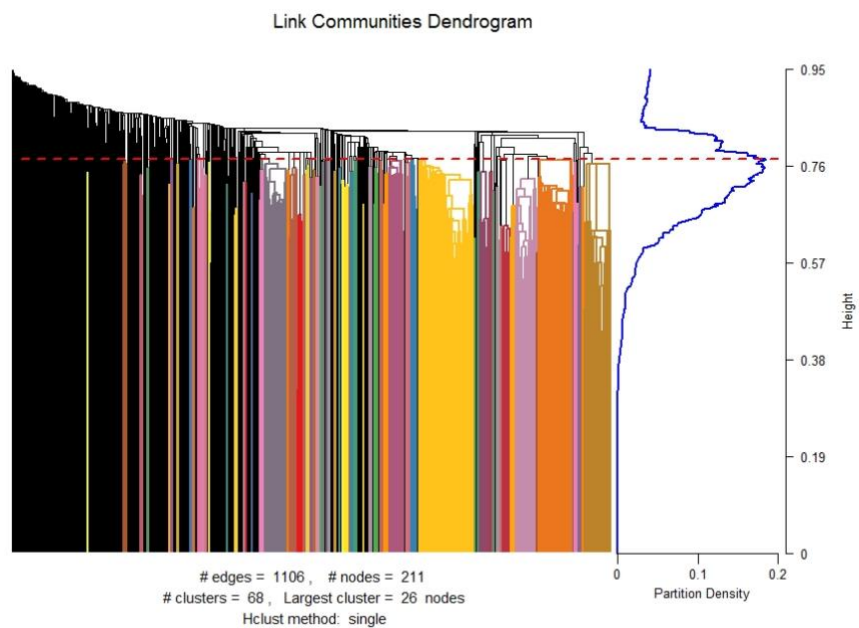

Figure S7

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 7 in Grade 8.
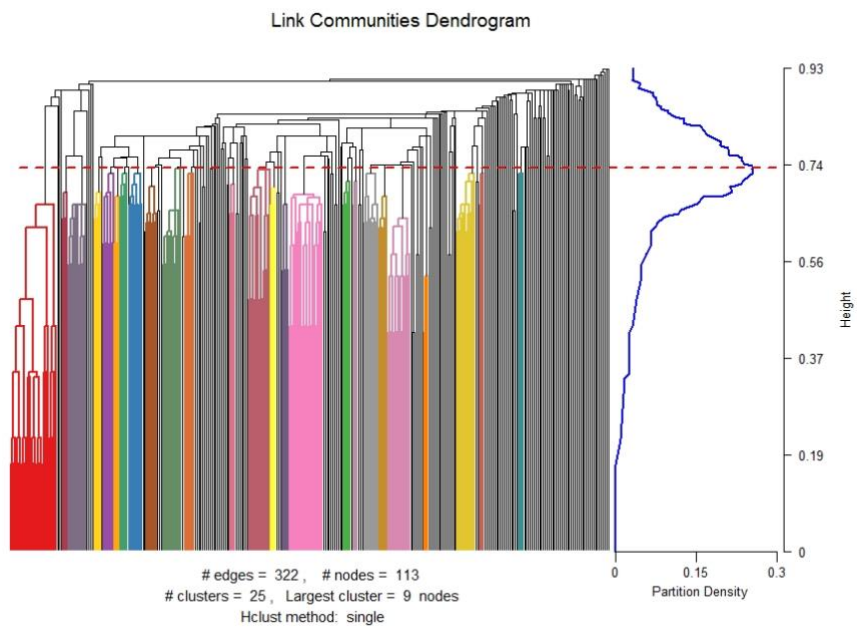
Figure S8

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 8 in Grade 8.
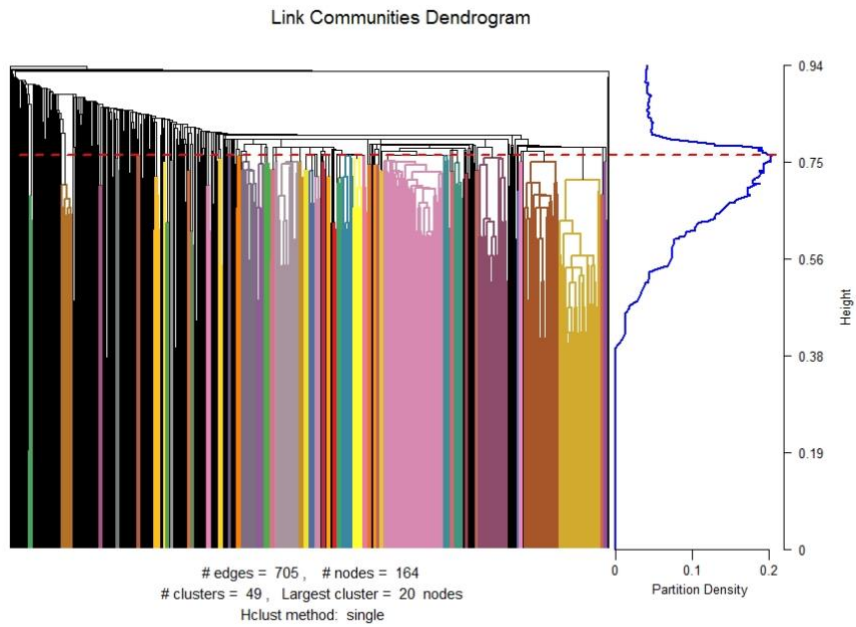

Figure S9

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 9 in Grade 8.
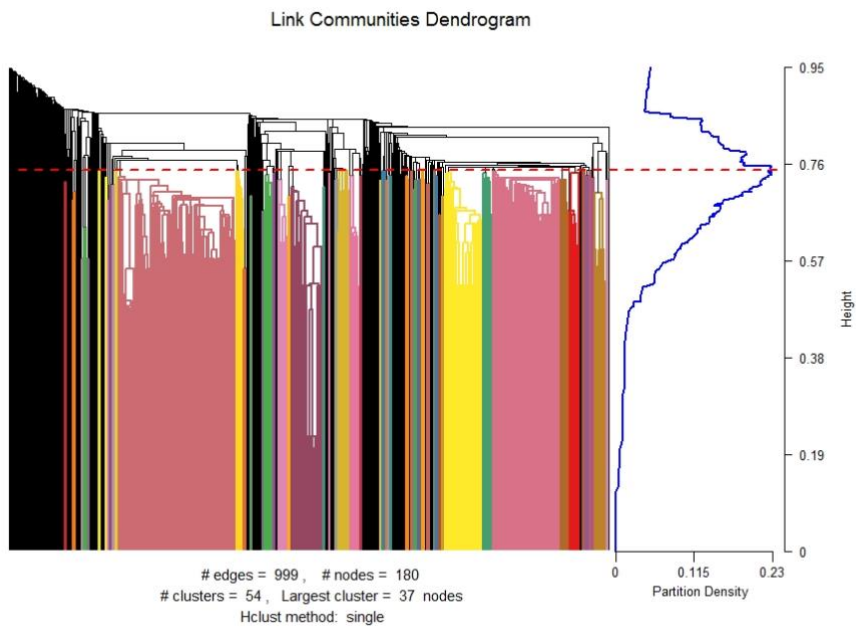
Figure S10

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 10 in Grade 8.

Figure S11

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 11 in Grade 8.

Figure S12

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

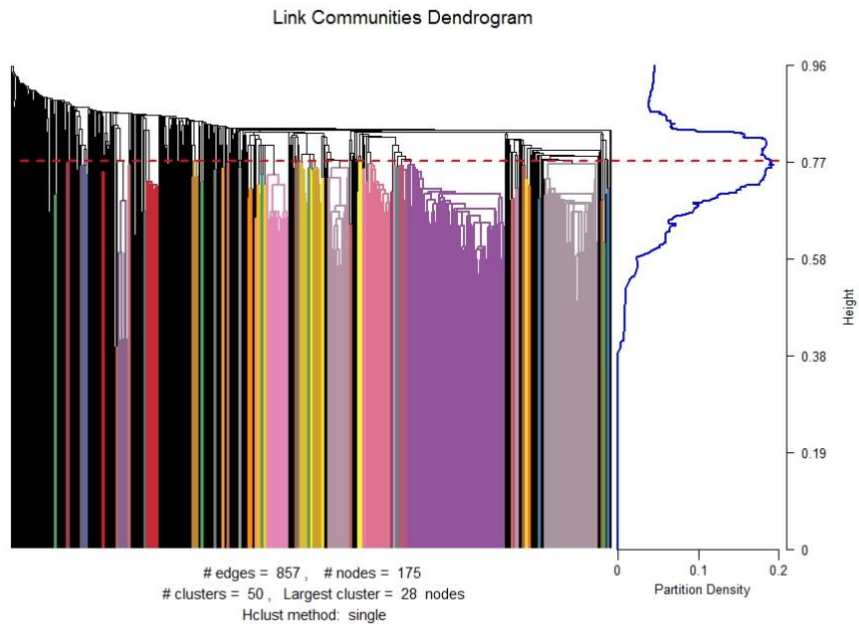*and Largest Cluster Size for the Friendship Networks Data of School 12 in Grade 8.*

Figure S13

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 13 in Grade 8.
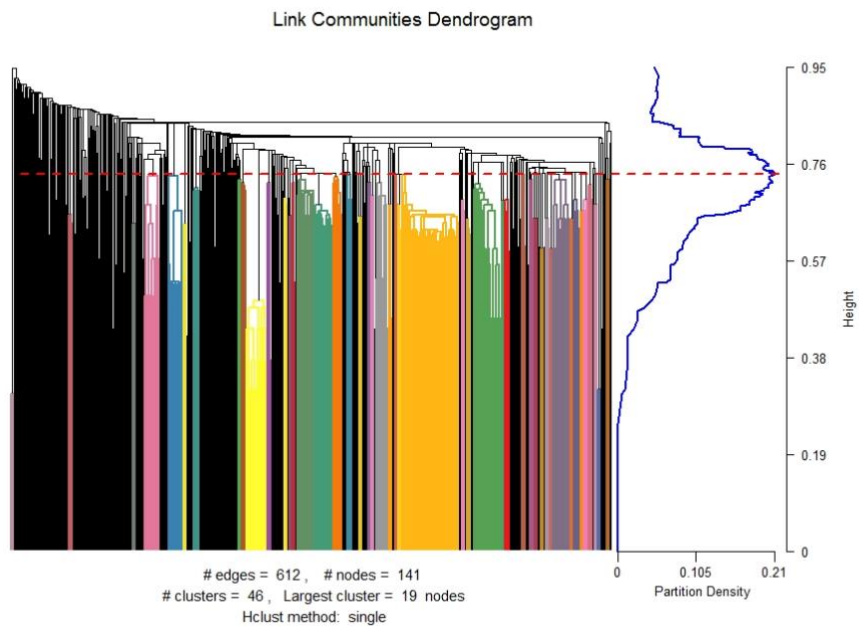
Figure S14

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 14 in Grade 8.

Figure S15

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 15 in Grade 8.

Figure S16

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

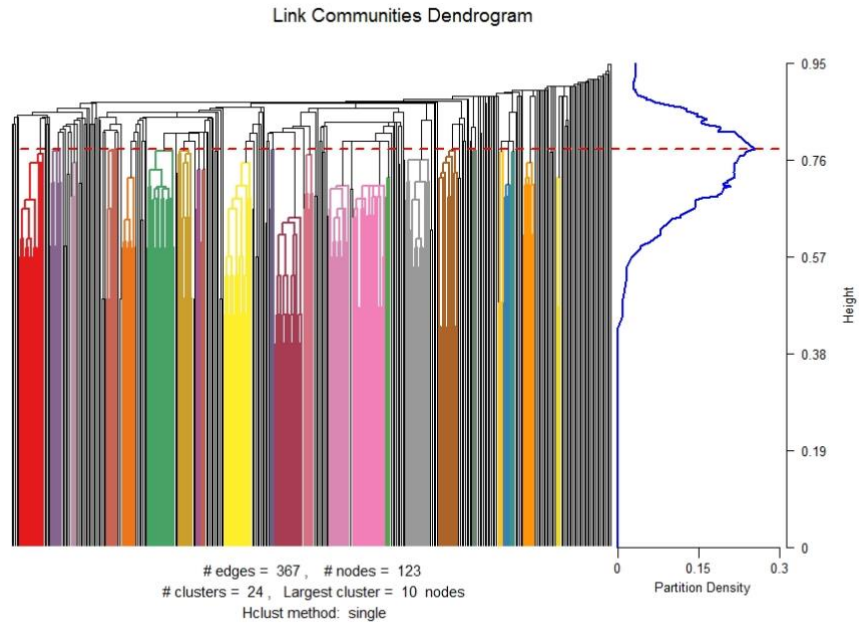*Clusters, and Largest Cluster Size for the Friendship Networks Data of School 1 in Grade 9.*

Figure S17

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 2 in Grade 9.
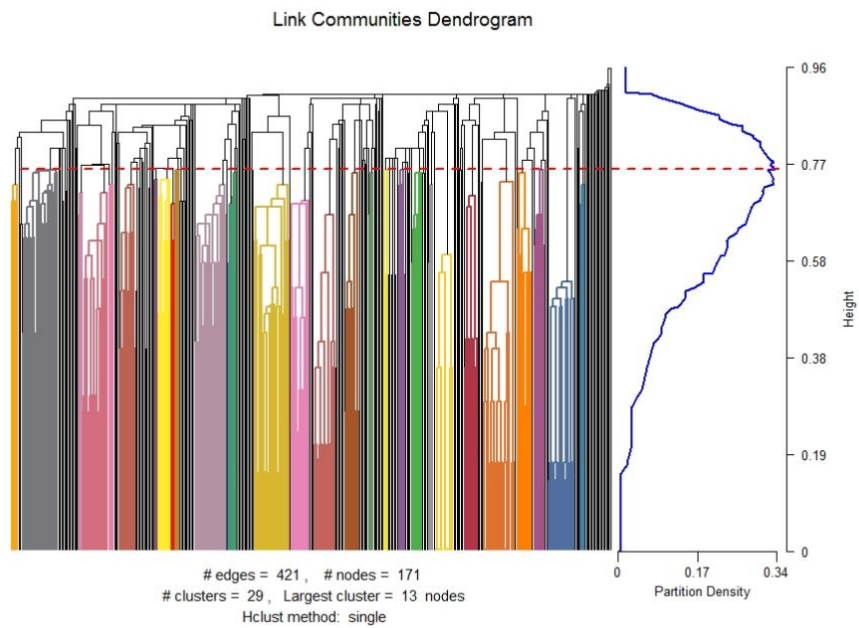
Figure S18

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 2 in Grade 9.

Figure S19

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 3 in Grade 9.
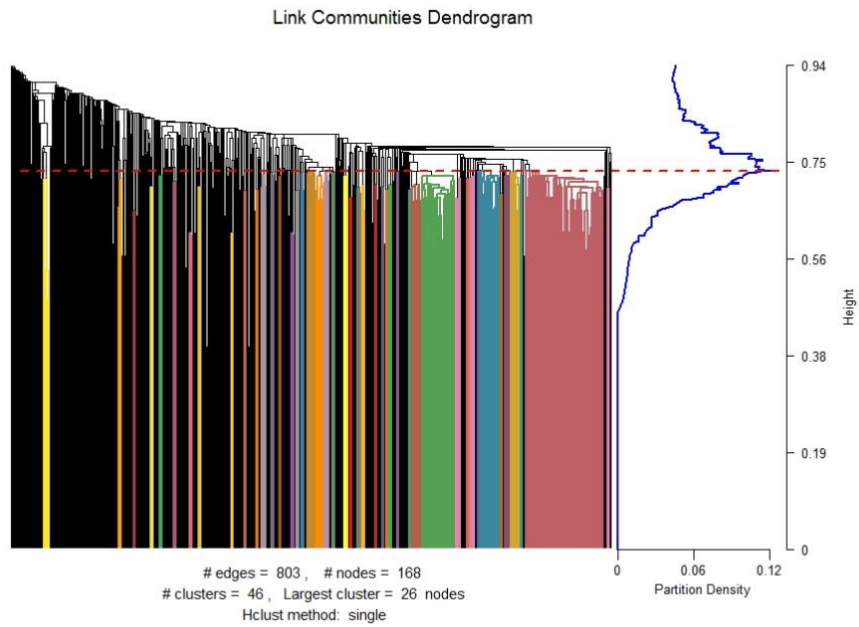
Figure S20

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 4 in Grade 9.

Figure S21

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 5 in Grade 9.
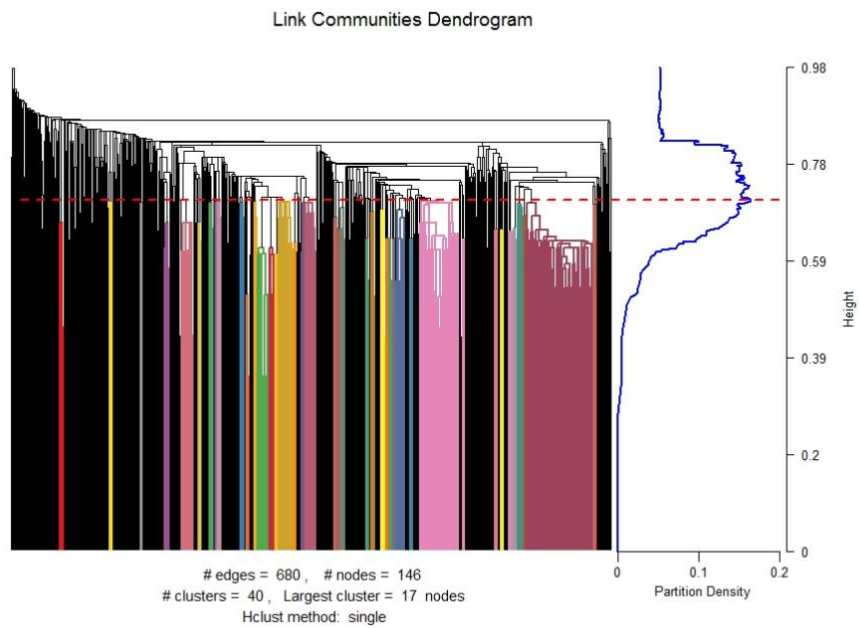
Figure S22

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 6 in Grade 9.
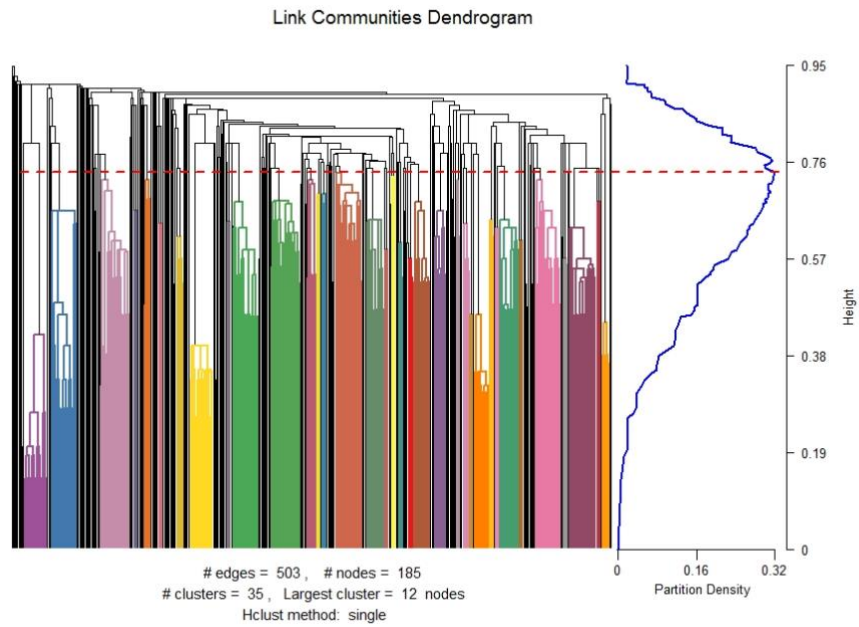

Figure S23

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 7 in Grade 9.

Figure S24

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 8 in Grade 9.

Figure S25

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and

Clusters, and Largest Cluster Size for the Friendship Networks Data of School 9 in Grade 9.
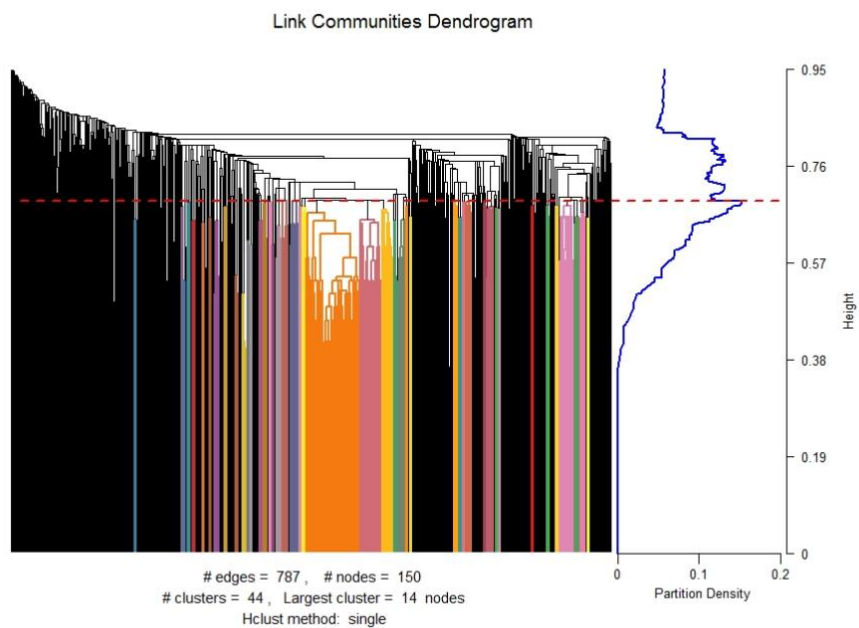
Figure S26

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

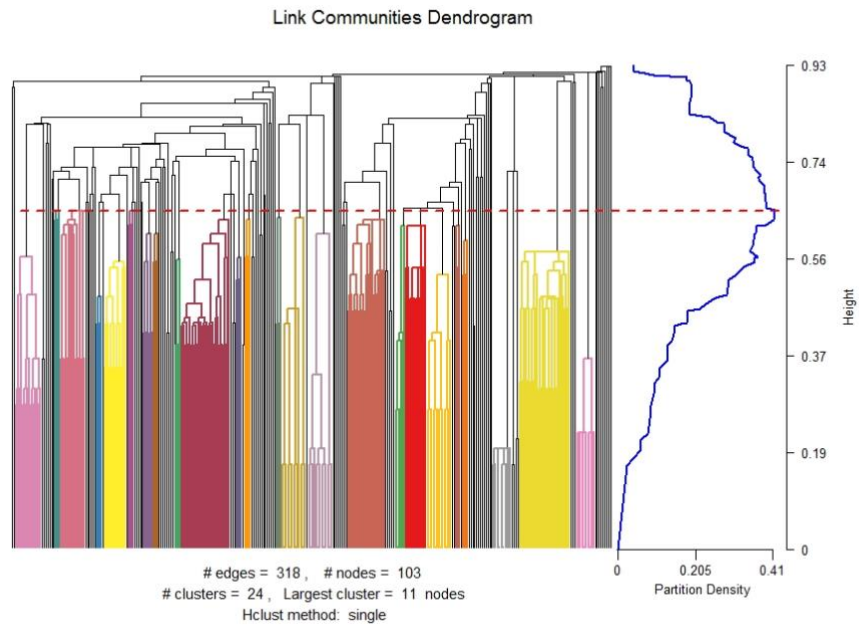*and Largest Cluster Size for the Friendship Networks Data of School 10 in Grade 9.*

Figure S27

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 11 in Grade 9.

Figure S28

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 12 in Grade 9.
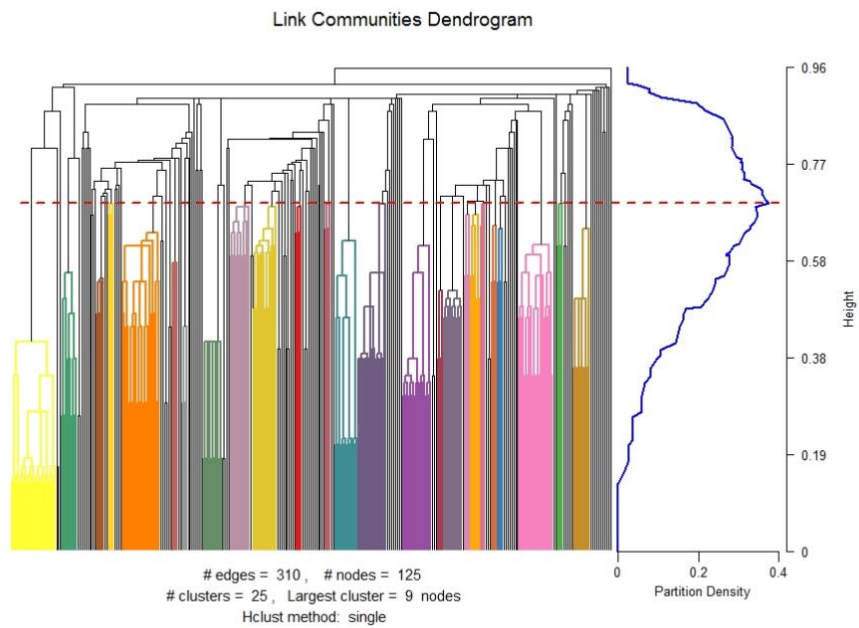

edges = 318 , # nodes = 103
clusters = 24 , Largest cluster = 11 nodes
Hclust method: single

Figure S29

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

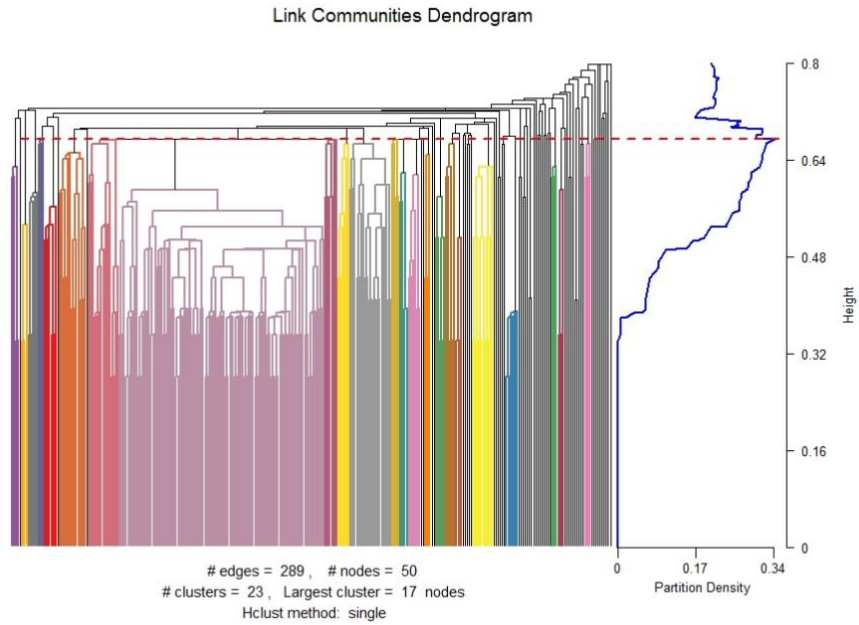*and Largest Cluster Size for the Friendship Networks Data of School 13 in Grade 9.*

edges = 310 , # nodes = 125
clusters = 25 , Largest cluster = 9 nodes
Hclust method: single

Figure S30

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 14 in Grade 9.
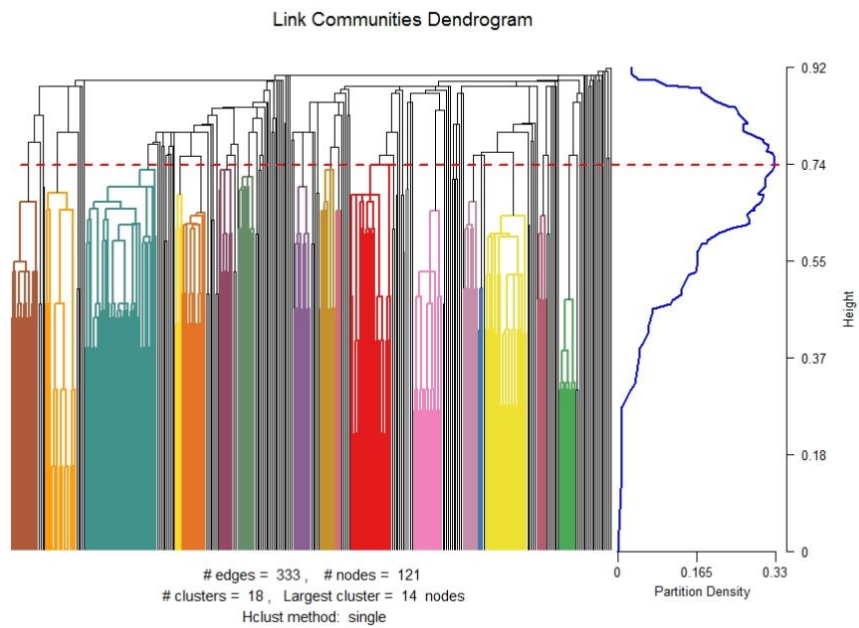

Figure S31

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 1 in Grade 10.

Figure S32

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 2 in Grade 10.
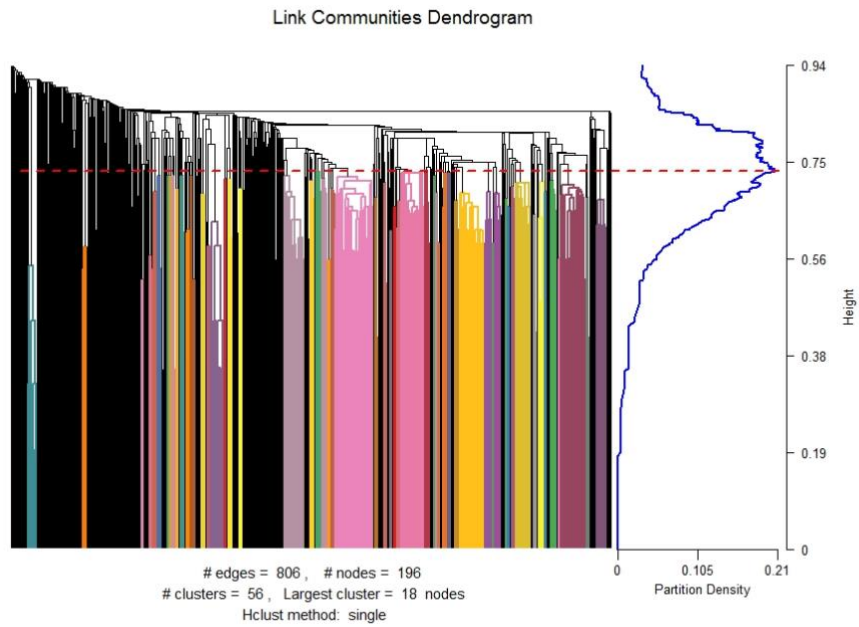

Figure S33

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 3 in Grade 10.

Figure S34

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 4 in Grade 10.
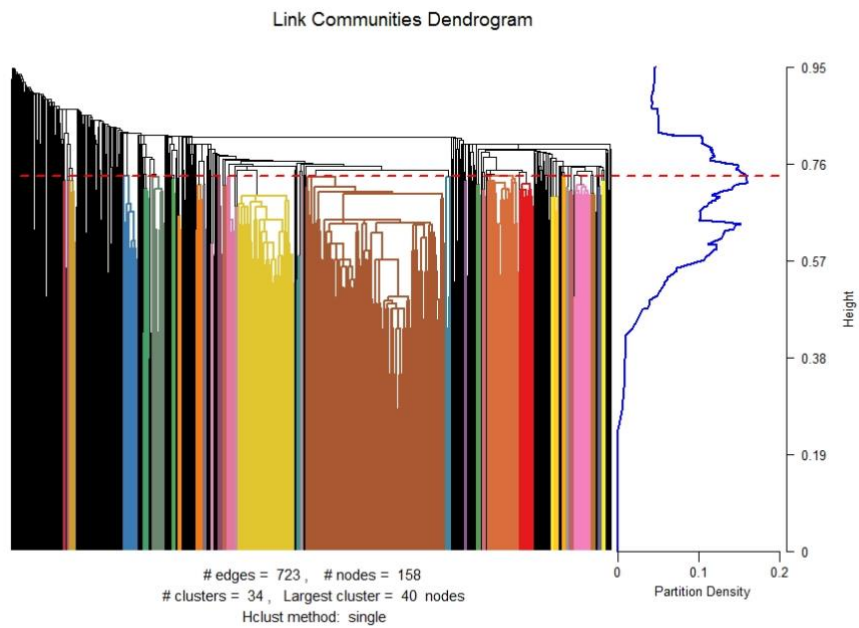

Figure S35

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 5 in Grade 10.

Figure S36

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 6 in Grade 10.
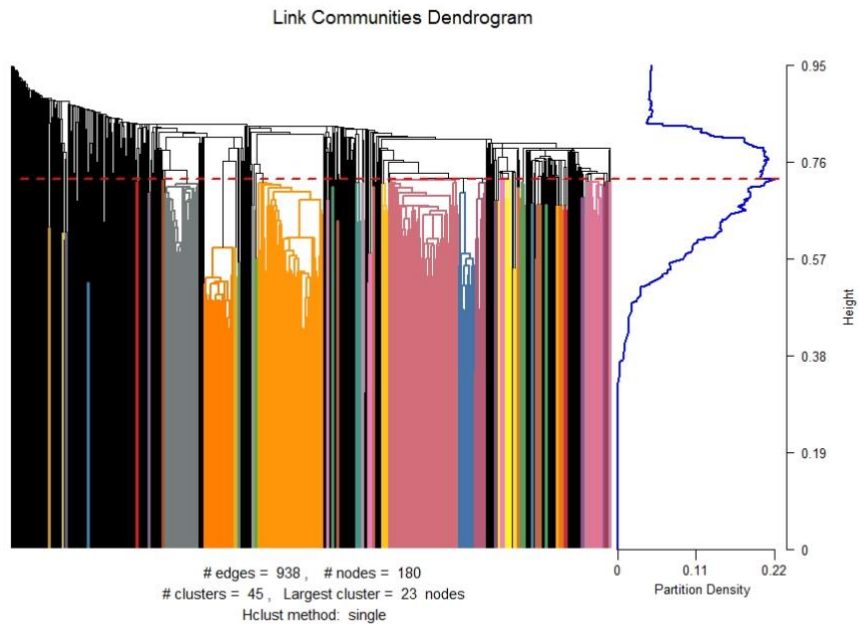

Figure S37

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 7 in Grade 10.

Figure S38

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 8 in Grade 10.
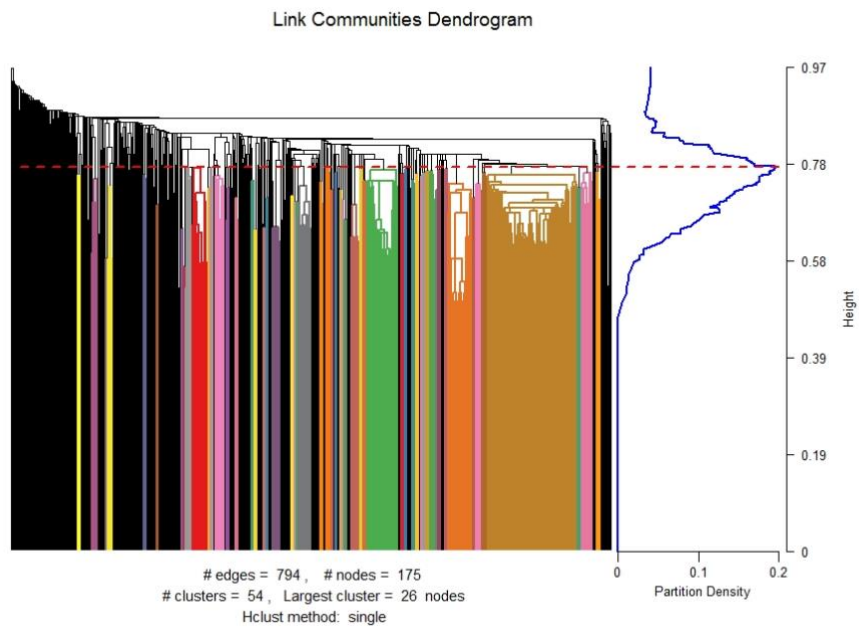

Figure S39

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 9 in Grade 10.

Figure S40

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 10 in Grade 10.
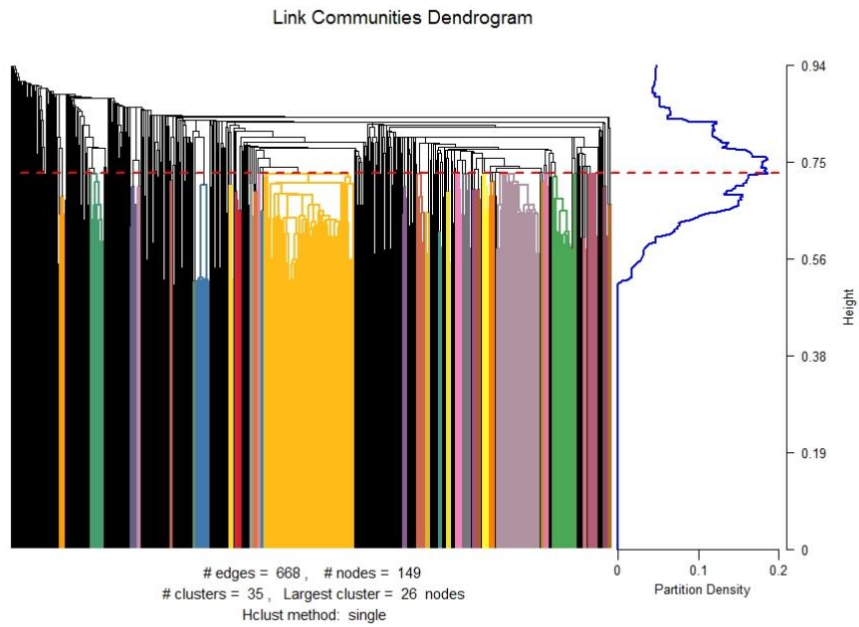

Figure S41

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 11 in Grade 10.

Figure S42

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 12 in Grade 10.
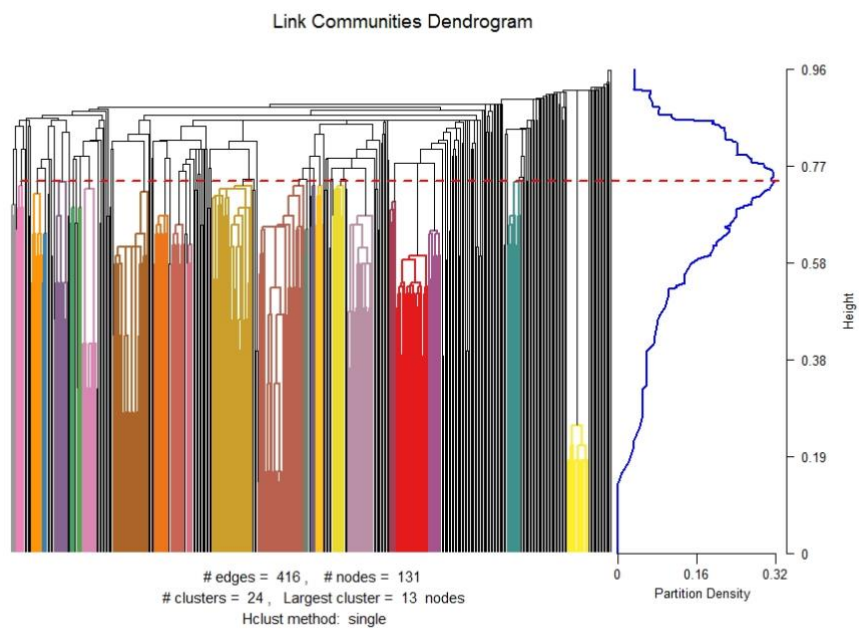

Figure S43

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 13 in Grade 10.

Figure S44

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 14 in Grade 10.
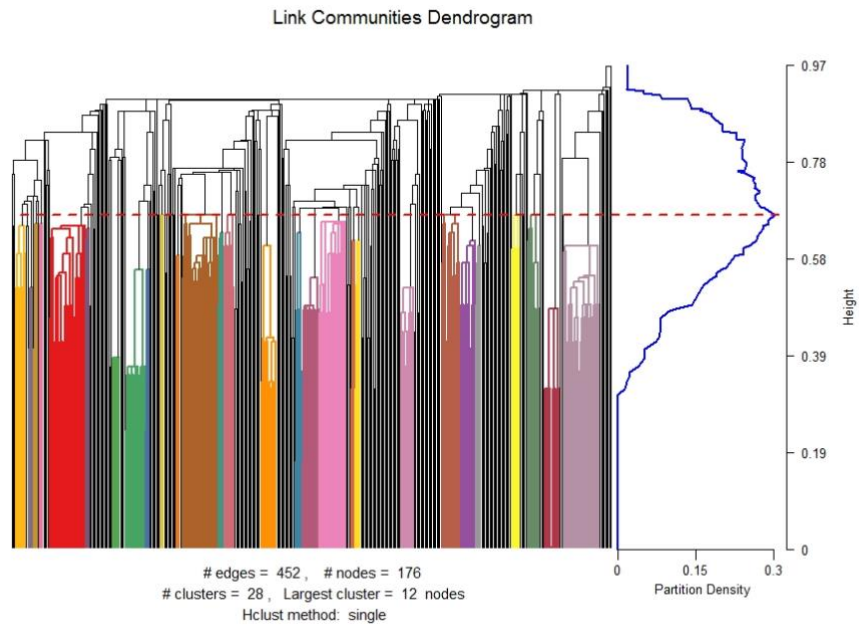

edges = 372 , # nodes = 122
clusters = 19 , Largest cluster = 14 nodes
Hclust method: single

Figure S45

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

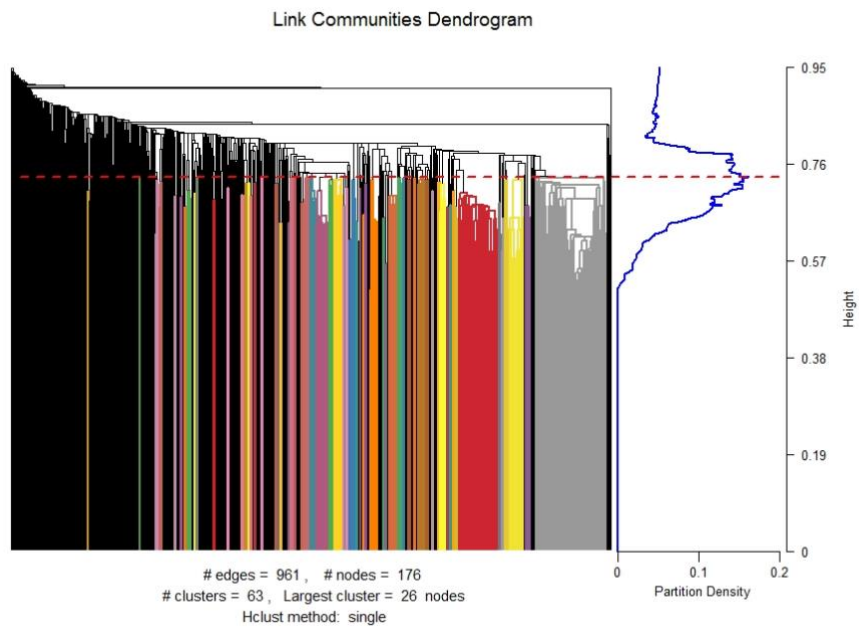*and Largest Cluster Size for the Friendship Networks Data of School 15 in Grade 10.*

edges = 279 , # nodes = 54
clusters = 28 , Largest cluster = 13 nodes
Hclust method: single

Figure S46

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

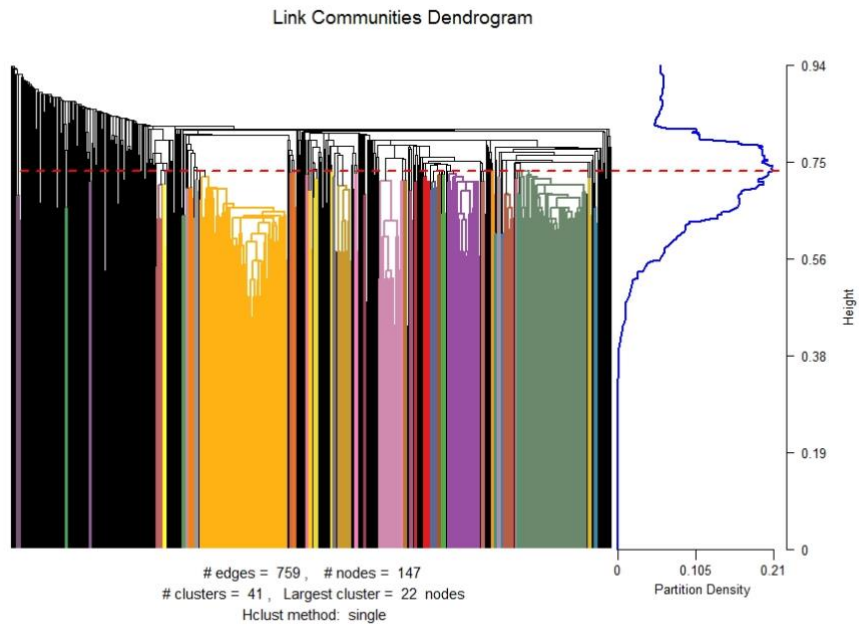*and Largest Cluster Size for the Friendship Networks Data of School 1 in Grade 11.*

Figure S47

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 2 in Grade 11.

Figure S48

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 3 in Grade 11.
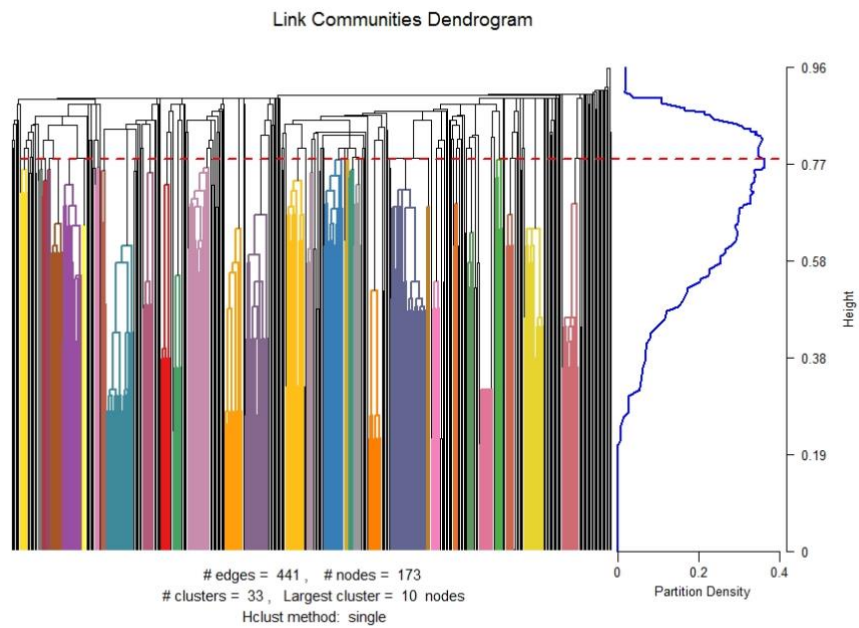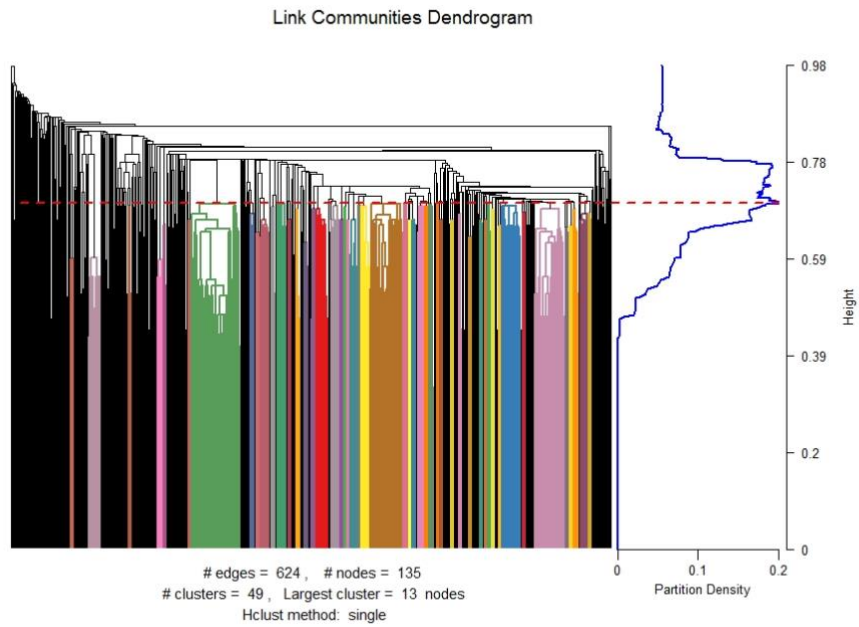

Figure S49

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 4 in Grade 11.
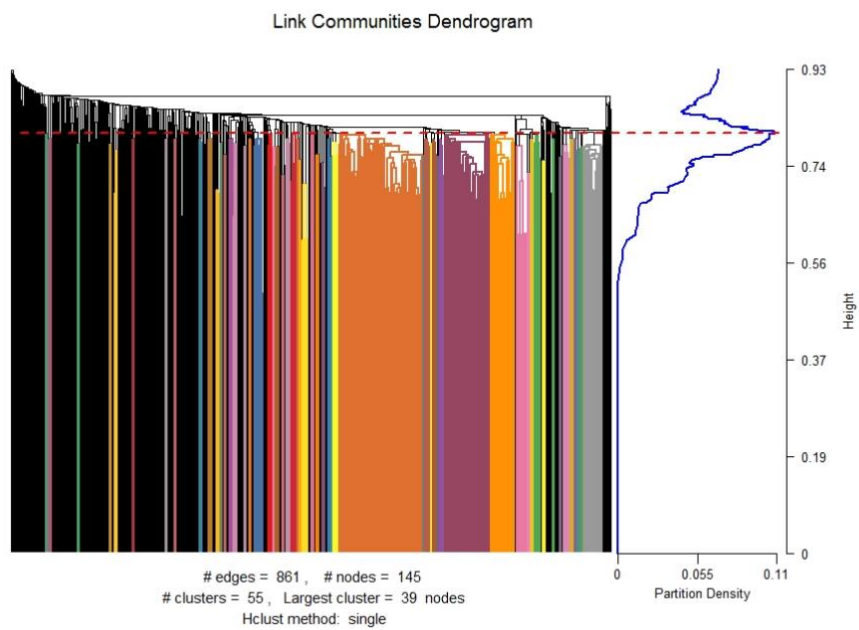
Figure S50

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 5 in Grade 11.
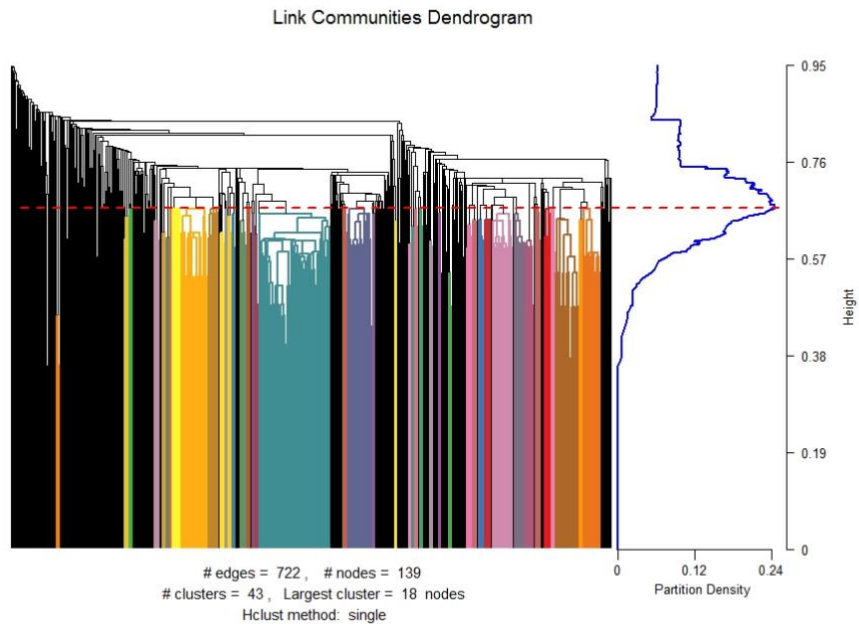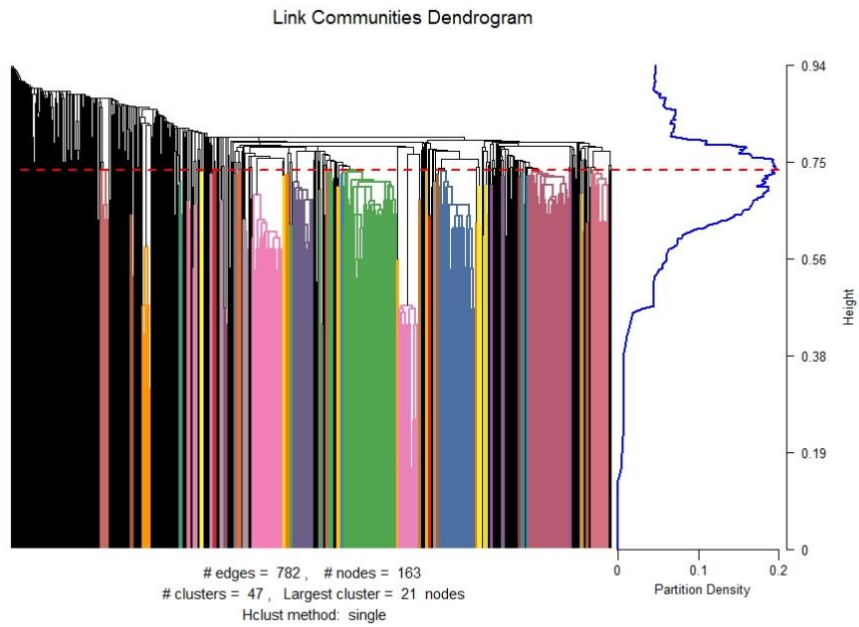

Figure S51

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 6 in Grade 11.
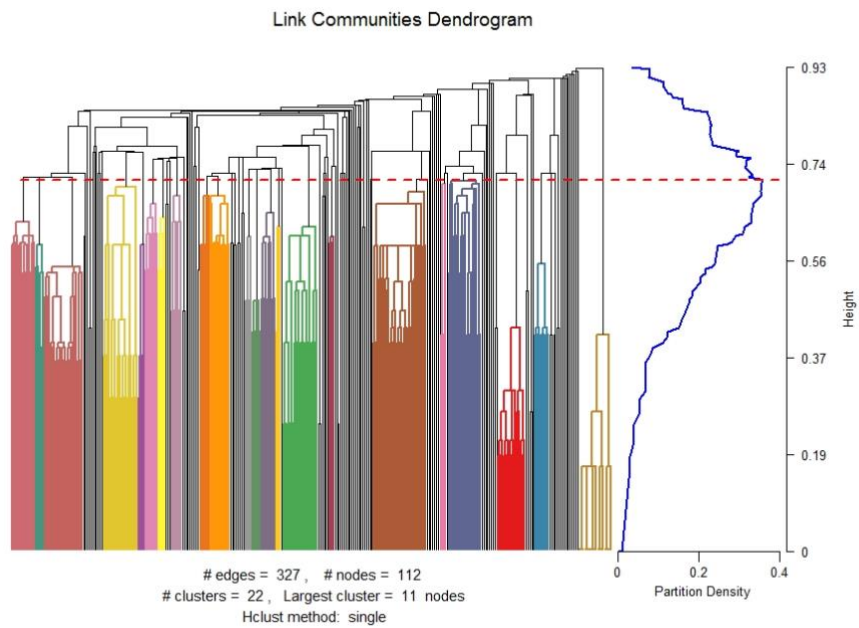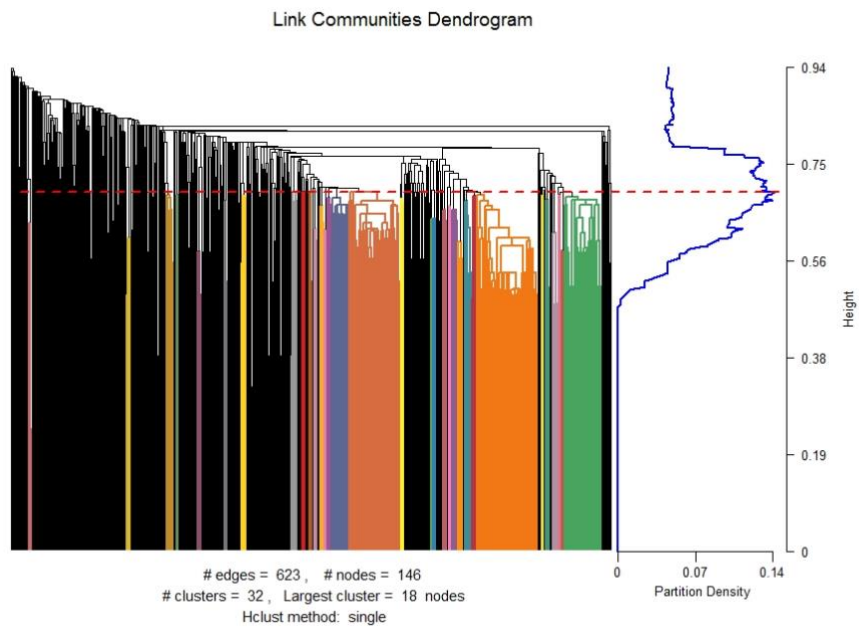
Figure S52

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 7 in Grade 11.
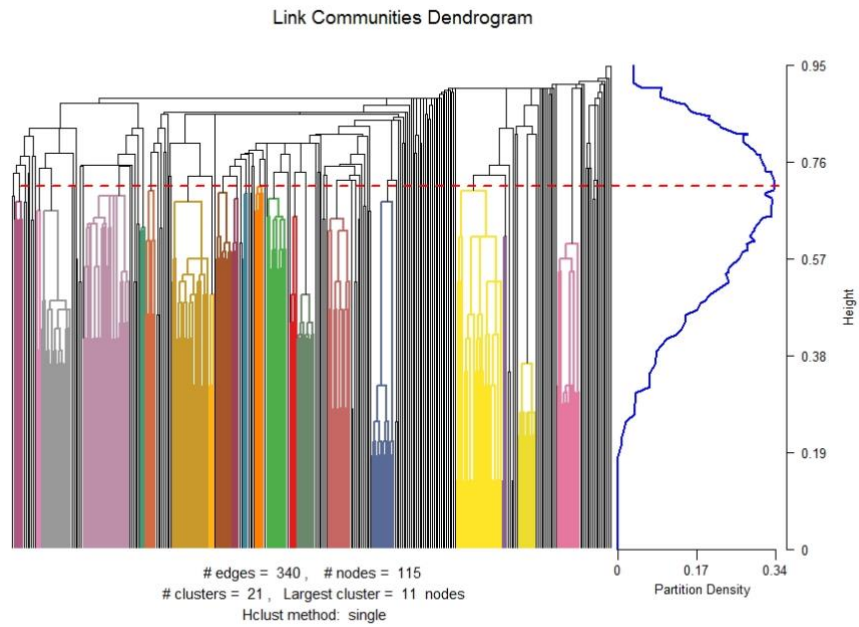
Figure S53

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 8 in Grade 11.
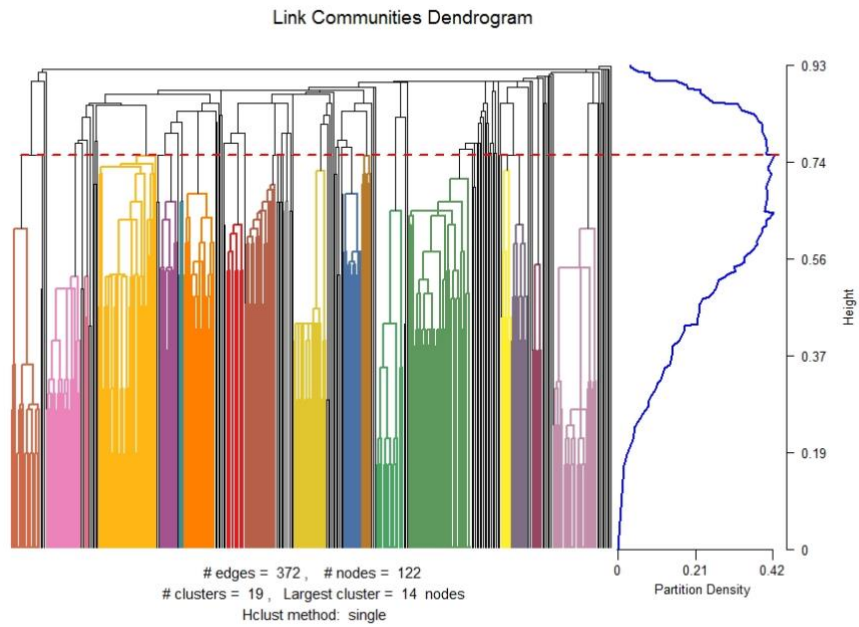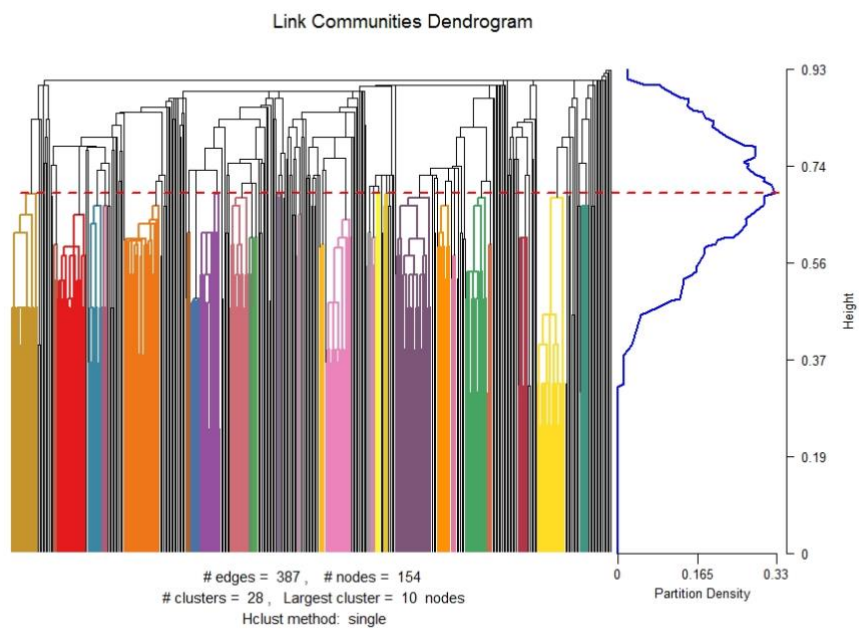
Figure S54

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 9 in Grade 11.
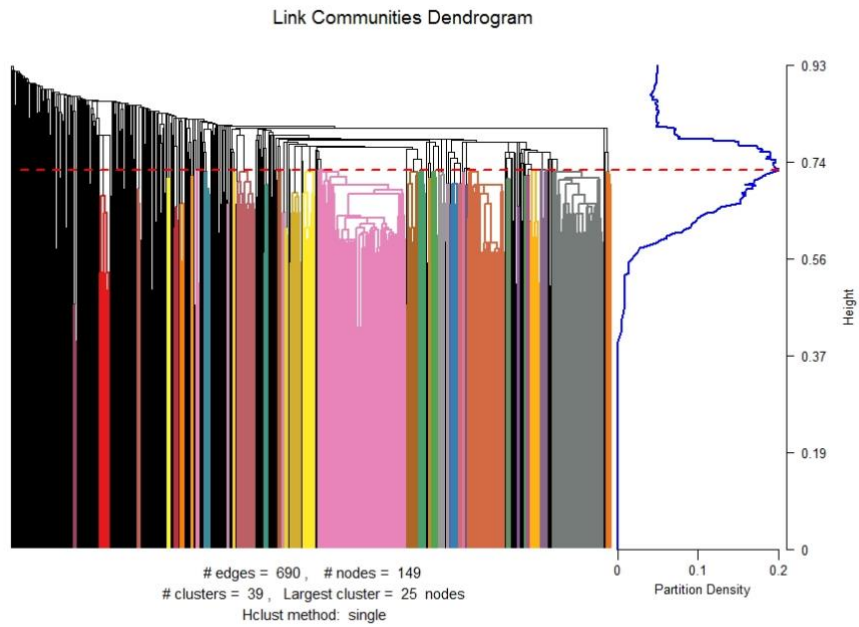
Figure S55

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 10 in Grade 11.
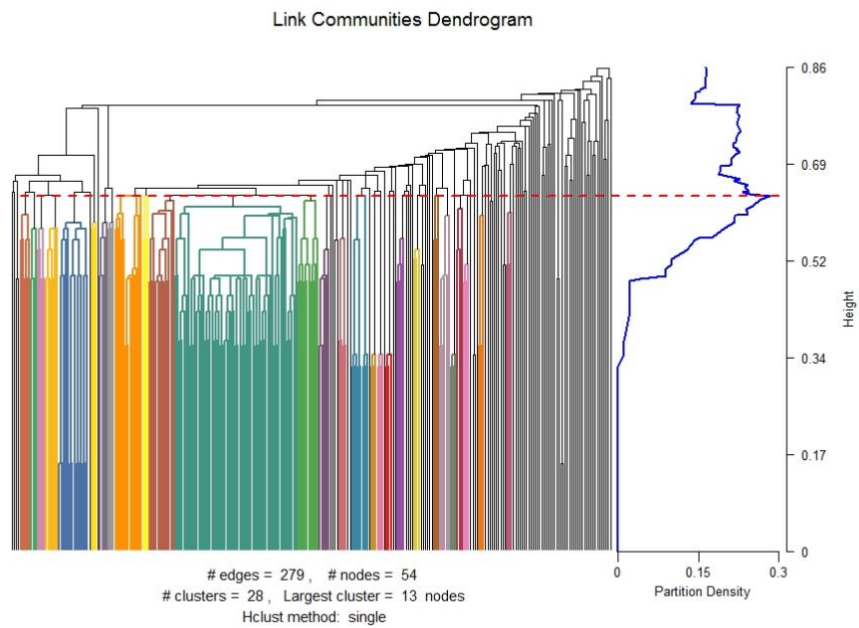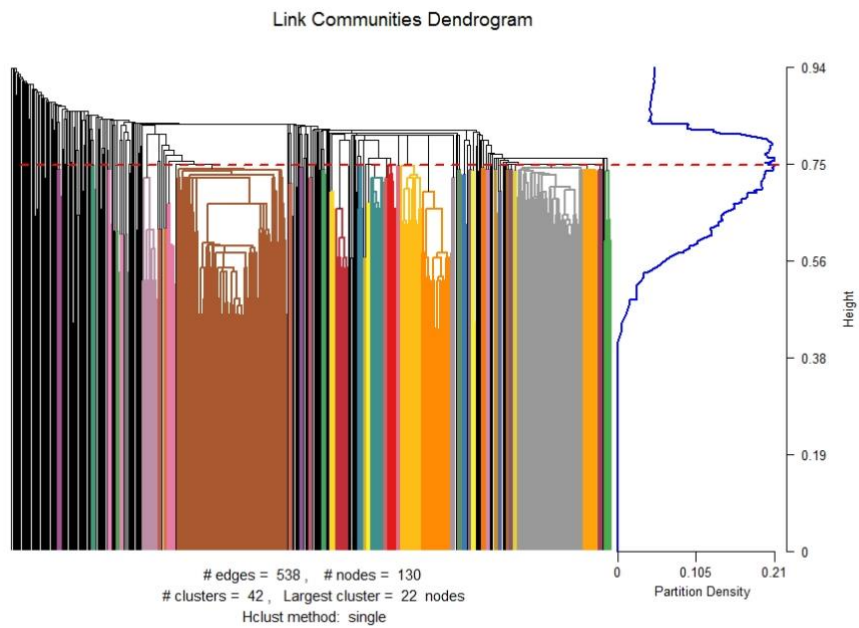
Figure S56

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 11 in Grade 11.
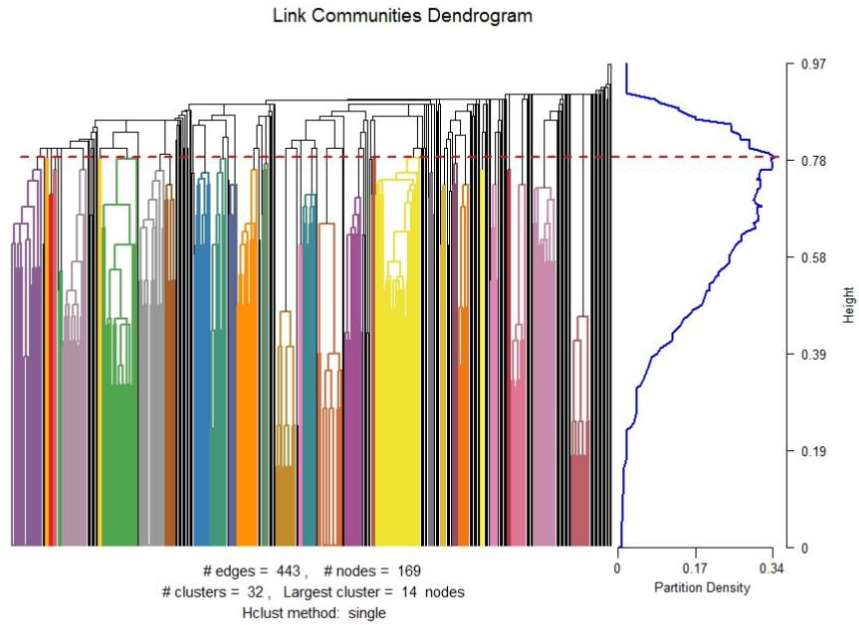
Figure S57

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 12 in Grade 11.
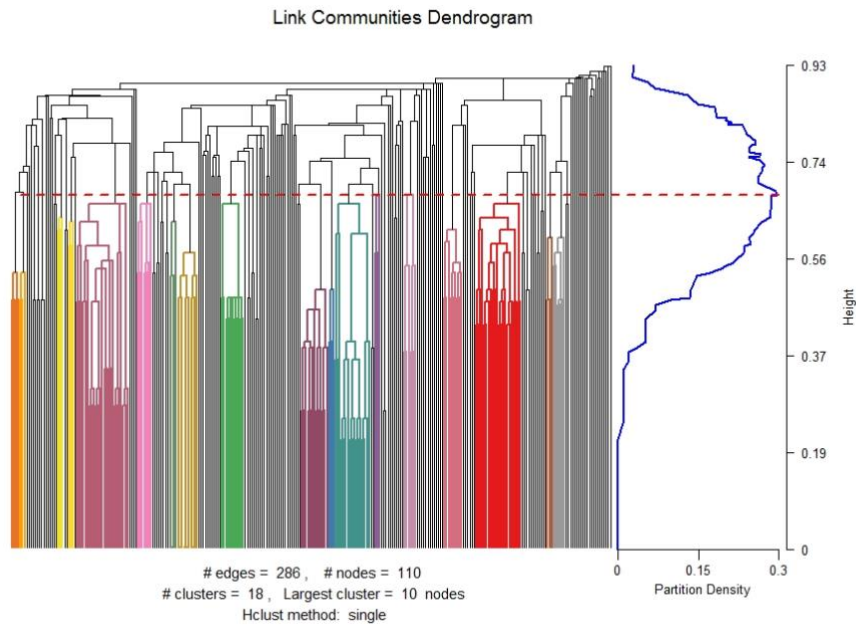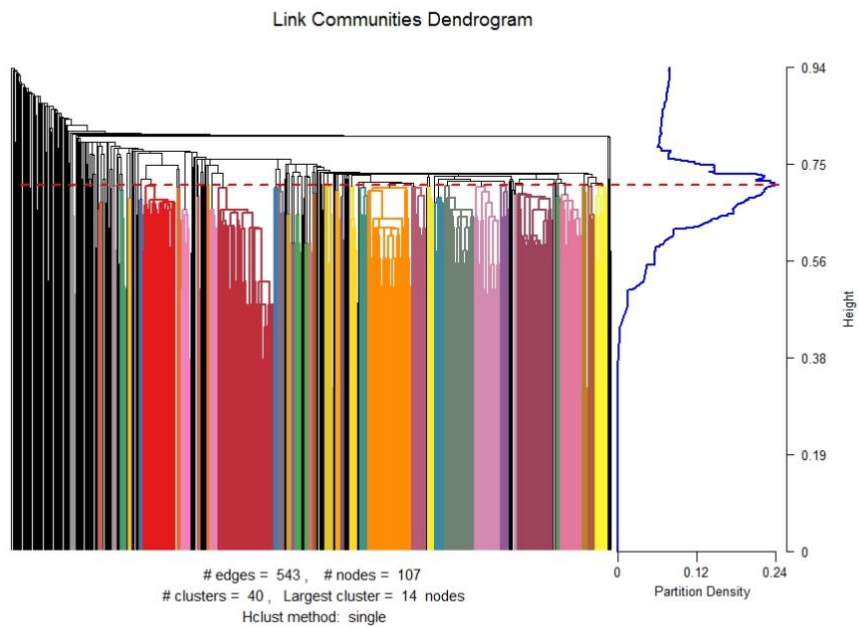
Figure S58

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 13 in Grade 11.

Link Communities Dendrogram

edges = 255 , # nodes = 101
clusters = 19 , Largest cluster = 14 nodes
Hclust method: single
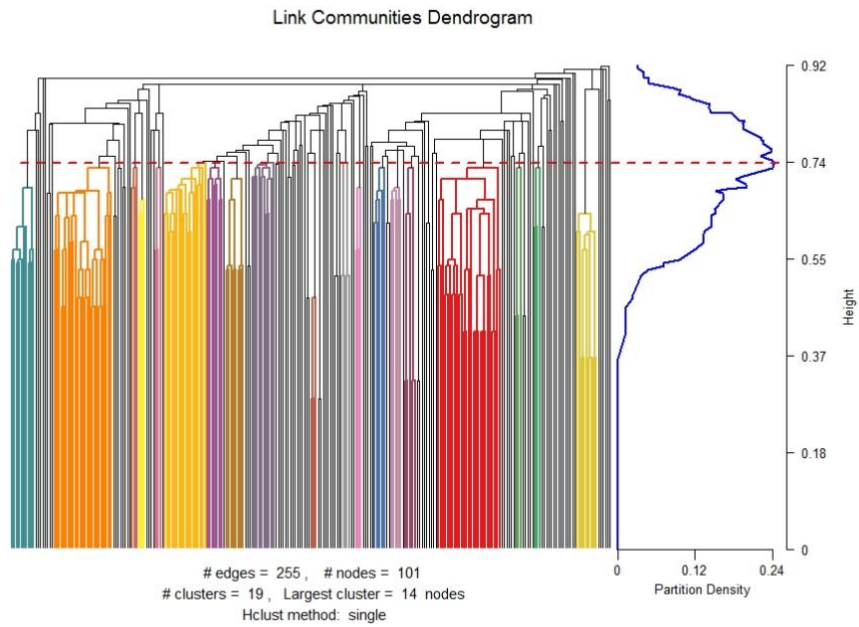
Figure S59

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

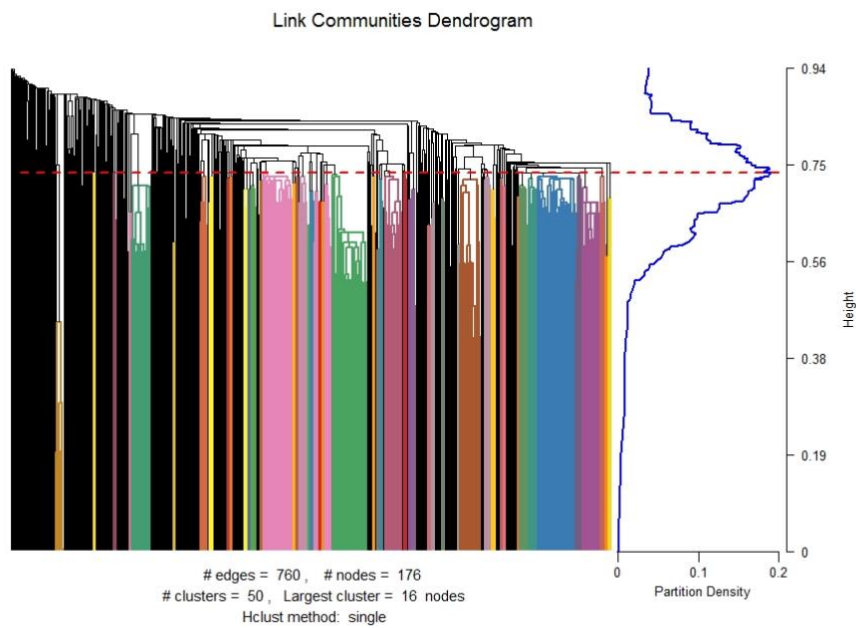*and Largest Cluster Size for the Friendship Networks Data of School 14 in Grade 11.*

Link Communities Dendrogram

edges = 308 , # nodes = 110
clusters = 25 , Largest cluster = 9 nodes
Hclust method: single
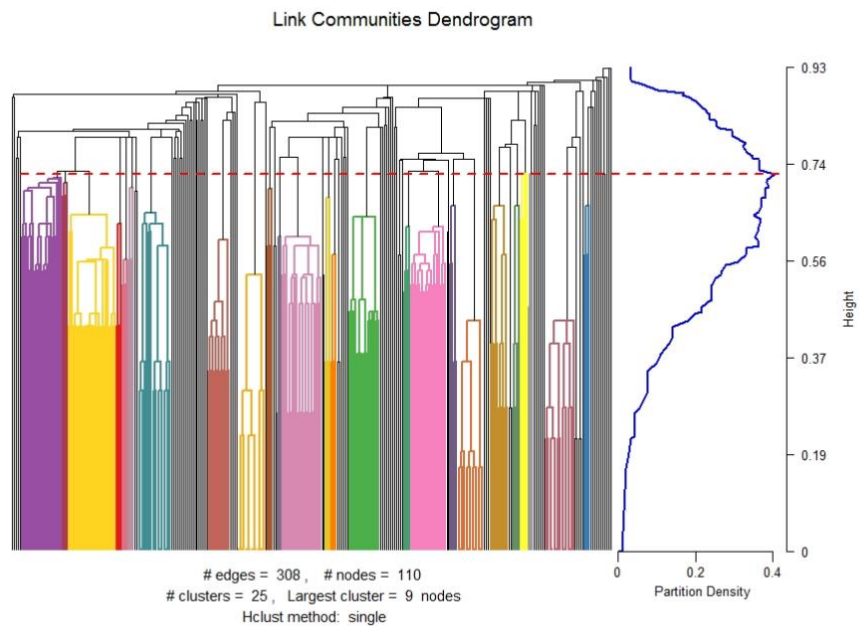
Figure S60

Link Communities Dendrogram, Partition Density Plot, Number of Edges, Nodes and Clusters,

and Largest Cluster Size for the Friendship Networks Data of School 15 in Grade 11.
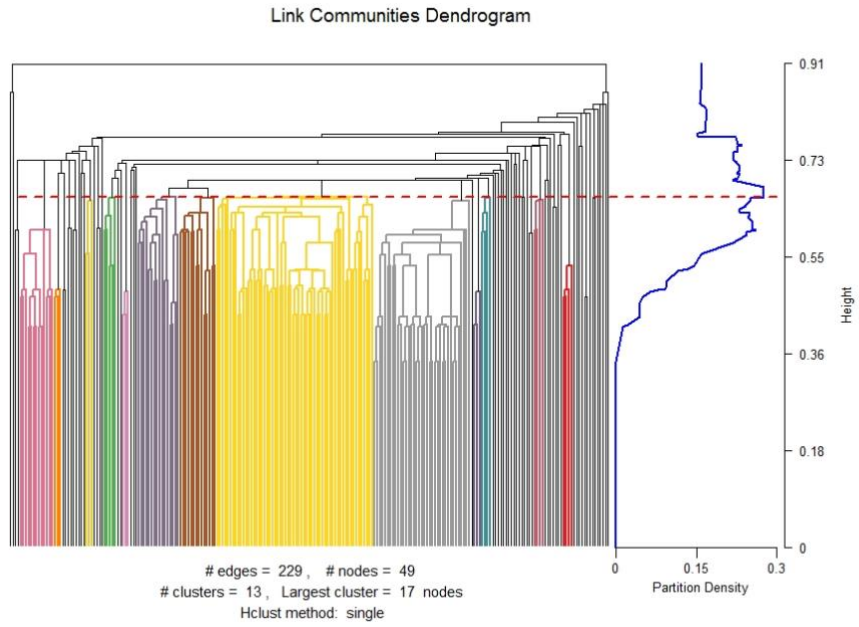
S4: Descriptive Statistics for Reciprocal Friendships

Table S1

Descriptive Statistics for the Reciprocal Friendship for Grades Eight to Eleven, by School

and also Combined

School	Grade 8 N	Grade 8 n (%)	Grade 8 M	Grade 9 N	Grade 9 n (%)	Grade 9 M	Grade 10 N	Grade 10 n (%)	Grade 10 M	Grade 11 N	Grade 11 n (%)	Grade 11 M
1	274	64 (23.36)	1.73	437	160 (36.61)	2.01	450	234 (52.00)	2.63	354	136 (38.42)	2.09
2	1,314	584 (44.44)	3.72	1,361	510 (37.47)	3.47	1,000	388 (38.80)	3.07	925	330 (35.68)	3.11
3	631	158 (25.04)	1.88	854	298 (34.89)	3.01	906	366 (40.40)	3.59	774	300 (38.76)	3.23
4	1,009	328 (32.51)	2.39	1,290	582 (45.12)	3.88	1,200	524 (43.67)	3.66	907	92 (10.14)	1.84
5	1,044	412 (39.46)	3.49	1,030	346 (33.59)	2.77	946	304 (32.14)	2.81	968	372 (38.43)	3.44
6	521	104 (19.96)	1.68	739	254 (34.37)	2.62	793	250 (31.53)	2.75	727	208 (28.61)	2.42
7	378	112 (29.63)	1.75	435	136 (31.26)	1.72	527	222 (42.13)	2.39	435	190 (43.68)	2.26
8	595	228 (38.32)	2.07	519	193 (37.76)	1.97	555	206 (37.12)	2.00	483	192 (39.75)	2.18
9	769	268 (34.85)	2.71	997	388 (38.92)	3.46	1,212	502 (41.42)	3.75	867	354 (40.83)	3.34
10	857	344 (40.14)	3.31	805	250 (31.06)	2.75	961	404 (42.04)	3.71	682	288 (42.23)	3.47
11	559	216 (38.64)	2.14	640	274 (42.81)	2.23	565	248 (43.89)	2.19	577	268 (46.45)	2.48
12	904	288 (31.86)	2.91	951	328 (34.49)	3.28	903	362 (40.09)	3.85	684	282 (41.23)	3.03
13	330	144 (43.64)	2.29	432	228 (52.78)	1.85	421	188 (44.66)	2.32	325	140 (43.08)	2.12
14	484	262 (54.13)	2.45	399	156 (40.21)	1.97	522	300 (57.47)	3.06	418	220 (52.63)	2.68
15	375	184 (49.07)	4.6	382	186 (48.69)	4.65	358	158 (44.13)	3.95	293	128 (43.69)	3.66
Total	10,044	3,396 (36.80)	2.70	11,260	4,289 (38.10)	2.85	11,319	4,656 (41.13)	3.05	9,419	3,500 (37.16)	2.82

Note: N = total number of nominations made; n(%) = the number of reciprocal nominations made and the percentage; M = the mean number of reciprocal friendships an individual has.

Table S2

Descriptive Statistics for the Non-Overlapping Friendship Communities for Grades Eight to Eleven, by School and also Combined

School	Grade 8 %(p)	N(g)	M	range	Grade 9 %(p)	N(g)	M	range	Grade 10 %(p)	N(g)	M	range	Grade 11 %(p)	N(g)	M	range
1	76.92	13	8.46	2 - 15	83.91	15	8	2 - 13	84.62	18	6.72	2 - 12	69.23	12	9.08	2 - 15
2	87.39	19	10.94	2 - 29	88.66	17	12.41	3 - 45	82.35	15	12.53	4 - 39	73.95	12	14.67	2 - 44
3	80.90	9	17.89	6 - 63	82.41	11	14.91	2 - 72	79.40	11	14.36	2 - 58	67.84	8	15	2 - 44
4	87.80	12	15	4 - 39	87.80	11	16.36	5 - 35	87.80	12	15	3 - 26	70.73	1	145	145
5	85.44	12	14.67	6 - 37	84.95	12	14.58	3 - 45	84.95	9	19.56	7 - 34	79.13	8	20.38	6 - 42
6	64.40	11	11.18	2 – 20	73.82	10	14.10	3 - 31	78.01	8	29.8	2 - 57	76.44	7	18.13	3 - 68
7	76.87	12	9.42	3 - 19	83.67	15	8.20	2 - 15	89.12	14	9.36	2 - 19	78.23	14	7.71	3 - 13
8	77.78	18	9.21	4 - 18	76.00	21	8.14	4 - 13	78.22	20	8.8	2 - 18	68.44	20	7.7	3 - 17
9	79.90	12	15.08	4 - 35	84.42	6	24	4 - 105	88.44	10	17.6	3 - 56	74.87	12	12.41	2 - 31
10	79.66	9	14.1	4 - 46	82.49	8	18.25	3 - 45	83.05	11	13.36	3 - 34	72.88	8	16.13	4 - 42
11	78.90	20	8.6	3 - 18	84.86	23	8.04	3 - 15	79.36	20	8.65	4 - 18	77.06	19	8.84	2 - 16
12	75.25	11	13.54	2 - 24	75.76	5	30	18 - 49	70.20	7	19.85	6 - 41	54.04	6	17.83	5 - 37
13	68.15	11	8.64	3 - 17	76.30	14	7.36	3 - 16	82.96	13	8.15	2 - 13	74.81	12	8.42	4 - 13
14	76.92	20	6.84	3 - 12	73.96	17	7.35	2 - 17	72.19	15	8.13	3 - 15	65.09	14	6.93	4 - 15
15	63.16	3	16	7 - 29	65.79	3	16.67	14 - 19	71.05	3	18	7 - 40	64.47	2	24.5	13 - 36
Total	78.40	191	11.97	2-63	81.14	188	13.89	2-105	81.03	186	13.99	2-58	71.39	155	22.18	2-145

Note. %(p) = the percentage of participants from the total sample who were identified as being a member of a friendship group; N(g) = the total number of friendship groups identified by the infoMap algorithm; M = the mean number of individuals in each friendship group; range = the size range of the friendship groups.

Table S3

Descriptive Statistics for the Overlapping Friendship Communities for Grades Eight to

Eleven by School and also Combined

School	Grade 8				Grade 9				Grade 10				Grade 11			
	%(p)	N(g)	M	range	%(p)	N(g)	M	range	%(p)	N(g)	M	range	%(p)	N(g)	M	range
1	73.64	14	6.21	3 - 14	86.67	29	5.55	3 - 10	79.34	18	6.33	3 - 14	67.27	18	5.22	3 - 10
2	82.21	75	5.21	3 - 18	84.83	68	6.07	3 - 26	76.02	56	5.63	3 - 18	76.14	50	5.92	3 - 16
3	68.83	24	6.58	3 - 21	84.15	49	5.96	3 - 20	75.32	34	7.09	3 - 40	77.78	49	5.41	3 - 13
4	78.33	44	6.59	3 - 27	93.33	54	6.63	3 - 37	76.67	45	6.24	3 - 23	83.45	55	6.16	3 - 39
5	67.20	41	5.98	3 - 21	84.57	50	5.88	3 - 28	84.57	54	5.57	3 - 26	72.39	47	5.85	4 - 21
6	73.98	31	5.61	3 - 16	76.60	46	5.33	3 - 19	69.80	35	5.77	4 - 26	60.27	32	5.75	3 - 18
7	81.42	25	5.00	3 - 9	78.86	24	5.42	3 - 10	83.97	24	5.88	3 - 13	80.87	21	5.71	4 - 11
8	82.29	31	5.77	3 - 15	84.21	29	5.66	3 - 13	68.75	28	5.71	3 - 12	72.73	28	5.11	3 - 10
9	79.25	44	5.91	4 - 24	65.48	46	5.57	3 - 26	77.84	63	5.51	3 - 26	79.19	39	6.23	3 - 25
10	72.34	41	5.80	3 - 23	67.81	40	5.38	4 - 17	77.55	41	5.85	3 - 22	87.69	42	5.59	3 - 22
11	87.79	23	7.04	3 - 15	84.32	35	5.74	3 - 12	83.24	33	5.21	3 - 10	91.72	32	5.97	3 - 14
12	73.83	48	5.67	3 - 19	58.00	44	5.48	3 - 14	81.29	43	6.05	4 - 18	86.92	40	6.43	3 - 14
13	76.08	16	5.62	3 - 10	88.35	24	5.46	4 - 11	85.71	22	6.05	4 - 11	88.12	19	5.58	3 - 14
14	76.15	29	4.90	3 - 7	82.40	25	5.16	3 - 9	95.90	19	6.89	3 - 14	84.55	25	5.40	3 - 9
15	93.75	12	8.42	4 - 19	88.00	23	6.35	4 - 17	87.04	28	5.21	3 - 13	77.55	13	7.31	4 - 17
Total	77.59	498	6.02	3-27	80.29	576	5.71	3-37	82.07	543	5.93	3-40	78.87	510	5.84	3-39

Note: %(p) = the percentage of participants from the total sample who were identified as

being a member of a friendship group; $N(g)$ = the total number of overlapping friendship

groups identified by the infoMap algorithm; M = the mean number of individuals in each

friendship group; range = the size range of the friendship groups.

Table S4

Degree of Overlap in Friendship Groups in Grade 8

	Grade 8														
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**
N(g)	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
0	29	37	53	39	51	32	21	31	33	39	21	39	22	31	3
1	75	51	69	58	58	43	62	113	42	27	140	44	55	61	13
2	6	63	30	45	29	24	27	27	46	42	11	28	11	33	18
3	-	32	7	20	26	16	3	3	29	13	-	9	3	5	7
4	-	15	2	12	10	6	-	-	7	13	-	15	1	-	5
5	-	4	-	3	1	1	-	-	1	6	-	5	-	-	1
6	-	4	-	2	1	1	-	-	1	1	-	6	-	-	1
7	-	2	-	1	-	-	-	-	-	-	-	1	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-

Note. S1 = School 1; S2 = School 2; S3 = School 3; S4 = School 4; S5 = School 5; S6 =

School 6; S7 = School 7; S8 = School 8; S9 = School 9; S10 = School 10; S11 = School 11;

S12 = School 12; S13 = School 13; S14 = School 14; S15 = School 15; *N*(g) = the number of

friendship groups an individual is a member of; *N* = the number of participants who were a

member of that number of groups.

Table S5

Degree of Overlap in Friendship Groups in Grade 9

	Grade 9														
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**
N(g)	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
0	16	32	26	12	27	33	26	27	57	56	29	63	12	22	6
1	58	56	57	57	61	39	67	126	39	37	117	32	58	83	8
2	37	60	40	60	47	33	27	16	27	15	33	12	27	14	6
3	8	30	22	29	24	19	3	2	26	21	6	18	5	6	11
4	1	24	8	16	13	9	-	-	11	10	-	11	1	-	7
5	-	4	9	6	3	4	-	-	7	3	-	5	-	-	8
6	-	4	2	-	-	2	-	-	1	1	-	5	-	-	3
7	-	1	-	-	-	1	-	-	-	3	-	2	-	-	1
8	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-

Note. S1 = School 1; S2 = School 2; S3 = School 3; S4 = School 4; S5 = School 5; S6 = School 6; S7 = School 7; S8 = School 8; S9 = School 9; S10 = School 10; S11 = School 11; S12 = School 12; S13 = School 13; S14 = School 14; S15 = School 15; *N*(g) = the number of friendship groups an individual is a member of; *N* = the number of participants who were a member of that number of groups.

Table S6

Degree of Overlap in Friendship Groups in Grade 10

	Grade 10														
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**
N(g)	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
0	25	47	39	42	27	45	21	55	39	33	29	26	16	5	7
1	78	60	49	49	59	43	80	85	37	53	120	26	62	103	12
2	18	44	42	52	48	34	29	33	42	21	21	31	31	14	8
3	-	26	23	19	24	18	1	3	28	20	2	27	3	-	7
4	-	11	4	14	14	8	-	-	16	15	1	9	-	-	10
5	-	5	2	3	3	1	-	-	8	5	-	5	-	-	6
6	-	1	1	-	-	-	-	-	4	-	-	6	-	-	1
7	-	2	1	-	1	-	-	-	2	-	-	-	-	-	3

Note. S1 = School 1; S2 = School 2; S3 = School 3; S4 = School 4; S5 = School 5; S6 = School 6; S7 = School 7; S8 = School 8; S9 = School 9; S10 = School 10; S11 = School 11; S12 = School 12; S13 = School 13; S14 = School 14; S15 = School 15; *N* groups = the number of friendship groups an individual is a member of; *N* = the number of participants who were a member of that number of groups.

Table S7

Degree of Overlap in Friendship Groups in Grade 11

	Grade 11														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
N(g)	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
0	36	42	30	24	45	58	22	42	31	16	14	14	12	17	11
1	54	41	26	27	36	35	67	86	57	48	119	20	75	57	8
2	20	47	18	38	37	23	25	21	23	34	36	25	11	31	14
3	-	26	22	28	22	19	1	5	20	17	-	21	3	4	9
4	-	17	19	13	17	9	-	-	13	9	-	16	-	1	4
5	-	3	9	5	5	2	-	-	2	5	-	7	-	-	2
6	-	-	1	6	1	-	-	-	3	1	-	3	-	-	1
7	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-
8	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-

Note. S1 = School 1; S2 = School 2; S3 = School 3; S4 = School 4; S5 = School 5; S6 = School 6; S7 = School 7; S8 = School 8; S9 = School 9; S10 = School 10; S11 = School 11; S12 = School 12; S13 = School 13; S14 = School 14; S15 = School 15; *N* groups = the number of friendship groups an individual is a member of; *N* = the number of participants who were a member of that number of groups.

Table S8

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates From Lagged Multilevel Models Using Reciprocal Friendships Where School is Included in the Models as a Random Intercept.

Variables at T	Estimate	SE	Confidence Interval	
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.617**	**0.013**	**0.590**	**0.643**
Individual Mental Ill-Health	0.021	0.016	-0.012	0.055
Group Aggression	0.023	0.019	-0.016	0.062
Group Mental Ill-Health	**0.038**	**0.013**	**0.011**	**0.065**
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.107**	**0.015**	**0.075**	**0.138**
Individual Mental Ill-Health	**0.443**	**0.017**	**0.409**	**0.477**
Group Aggression	-0.029	0.023	-0.079	0.021
Group Mental Ill-Health	0.021	0.016	-0.011	0.052
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.113**	**0.027**	**0.056**	**0.169**
Individual Mental Ill-Health	0.007	0.020	-0.034	0.047
Group Aggression	**0.289**	**0.029**	**0.226**	**0.353**
Group Mental Ill-Health	-0.042	0.027	-0.101	0.017
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.021	0.017	-0.015	0.056
Individual Mental Ill-Health	0.019	0.018	-0.018	0.055
Group Aggression	0.034	0.022	-0.012	0.080
Group Mental Ill-Health	**0.156**	**0.025**	**0.103**	**0.210**

Notes. T = time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table S9

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using Non-Overlapping Friendship Groups Where School is

Included in the Models as a Random Intercept

Variables at T	Estimate	SE	Confidence Interval	
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.604**	**0.017**	**0.568**	**0.640**
Individual Mental Ill-Health	0.026	0.014	-0.003	0.054
Group Aggression	0.019	0.015	-0.012	0.050
Group Mental Ill-Health	-0.024	0.017	-0.059	0.010
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.101**	**0.019**	**0.062**	**0.140**
Individual Mental Ill-Health	**0.453**	**0.016**	**0.419**	**0.486**
Group Aggression	-0.014	0.018	-0.052	0.023
Group Mental Ill-Health	-0.004	0.018	-0.041	0.033
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.105**	**0.016**	**0.073**	**0.137**
Individual Mental Ill-Health	0.007	0.015	-0.023	0.037
Group Aggression	**0.348**	**0.024**	**0.298**	**0.398**
Group Mental Ill-Health	**-0.063**	**0.020**	**-0.103**	**-0.022**
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.022	0.012	-0.002	0.046
Individual Mental Ill-Health	**0.067**	**0.014**	**0.039**	**0.094**
Group Aggression	**0.042**	**0.015**	**0.013**	**0.072**
Group Mental Ill-Health	**0.228**	**0.016**	**0.197**	**0.260**

Notes. T = time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table S10

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using Overlapping Friendship Groups Weighted by Size Where

School is Included in the Models as a Random Intercept

Variables at T	Estimate	SE	Confidence Interval	
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.608**	**0.023**	**0.558**	**0.658**
Individual Mental Ill-Health	0.041	0.021	-0.005	0.086
Group Aggression	0.064	0.062	-0.065	0.194
Group Mental Ill-Health	-0.062	0.065	-0.199	0.076
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.089**	**0.020**	**0.046**	**0.131**
Individual Mental Ill-Health	**0.468**	**0.021**	**0.423**	**0.512**
Group Aggression	**0.126**	**0.059**	**0.004**	**0.248**
Group Mental Ill-Health	**-0.151**	**0.059**	**-0.272**	**-0.030**
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	0.019	0.021	-0.024	0.062
Individual Mental Ill-Health	-0.034	0.025	-0.087	0.020
Group Aggression	**0.217**	**0.090**	**0.025**	**0.409**
Group Mental Ill-Health	-0.016	0.097	-0.223	0.192
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	-0.025	0.020	-0.066	0.172
Individual Mental Ill-Health	-0.004	0.024	-0.055	0.047
Group Aggression	0.050	0.082	-0.125	0.224
Group Mental Ill-Health	0.156	0.089	-0.034	0.347

Notes. T = time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table S11

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using Overlapping Friendship Groups Weighted by Outdegree

Where School is Included as a Random Intercept in the Models

			Confidence Interval	
Variables at T	Estimate	SE	Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.599**	**0.018**	**0.563**	**0.636**
Individual Mental Ill-Health	0.018	0.017	-0.015	0.053
Group Aggression	-0.006	0.050	-0.110	0.100
Group Mental Ill-Health	-0.003	0.055	-0.120	0.114
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.077**	**0.018**	**0.039**	**0.115**
Individual Mental Ill-Health	**0.464**	**0.020**	**0.423**	**0.504**
Group Aggression	**0.161**	**0.049**	**0.060**	**0.263**
Group Mental Ill-Health	**-0.187**	**0.051**	**-0.292**	**-0.082**
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	0.027	0.022	-0.199	0.074
Individual Mental Ill-Health	-0.030	0.023	-0.078	0.017
Group Aggression	**0.211**	**0.078**	**0.044**	**0.379**
Group Mental Ill-Health	0.005	0.080	-0.168	0.178
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	-0.017	0.021	-0.059	0.026
Individual Mental Ill-Health	0.023	0.019	-0.016	0.063
Group Aggression	**0.144**	**0.068**	**0.001**	**0.287**
Group Mental Ill-Health	0.056	0.072	-0.096	0.209

Notes. T = time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table S12

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using Overlapping Friendship Groups Using the Biggest Group

Where School is Included as a Random Intercept in the Models

Variables at T	Estimate	SE	Confidence Interval	
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.612**	**0.017**	**0.578**	**0.647**
Individual Mental Ill-Health	0.018	0.016	-0.015	0.052
Group Aggression	0.022	0.017	-0.014	0.057
Group Mental Ill-Health	0.023	0.020	-0.018	0.065
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.099**	**0.017**	**0.064**	**0.134**
Individual Mental Ill-Health	**0.428**	**0.0165**	**0.397**	**0.459**
Group Aggression	-0.004	0.021	-0.047	0.040
Group Mental Ill-Health	0.045	0.026	-0.010	0.010
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.171**	**0.024**	**0.121**	**0.221**
Individual Mental Ill-Health	-0.007	0.020	-0.049	0.034
Group Aggression	**0.357**	**0.023**	**0.310**	**0.405**
Group Mental Ill-Health	0.022	0.025	-0.030	0.073
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.013	0.016	-0.019	0.045
Individual Mental Ill-Health	**0.081**	**0.023**	**0.033**	**0.130**
Group Aggression	**0.046**	**0.018**	**0.009**	**0.083**
Group Mental Ill-Health	**0.312**	**0.029**	**0.251**	**0.372**

Notes. T = time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table S13

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the Most Influential Group Where School is Included as a

Random Intercept in the Models

| Variables at T | Estimate | SE | Confidence Interval | |
			Lower	Upper
Individual Aggression at Time T+1 (Model 1)				
Individual Aggression	**0.600**	**0.016**	**0.567**	**0.632**
Individual Mental Ill-Health	0.024	0.016	-0.008	0.057
Group Aggression	**0.041**	**0.020**	**0.000**	**0.082**
Group Mental Ill-Health	0.015	0.025	-0.038	0.068
Individual Mental Ill-Health at Time T+1 (Model 2)				
Individual Aggression	**0.096**	**0.019**	**0.056**	**0.135**
Individual Mental Ill-Health	**0.435**	**0.019**	**0.396**	**0.474**
Group Aggression	0.004	0.020	-0.037	0.045
Group Mental Ill-Health	0.036	0.019	-0.002	0.074
Group Aggression at Time T+1 (Model 3)				
Individual Aggression	**0.156**	**0.022**	**0.110**	**0.202**
Individual Mental Ill-Health	-0.008	0.020	-0.051	0.035
Group Aggression	**0.368**	**0.030**	**0.305**	**0.432**
Group Mental Ill-Health	0.026	0.033	-0.046	0.098
Group Mental Ill-Health at Time T+1 (Model 4)				
Individual Aggression	0.013	0.018	-0.023	0.050
Individual Mental Ill-Health	**0.080**	**0.022**	**0.034**	**0.128**
Group Aggression	**0.060**	**0.018**	**0.025**	**0.096**
Group Mental Ill-Health	**0.299**	**0.023**	**0.251**	**0.348**

Notes. T = time; SE = standard error; Lower = lower limit of the 95% confidence interval;

Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table S14

Summary table of the sensitivity analyses conducted with school as a random intercept.

Variables at T		Variables at T+1			
		Agg	GHQ	L2Agg	L2GHQ
Reciprocal friendships: L2Agg and L2GHQ scores computed as the average self-reported aggression and mental ill-health scores, respectively, across all reciprocated friends of each participant.	Agg	+	+	+	-
	GHQ	+	+	-	+
	L2Agg	-	+	+	+
	L2GHQ	-	-	+	+
Non-overlapping groups: L2Agg and L2GHQ computed as the average of the aggression and mental ill-health scores across all members in an individual's non-overlapping friendship group.	Agg	+	+	+	+
	GHQ	+	+	-	+
	L2Agg	+	-	+	+
	L2GHQ	+	+	+	+
Overlapping groups: L2Agg and L2GHQ scores were computed as the average aggression and mental ill-health scores, respectively, across the multiple groups an individual belongs to, weighted by the size of each group.	Agg	+	+	+	+
	GHQ	+	+	-	+
	L2Agg	+	+	+	+
	L2GHQ	+	+	+	+

Notes. T= time; Agg = Aggression; GHQ = mental ill-health; L2Agg = friends' aggression;

L2GHQ = friends' mental ill-health; + = a positive estimate; - = a negative estimate

Dark shaded boxes are those for which there was a significant estimate between the variables.

Table S15

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the Reciprocal Friendships, Non-Overlapping Friendship

Groups, Biggest Friendship Groups, and Most Influential Friendship Group

Conceptualisations

Group Conceptualisation	Variables at T	Estimate	SE	CI Lower	CI Upper
Reciprocal	Individual Aggression at Time T+1				
	Individual Aggression	**0.623**	**0.013**	**0.597**	**0.648**
	Group Aggression	0.035	0.018	-0.003	0.073
Non-Overlapping	Individual Aggression at Time T+1				
	Individual Aggression	**0.613**	**0.016**	**0.579**	**0.647**
	Group Aggression	0.008	0.015	-0.022	0.037
Biggest	Individual Aggression at Time T+1				
	Individual Aggression	**0.618**	**0.015**	**0.587**	**0.649**
	Group Aggression	0.027	0.015	-0.004	0.058
Most Influential	Individual Aggression at Time T+1				
	Individual Aggression	**0.599**	**0.014**	**0.570**	**0.628**
	Group Aggression	0.034	0.020	-0.009	0.077

Notes. T = time; SE = standard error; CI = confidence interval; Lower = lower limit of the

95% confidence interval; Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.

Table S16

Standardised Fixed Effects, Standard Errors, and 95% Confidence Interval Estimates from

Lagged Multilevel Models Using the Reciprocal Friendships, Non-overlapping Friendship

Groups, Biggest Friendship Groups, and Most Influential Friendship Group

Conceptualisations

Group Conceptualisation	Variables at T	Estimate	SE	CI Lower	Upper
Reciprocal	Individual Mental Ill-Health at Time T+1				
	Individual Mental Ill-Health	**0.479**	**0.014**	**0.450**	**0.508**
	Group Mental Ill-Health	0.013	0.015	-0.018	0.043
Non-Overlapping	Individual Mental Ill-Health at Time T+1				
	Individual Mental Ill-Health	**0.490**	**0.017**	**0.455**	**0.524**
	Group Mental Ill-Health	-0.012	0.021	-0.054	0.031
Biggest	Individual Mental Ill-Health at Time T+1				
	Individual Mental Ill-Health	**0.462**	**0.014**	**0.434**	**0.491**
	Group Mental Ill-Health	0.047	0.023	-0.001	0.094
Most Influential	Individual Mental Ill-Health at Time T+1				
	Individual Mental Ill-Health	**0.458**	**0.022**	**0.410**	**0.506**
	Group Mental Ill-Health	0.038	0.023	-0.010	0.086

Notes. T = time; SE = standard error; CI = confidence interval; Lower = lower limit of the

95% confidence interval; Upper = upper limit of the 95% confidence interval.

Rows in bold are those for which the confidence interval does not include zero.