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**Pro-environmental behaviours in a high school
social network**

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A thesis submitted in fulfilment of the requirements for the degree of Doctor of
Philosophy in Psychology at the University of Auckland, 2015.

Thesis abstract

Managing and mitigating our impact on the natural environment is arguably the greatest challenge facing the world today. Social interactions can shape both collective and individual responses to environmental degradation. During adolescence friends may be particularly influential in pro-environmental behaviour as this is thought to be a time of heightened susceptibility to peer influence. This thesis takes an in-depth look at the role of friends in shaping the pro-environmental behaviour of students attending a high school in Auckland, New Zealand. It reports results from focus groups and a three-wave social network longitudinal survey focusing on waste sorting behaviour and transport choices.

The results showed that waste and transport behaviours clustered in the school social network such that students behaved similarly to their friends. Repeated measures analyses indicated that friends tended to become more similar over time in cycling (for males only) as well as in littering and recycling. This is consistent with a “contagion” process whereby students’ behaviour is influenced by friends’ behaviour. Investigation of three potential mechanisms did not identify any significant mediators of contagion, possibly due to the analytical approach used in this study. Further research is needed to explore what drives the apparent contagion in these behaviours.

To examine the broader context of social influence, the final chapter investigates the role of conversation in constructing environmental action. The analysis of the focus group comments argues that justifications and stereotypes of pro-environmental action can serve to reinforce behavioural norms around minimal environmental action.

These findings suggest that interventions focusing on littering, recycling and cycling behaviour (in males) should consider the subsequent effects that encouraging a behaviour in a set of individuals may have for their friends’ behaviour.

Acknowledgements

A number of people contributed to the development of this thesis. First, I am very grateful to the students who participated in this study, without your input none of this research would have been possible. Volunteers, teachers and other post-graduate students assisted with survey supervision making this job far more manageable than it would otherwise have been.

To my supervisors, thank you supporting me through this process, in particular for your feedback on previous drafts and for training my writing style. The development of this thesis was benefitted by your complementary strengths and perspectives. Thank you for your patience during my learning journey and for giving me room to follow my interests (and silly ideas!). Thank you also to the anonymous reviewers whose feedback provided valuable ideas for Chapters 3, 4, and 7. I am grateful to Simon Greenhill for programming an application to calculate distance information and Thomas Lumley for pointing us to the sandwich variance estimator and assisting with implementation.

A large social network also contributed to the development of this thesis. Thank you to Brian, Ewan and Heather for proofreading sections of this thesis. I am also grateful to the fabulous team of students in the School of Psychology (particularly Joseph, Sarah, Sam, Brenna, Yuthika, Octavia and Charlotte) for your camaraderie. Thanks in particular to Sam for conversations about R and statistics and Brenna for many hours of laughter and collegiality. Thank you to the friends (particularly Heather, Jo and Emily) and flatmates past and present who have enriched my life with your laughter, positivity, inspiration, kindness and caring. Thanks also to Ewan for your support, distracting me just the right amount and for reminding me to believe in myself. Finally, I am indebted to my mother and father for their support over the years and for tolerating my mundane phone calls about thesis-life.

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"Social Clustering in high school transport choices"

Nature of contribution by PhD candidate

Research design, data collection, data analysis, literature review, wrote manuscript.

Extent of contribution by PhD candidate (%)

80

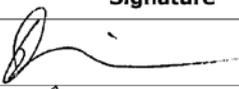
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"Understanding Change in Recycling & Littering Across School Network"

Nature of contribution by PhD candidate: Research design, data collection, data analysis, literature review, wrote manuscript.
Extent of contribution by PhD candidate (%): 80

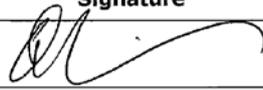
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Name	Nature of Contribution
Quentin Atkinson	Supervised design, analysis and write-up.
Niki Harre	Supervised design, analysis and write-up

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Chapter 1: Introduction

The introduction to this thesis begins by arguing for the importance of engaging adolescents in pro-environmental behaviours. It then discusses the potential role of social networks in shaping these behaviours and literature detailing possible mechanisms by which friends may influence each other's behaviour. Finally, the introduction briefly discusses the role of individual differences in shaping behaviour and the role of conversations in negotiating and communicating what pro-environmental behaviours are appropriate for students at this school.

1.1 Background

Environmental degradation is arguably the biggest challenge currently facing humanity. People have been concerned about the environment for centuries (Frank, Hironaka, & Schofer, 2000; Grove, 1996), yet recently the rate of increase in concern has accelerated as the rate of environmental degradation, and our knowledge of this degradation, has increased.

Pollution of the air, water and natural environments have substantial impacts on wildlife, water supplies and human health (Jacobson, 2009). For example, air pollution increases the risk of mortality, and chemical pollution can have disastrous effects for local wildlife (e.g. Pope, Thun, Namboodiri, Dockery, Evans, Speizer, & Heath, 1995). The case for taking action in order to mitigate humanity's impact on the environment is strong from an environmental, humanitarian (IPCC, 2014) and economic standpoint (N. H. Stern, 2007).

Climate change is one of the most concerning forms of environmental degradation. Human consumption and pollution are contributing to warmer temperatures, species extinction and habitat destruction. Adverse environmental changes are likely to increase dramatically over the coming years with serious impacts on food and water supplies, livelihoods, weather events and migration (IPCC, 2014). Scientists are confident that current

and forecasted changes in climate are driven to a large extent by human activity (IPCC, 2013).

People impact on the environment through the consumption of limited resources (e.g. fisheries and timber) and through the consumption of resources that have extraction costs for the environment (e.g. palm oil and precious metals). Transport is one of the biggest contributors to greenhouse gas emissions in developed nations, therefore making even small changes in this behaviour is important (Hertwich & Peters, 2009; Tukker & Jansen, 2006). Consumer behaviour, such as littering or purchasing products from environmentally irresponsible manufacturers, may also directly or indirectly pollute physical environments. Pollution may affect parks, waterways and forests, as well as the animals and other organisms that inhabit these. This thesis focuses primarily on the actions available for people living in developed nations and on the academic literature produced in these nations, acknowledging that situations and bodies of knowledge may be different in developing nations.

A range of activities can be undertaken to minimise our environmental footprint. Strategies include national and international policies and sanctions, environmental protection campaigns, and technological developments targeting pollution and resource use (Corner & Randall, 2011; Koger, Leslie, & Hayes, 2011). Given the numerous ways people negatively impact on the environment, a key part of reducing our impact on the environment will also involve replacing some of our existing behaviours with behaviours that harm the environment less. Transport and waste are important opportunities for individual action and the key focus of the current study.

“Behaviour that harms the environment as little as possible, or even benefits the environment” is often described using the term “pro-environmental behaviour” (Steg & Vlek, 2009, p.309). I use the term pro-environmental behaviour to refer to behaviours that minimise harm to the environment, regardless of whether all people engaging in the behaviour are

motivated to do so out of concern for the environment. Similar terms include “environmentally significant behaviour” (e.g. P. C. Stern, 2000), “environmentally responsible behaviour” (e.g. Thøgersen, 2004) and “green behaviour”. Pro-environmental behaviours include behaviours that reduce carbon emissions such as composting food waste aerobically and minimise the use of fossil fuels for power, heating and household transportation. As mentioned, these behaviours may not always be motivated by environmental concerns (Whitmarsh, 2009).

Of the range of possible pro-environmental behaviours, recycling (and other forms of waste sorting), water conservation and energy conservation are relatively common and easy to perform (Arscott et al., 2007; Whitmarsh, 2009). The perceived ease of recycling (in communities with access to recycling facilities) and the ease of conserving power and water have made these behaviours the target of a number of educational, community and local government campaigns (McKenzie-Mohr, 2013). The minimal effort involved in adopting these behaviours may also make them potentially conducive to influence from other people.

Whilst people of all ages engage in environmentally harmful and beneficial behaviours, in the following section I argue that adolescence may be a particularly important period for promoting pro-environmental behaviours.

1.1.1 Adolescents and environmental mitigation

Environmental degradation and climate change are key issues for today’s adolescents. This generation will be more affected by environmental degradation than previous generations (United Nations, 2010). By 2040 climate change is expected to exceed a 2°C increase above pre-industrial temperatures in many parts of the world (Joshi, Hawkins, Sutton, Lowe, & Frame, 2011). Further, adolescents will eventually inherit key decision making positions within households, communities, organisations and politics and accordingly

they will have a strong impact on attempts to manage and mitigate environmental degradation.

Encouraging environmental engagement and pro-environmental behaviour in adolescence is also important because habits developed in childhood and adolescence are likely to have implications for habits later in life. For example, transport choices during childhood and adolescence are a key predictor of transport choices in adulthood (e.g. Line, Chatterjee, & Lyons, 2012). As such, a number of education programmes have been developed. Some focus on environmental education in formal classroom settings (e.g. Bogner, 1999) and others adopt whole of school approaches which attempt to embed environmental goals across all areas of the school (Henderson & Tilbury, 2004; Shallcross & Robinson, 2008). Whilst these programmes have had some success at alternating knowledge and attitudes (e.g. Bogner, 1999; Grodzinska-Jurczak, Bartosiewicz, Twardowska, & Ballantyne, 2003) they are clearly not the whole solution.

In addition, the relevance of environmental degradation for adolescents does not map onto engagement: a high proportion of adolescents appear to be relatively disinterested or uninvolved in mitigation efforts (Connell, Fien, Lee, Sykes, & Yencken, 1999; Partridge, 2008). Whilst studies do not appear to have directly compared adolescents with adults, studies from the United Kingdom (Gilg, Barr, & Ford, 2005), United States (Swami, Chamorro-Premuzic, Snelgar, & Furnham, 2011) and Brazil (Pinto, Nique, Añaña, & Herter, 2011) have found that younger adults tend to engage in fewer pro-environmental behaviours, or rate pro-environmental behaviour as less important, compared to older adults. Further, survey results reveal that, relative to primary school students, Australian students in their first year of high school report lower willingness to engage in recycling, public transport use, tree planting and purchasing (Skamp, Boyes, & Stannistreet, 2009). Disengagement of adolescents in the United States appears to have increased over recent decades, according to a

survey tracking trends in self-reported pro-environmental behaviour and concern for the environment among US adolescents (Wray-Lake, Flanagan, & Osgood, 2010). Despite the rationale for focusing on adolescence, most research on pro-environmental behaviour has focused on adults (see Gifford, 2011; Gifford & Nilsson, 2014; Steg & Vlek, 2009).

Adolescent environmental engagement may differ from engagement in adulthood, on average, due to differences in cognitive development, domains of responsibility and social context. These characteristics of adolescence also mean that factors which predict and influence pro-environmental behaviour in adolescence may not do so in adulthood and vice versa. I discuss these key developmental differences below.

First, from a cognitive perspective, the ability to process risk and consider abstract concepts continues to develop during adolescence (Piaget, 1972). This is mirrored by an increase in the understanding of sustainability issues related to the design of public spaces (Svetina, Istenič-Starčič, Juvančič, Novljan, Šubic-Kovač, Verovšek, & Zupančič, 2011). Younger adolescents are also, on average, less future oriented than older adolescents and adolescents as a whole perform worse on planning oriented tasks (Steinberg, Graham, O'Brien, Woolard, Cauffman, & Banich, 2009). This ability to engage in forward planning is important for pro-environmental behaviours as these behaviours frequently are inconvenient in the short term but have long term benefits. Further, individuals who tend to emphasise the future over the present and past when making decisions, tend to engage in more pro-environmental behaviour (Milfont, Wilson, & Diniz, 2012).

Second, during adolescence domains of responsibility and autonomy are greater than during childhood (Steinberg, 1990) but still remain rather limited. For example, decisions related to household consumption practices are still typically made by parents or caregivers (Grønhøj, 2006). Furthermore, a sense of low control over environmental consumption may contribute to an overarching sense of low efficaciousness for responding to environmental

degradation. While limited control over behaviours and self-efficacy are not unique to adolescents, these factors are likely to be particularly strong during adolescence, posing problems for encouraging a culture of pro-environmental behaviour among this group.

Third, from a social perspective, adolescence involves a heightened focus on the behaviour and appraisals of peers (Brechwald & Prinstein, 2011; Steinberg & Monahan, 2007). Relative to children, adolescents typically spend more time with friends and other peers and less with parents (Dunton, Whalen, Jamner, & Floro, 2007; Larson & Richards, 1991). Adolescents have a number of opportunities for observation and comparison with other adolescents, particularly in school settings. Classroom and playgrounds are densely populated with students of a similar age offering many opportunities for comparisons of any pro-environmental behaviour performed in these contexts.

Of particular interest to this thesis, adolescent social networks appear to be influential in the spread of a number of behaviours. Adolescent social networks have been investigated in some depth outside the environmental domain. Research indicates that friends' behaviour impacts on the likelihood of performing anti-social behaviours (Brechwald & Prinstein, 2011; Brown, Bakken, Ameringer, & Mahon, 2008), pro-social behaviours such as academic achievement (Blansky, Kavanaugh, Boothroyd, Benson, Gallagher, Endress, & Sayama, 2013) and health behaviours (Maturo & Cunningham, 2013; Salvy, de la Haye, Bowker, & Hermans, 2012).

Qualitative research with adolescent environmental leaders provides an initial suggestion that friends may also be influential in adolescent pro-environmental behaviour. Arnold, Cohen, and Warner (2009) interviewed twelve Canadian adolescents about factors they believed influenced their environmental engagement. Nine of the twelve said that friends or peers who engaged in environmental actions were important for their own involvement in environmental activity. Interviewees reported that the ability to share environmental activities

made the experiences more meaningful. Friends and other peers involved in environmental action also served as role models and points of introduction to environmental groups and projects. Reportedly, friendships were also formed because of environmental activities and these in turn supported ongoing involvement in these activities (Arnold et al., 2009).

The potential of social connections to influence pro-environmental behaviours has been utilised in a number of interventions, most of which have targeted adults or university students. In the next section I discuss evidence for a range of social interventions aiming to encourage pro-environmental behaviour.

1.1.2 Social interventions targeting pro-environmental behaviour

Interventions which utilise interpersonal relationships or social interactions appear to be promising options for promoting pro-environmental behaviour. A meta-analysis of social interventions (Abrahamse & Steg, 2013) assessed their effectiveness for promoting pro-environmental behaviours relative to the control intervention used in each study. In general, social interventions were effective relative to control interventions such as goal setting (Abrahamse & Steg, 2013). In particular, peer-leader and social network approaches, most of which involved leaders encouraging their neighbours to perform environmentally friendly behaviour, were the most effective (Abrahamse & Steg, 2013).

Peer-leader interventions were referred to as “block-leader” interventions in Abrahamse & Steg (2013), yet here I use the term peer-leader for consistency with interventions which also utilise principles of recruiting a small subset of individuals to encourage, promote or inform their existing social network (Bell, Audrey, Cooper, Noble, & Campbell, 2014; Campbell et al., 2008). The specific actions undertaken by peer leaders in the interventions reviewed by Abrahamse and Steg (2013) varied. Some involved approaching neighbours and giving them information whilst others involved more direct encouragement, reminders or involved group-based conservation. Likewise, Valente (2012) describes a variety of social

network interventions which either utilise the involvement of existing relationships to spread behaviour or seek to develop or disrupt relationships as a way to foster intervention outcomes. Whilst none of the peer-leader or social network studies reviewed in Abrahamse and Steg (2013) focused on adolescents, a recent United States study suggests that peer-leader interventions can generate small temporary impacts on the electricity conservation of older adolescents (Bloodhart, Swim, & Zawadzki, 2013).

In this peer-leader intervention¹, Bloodhart et al. (2013) trained volunteers from university halls of residence in proactive coping, goal setting, and behaviour-change techniques (Bloodhart et al., 2013). University halls with a volunteer leader reduced their energy by 3-4% more than halls without a leader, during an inter-hall electricity reduction competition. These reductions were maintained two weeks after the competition (Bloodhart et al., 2013) but it is unknown whether reductions were maintained over the long-term. Electricity reductions correlated with conversations between the leaders and other residents on this topic suggesting that conversations were important for the effectiveness of this peer-leader intervention (Bloodhart et al., 2013).

Peer-leader interventions do not appear to have been formally researched with younger adolescents, nor is it clear whether adolescents' peers can influence behaviours in areas other than electricity reduction, or influence behaviours over the long term. A number of factors such as behavioural difficulty, importance of the behaviour to the peer context and intervention design may govern how successful an intervention is at changing each behaviour. This means that it is not possible to simply generalise from this one study. Pro-environmental behaviours vary widely in their ease, and relevance, to the peer context such

¹ This intervention differed from some other peer leader intervention because leaders were volunteers who self-identified, rather than being nominated or elected by their peers.

that the scoping and design of interventions should be performed separately for different behaviours.

1.2 Social networks

In real world settings friendships do not exist in isolation from other friendships, nor are they formed randomly. Friendship structure and formation has important implications for attempts to utilise social influence to promote pro-environmental behaviours such as peer leader interventions. In this section I discuss four key concepts of social networks. These focus on the interconnected nature of relationships, relationship selection preferences, the distribution of behaviours in a network and influence by people we form relationships with. I introduce terms from the social network literature as I discuss each concept.

1.2.1 Social network definition

The first key concept is that people form relationships with others and these relationships tend to be overlapping rather than comprising of discrete groups. At its simplest level, a social network describes a set of social actors and the social connections that exist between them (Robins, 2013; Wasserman & Faust, 1994). In the case of friendships, social network representations expand the concept of a friendship relation, friendship group or clique by allowing relationships to be represented as a complex system of inter-related friendship ties (Prell, 2012; Snijders, 2011b). Depending on the topic of interest, relationship ties can also represent colleagues, working relationships, advice networks and virtually any other type of social connection between actors. Within a social network a focal individual is referred to as the “ego” and the individuals they share relationships with are referred to as their “alters”.

1.2.2 Social networks and homophily processes

The second key concept of social contexts is that people tend to make friends with people who share at least some of their dispositions or characteristics. Common dimensions of similarity include age, gender and interests (McPherson, Smith-Lovin, & Cook, 2001). This tendency to seek similarity in the choice of friends is also known as “homophily”.

Researchers typically distinguish between three key types of homophily. First, people tend to select friends according to whether these potential friends also perform the target behaviour (manifest homophily). Friend selection may also occur on measured factors which influence the target behaviour (secondary homophily) or on unmeasured factors which influence the target behaviour (latent homophily).

Many survey-based studies have overlooked how homophily processes may generate results which could be interpreted as indicators of social influence. As an illustrative example, Lee (2010) noted that “peer effects” were the primary predictor of concurrent consumption decisions among Chinese adolescents. However their measure of peer effects included items such as “*How much do you learn from your peers about environment related subjects?*” which could simply reflect friend selection based on similar levels of environmental interests. Likewise, studies which investigate influence by examining perceptions of descriptive norms (perceptions of how common a behaviour is in a relevant group or setting) could be capturing the tendency for people to make friends with people who are similar to themselves (i.e. homophily) rather than any influence of the perceptions of friends’ behaviour on their own.

Homophily (tendencies for people to select friends who are similar to themselves) may be considered a nuisance trait when attempting to study social influence. However understanding what generates homophily may be important for understanding the distribution of behaviour in the social context which, as discussed in the following section, has implications for social processes that operate within that community.

Traits which predict pro-environmental behaviour may be important drivers of the perception that pro-environmental behaviour is common or uncommon, if these traits are both socially clustered and influence pro-environmental behaviour. Within this thesis I explore demographic variables (such as age and gender), contextual variables (such as distance to school) and personality traits as possible contributors to homophily processes which should then in turn influence the development of local descriptive norms around pro-environmental behaviour.

1.2.3 Social networks and social clustering

The third key concept, is that relationship preferences can generate “clusters” of behaviours or characteristics in a social network. As an example of social clustering, Figure 1.1 displays a social network graph of students who participated in the first wave of the data collection for this thesis. Each student or ‘actor’ is represented by a circle, which is coloured according to their grade level. The lines connecting the circles represent friendships. The network is laid out using a Fruchterman-Reingold algorithm which places connected ties close together in the network graph. The high density of each colour in separate areas of the network demonstrates school year level is *socially clustered* in the network. In other words students are more likely to be friends with students from the same year level (i.e. dots of the same colour). These patterns of similarity among connected individuals are also referred to as social clustering or network autocorrelation. Due to the complexity of interpreting the strength of clustering in network visualisations, social clustering is often tested using quantitative statistics which are described in Chapter 2.

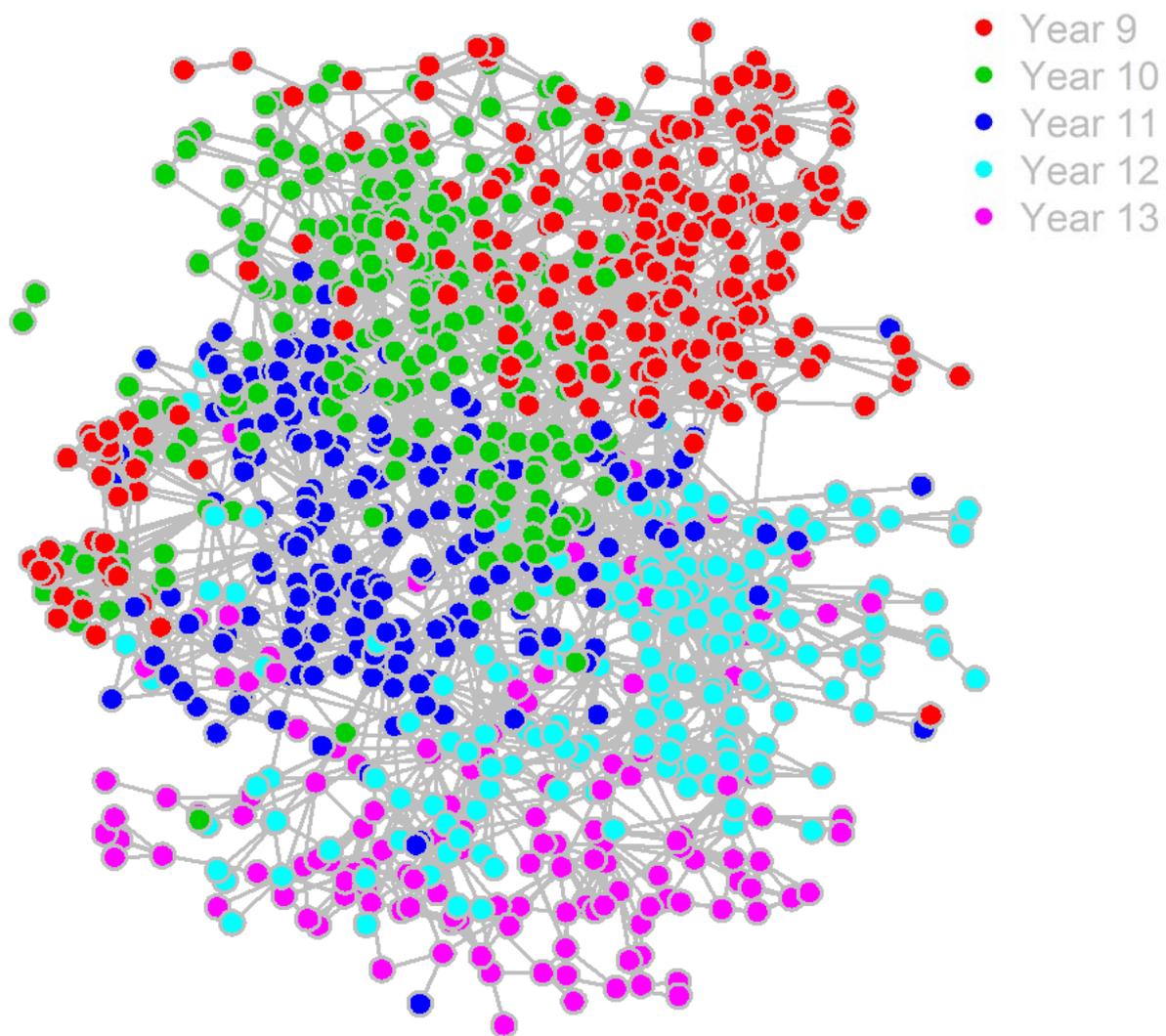


Figure 1.1. Social network graph of students participating in the Time 1 questionnaire, coloured by school year level.

Social clustering and other structural properties of the network may also be important for the maintenance of minority norms (Latané, 1996b). Theories about the conformity-inducing effects of norms (e.g. normative focus theory: Cialdini, Reno, & Kallgren, 1990) predict that social clustering should facilitate engagement in pro-environmental behaviours in parts of the network where pro-environmental behaviours are common. Where a group of friends all participate in a behaviour this could generate a sense that the behaviour is common in wider

society and in turn generate pressure to conform to this group norm (Asch, 1951; Latané, 1981). Thus in situations where the behaviour is already common, normative and conformity processes may support attempts to encourage pro-environmental behaviour. On the other hand, in areas where these behaviours are uncommon, clustering may act as a hindrance to encouraging pro-environmental behaviour.

Social network studies have identified peer similarities in a large number of behaviours and across a diverse variety of contexts. For example, social clustering in physical activity levels has been found in males and females, in a variety of ages (de la Haye, Robins, Mohr, & Wilson, 2011b; Jago, MacDonald-Wallis, Thompson, Page, Brockman, & Fox, 2011), across a range of countries (Luszczynska, Gibbons, Piko, & Tekozel, 2004) and using both self-report and objective measures (Schofield, Mummery, Schofield, & Hopkins, 2007). However research is yet to identify whether environmental engagement tends to cluster in school social networks. Social clustering may be generated by homophily or by influence processes.

1.2.4 Social networks and contagion

The fourth key concept of social networks is that our behaviour may be influenced by the behaviour of those around us. Most conceptualisations of influence (i.e. conformity, persuasion, peer pressure, normative influence) argue that if person A influences person B's behaviour they will influence it to become more similar to their own behaviour. Thus social clustering may be an indicator that interpersonal influence has occurred.

When performance of a behaviour is influenced by the performance of that behaviour among people they are connected to in a social network this is called "contagion" (Brechtwald & Prinstein, 2011; Christakis & Fowler, 2008; Dishion & Tipsord, 2011; Eisenberg, Golberstein, Whitlock, & Downs, 2013; Shalizi & Thomas, 2011). For example, if the presence of recycling behaviour among an actors' friends causally increases the likelihood of

that actor increasing the frequency of their recycling behaviour this would be described as contagion of recycling.

The term contagion has also been used to describe more specific types of influence. Among the earliest definitions, Le Bon, in the late 1800s, argued that contagion was a process arising from suggestibility that lead to imitation (Levy & Nail, 1993). Two reviews (Levy & Nail, 1993; Wheeler, 1966) propose that the term contagion should be used to describe a subset of imitation processes that is distinct from conformity and other types of influence. However in this thesis I follow the contemporary use of the term contagion to describe influence processes by which the likelihood of adopting a behaviour is increased by the performance of that behaviour by friends (e.g. Brechwald & Prinstein, 2011; Christakis & Fowler, 2008; Dishion & Tipsord, 2011; Eisenberg et al., 2013; Shalizi & Thomas, 2011). Often the term “influence” and “contagion” are used interchangeably. However, technically, “influence” describes a broader set of social processes which result in behaviour change whereas the contemporary use of the term “contagion” covers influence that results in increased similarities in the behaviour among socially connected individuals.

1.3 Potential mechanisms of contagion

It is important to ascertain what mechanisms may be causing people to adopt behaviour that is similar to their friends. The term contagion is also used to describe a process of disease spread through social contact, an analogy which has likely helped to generate substantial interest in the possibility of contagion of behaviours or attitudes. Yet this analogy may misrepresent the processes by which one person’s behaviour influences another. People cannot simply “catch” a behaviour. Rather some intermediary interaction, perceptual or unconscious process is needed for behaviours to be contagious along social ties. Social network researchers have paid relatively little attention to cognitive mechanisms or aspects of social interactions which are likely to underpin social contagion. However social psychology

has outlined a number of influence processes which could operate as mechanisms of contagion (Robins, 2013).

Several of these mechanisms are described in some of the social psychological theories of social influence. Key potential mechanisms include conformity to perceptions of how common a behaviour is among others in the setting or among people who are important to the individual (“descriptive norms” outlined in normative focus theory), with socially shared rules about morally appropriate behaviour (“injunctive norms” outlined in normative focus theory), with norms associated with reference group membership (self-categorisation theory) and adopting behaviour as a result of observational learning (social learning theory).

There are also a number of other potential mechanisms of social influence worthy of consideration which are not covered in these main theories. Additional possible mechanisms of contagion include; unconscious imitation, opportunities for co-participation (participating in an activity with a friend), encouragement or verbal support and overt peer pressure. These potential mechanisms and the mechanisms introduced previously are presented in Table 1.1. The mechanisms have been arranged according to how much each reflects a passive process that simply depends on friends performing the behaviour and observing this behaviour (left) versus active, deliberate forms of influence that involve additional actions on the part of the influencer (right).

Where mechanisms of contagion are located on this continuum has important implications for understanding and theorising about contagion. The location helps to conceptualise whether contact itself is likely to be sufficient for behaviour to occur, or whether contagion is capturing more deliberate active processes of influence that could be fostered in order to generate influence. If influence is driven by mechanisms at the passive end then fostering contact with people performing the behaviour may be sufficient. Thus the

location on this continuum also has implications for intervention development. In Table 1.1, I discuss these potential mechanisms in order from the most passive to the most active.

The most passive potential mechanism of contagion is unconscious imitation.

Unconscious imitation describes situations when behaviour is influenced by the behaviour of others even when people are not aware that they are imitating another person's behaviour (Iacoboni, 2009). One possible reason for unconscious imitation is that observing someone else perform a behaviour activates parts of the brain involved in performing the behaviour (Iacoboni, 2009). Unconscious imitation is akin to a simple contagion process – no further activity or perceptions are required other than an ego observing the behaviour of others.

Social learning theory (Bandura, 1977) is primarily a theory for explaining how people learn from others. It emphasises the role of observational learning processes such as imitation or modelling, through which people learn how to perform certain actions. These processes may also act as mechanisms through which people influence each other's behaviour: if people imitate and model observed behaviours then observing a behaviour can increase the likelihood of performing that behaviour. Observational learning is not only restricted to novel behaviour. Observing a familiar behaviour being rewarded in others may also increase the likelihood that the observer will perform the behaviour (Bandura, 1977).

Co-participation opportunities predict engagement in physical activity (Matureo & Cunningham, 2013) and may be important for engaging in pro-environmental behaviour. People have a desire to have positive, meaningful and stable relationships with other people (Baumeister & Leary, 1995), which should in turn motivate people to engage in activities which foster relationships, such as participating together in activities. In turn behaviours which are performed with friends are more likely to be maintained because shared participation should make the behaviours more rewarding. Among a sample of university students from the United States, the desire to meet new people was the strongest motivation

for participating in environmental organisations, behind the desire to support environmental causes (McDougle, Greenspan, & Handy, 2011). These mechanisms are passive when they occur naturally but may become more active if one individual invites the other to perform pro-environmental behaviours with them.

Central to a number of theories of social influence is the concept of social norms. Yet norms have been conceptualised in a variety of ways. For example, Hogg and Reid (2006) define social norms as “shared patterns of thought, feeling, and behaviour” (p.8) and Miller and Prentice (1996) define a social norm as “an attribute of a group that is considered to be both descriptive and prescriptive for its members” (p.800). Other authors (e.g. Cialdini et al., 1990; Deutsch & Gerard, 1955) have emphasised the importance of distinguishing between “descriptive” norms (perceptions about the how common a behaviour or attitude is) and “prescriptive” or “injunctive” norms (understandings of what others think ought to be thought or done).

Building on the subcategories developed by Deutsch and Gerard (1955), normative focus theory (Cialdini et al., 1990) argues that descriptive and injunctive norms are not necessarily the same, nor are they necessarily underpinned by the same motivations. Normative focus theory argues that perceptions of the common behaviour of other people (descriptive norms) can elicit *informational influence* (Deutsch & Gerard, 1955) or “social proof” as people assume that what is common is likely to be successful in a given scenario (Cialdini, 2001). That is, descriptive norms are theorised to influence others’ behaviour because they provide a short-cut to decision making, particularly in situations of ambiguity (Cialdini & Goldstein, 2004).

Normative focus theory defines injunctive norms as socially shared rules about morally appropriate behaviour. Thus injunctive norms are prescriptive about how people should behave. Injunctive norms elicit *normative influence* because they contain information about

what behaviours are likely to be rewarded or socially sanctioned by different groups (Cialdini et al., 1990). In addition to emphasising the distinction between descriptive and injunctive norms, normative focus theory also proposes that the relative influence of these norms will be dependent on which are more salient in a given context (Cialdini et al., 1990; Kallgren, Reno, & Cialdini, 2000). Norms may also be influential because conforming to these may assist people to gain the social approval of others, or avoid social sanctions for performing behaviours that are not consistent with what others are doing (Cialdini & Goldstein, 2004).

Another important level of conceptual variation among definitions of norms is the group described by the norm. Typically within the environmental psychology literature, attention has been paid to the role of setting-level norms which describe the beliefs or behaviours of other people who use the same setting (e.g. Allcott & Rogers, 2012; Cialdini et al., 1990; Schultz, 1999; Schultz, Khazian, & Zaleski, 2008). In contrast, within the Theory of Planned behaviour (Ajzen, 1991) injunctive norms focus on what important others think, and likewise, when the Theory of Planned behaviour has been extended to include descriptive norms these also focus on important others as the reference group (Rivis & Sheeran, 2003).

There are a number of reasons to think that friends' behaviour within a setting may be particularly influential. During adolescence, increasing amounts of time is spent with friends (e.g. Dunton et al., 2007), friends are known influential on a range of behaviours (Brechtwald & Prinstein, 2011) and friends tend to be similar to each other on a number of traits (Goodreau, Kitts, & Morris, 2009) which should increase the likelihood that they are influential (Rogers, 1983). However this does not preclude the possibility that situational or wider societal or family norms also impact on behaviour.

In particular, the behaviour and perceived beliefs of broad social groups, such as young people, New Zealanders or young people may also be an important for shaping behaviour. Self-categorisation theorists (Abrams, Wetherell, Cochrane, Hogg, & Turner, 1990; Turner,

Hogg, Oakes, Reicher, & Wetherell, 1987) propose that norms should be motivating only when they are associated with a valued group identity. Self-categorisation theory draws many of its premises from social identity theory (Tajfel, 1981; Tajfel & Turner, 1986). The overlapping premises are; people develop part of their self-concept based on groups they identify with, people are motivated to maintain a positive sense of self (and thus a favourable group identity) and people internalise group characteristics as their own norms in situations when group identity is salient. Social identity theory was developed to explain inter-group behaviour, whereas social categorisation theory uses these premises to theorise about categorisation as well as perceptual and normative influence processes (Abrams et al., 1990; Turner et al., 1987).

Self-categorisation theorists (Abrams et al., 1990; Turner et al., 1987) propose that group norms are influential because they are incorporated into one's self-concept, rather than due to information they convey about the likely utility or likely social sanctions or rewards that may arise from performing a behaviour. Self-categorisation theorists argue that people adopt normative behaviour due to processes of self-stereotyping or depersonalisation where the group norm is internalised in their own self-concept. Conforming to behaviours or attitudes that are common in a reference group can in turn boost a person's self-esteem due to links between self-esteem and group-categorisation processes (Turner et al., 1987). Influence also may occur as a result of a perceived discrepancy between their own behaviour and the behaviour of another group member leading people to either adopt the behaviour of the member (i.e. influence) or to re-categorise the group member as not typical of the group membership.

Self-categorisation theorists focus on broad reference groups which contrasts with a social network focus on relational groups. The self-categorisation and social identity literature has typically operationalised reference groups as broad social groups that people

identify with such as teachers, women, students, fathers, bus drivers and New Zealanders. By contrast, a social network perspective focuses on influence arising from people they directly interact with such as friends, classmates, family members (Miller & Prentice, 1996; Turner, 1982). Nonetheless there is likely to be some overlap between friendships (relational groups) and membership groups because, as mentioned in the earlier discussion of homophily, people tend to form friendships with people who are like themselves (McPherson, Smith-Lovin, & Cook, 2001) who are in turn likely to be members of some of the reference groups that the ego belongs to. This means that people could conform to the behaviour of the people they are connected to in the social network because those people represent prototypical members of important social groups.

At the active end of the continuum are more deliberate forms of influence such as forms of deliberate verbal influence. Verbal influence may be positive, such as praise or encouragement, or it may be negative, such as teasing and bullying (Brown et al., 2008). These mechanisms are frequently studied by researchers interested in anti-social behaviour (Brown et al., 2008) and, to a lesser extent, researchers interested in health-related behaviours (Maturro & Cunningham, 2013). Verbal influence may be particularly relevant for pro-environmental behaviours which are performed under the scrutiny of other adolescents. Encouragement predicts concurrent physical activity (Maturro & Cunningham, 2013) and could be important for understanding influence on transport behaviour given that active transport (transport modes that involve physical activity, such as walking and cycling) is often performed as a way to improve health and physical activity (Whitmarsh, 2009).

Whilst this review of potential mechanisms has outlined a somewhat disparate list of potential mechanisms of contagion, it offers a platform for a broad investigation of contagion and potential mechanisms. Such a broad sweep of potential mechanisms is useful given that

there has been little work to identify mechanisms underpinning contagion, particularly in relation to pro-environmental behaviour.

Table 1.1. Potential mechanisms of social contagion ranked from most passive to active

	Passive						Active
Mechanism	Unconscious imitation	Observational learning	Co-participation	Descriptive norms (of situational or relational partners)	Descriptive or injunctive norms (of reference groups)	Injunctive norms (of situational or relational partners)	Verbal support (i.e. encouragement and affirmation) or negative peer pressure
How/Why	Due to imitative firing of mirror neurons or classical conditioning, people copy observed behaviour.	People learn how to perform behaviours and learn which behaviours are likely to be rewarded.	People adopt or maintain behaviours friends perform because they want to spend time with them and co-participation can make behaviour more rewarding.	Descriptive norms provide information about which behaviours are likely to be successful in a given context.	Group identification focuses attention on favourable in-group norms, conforming to these norms enhances one's self-esteem.	Injunctive norms contain information about which behaviours are likely to be socially sanctioned in a given context.	People verbally reinforce or punish particular behaviours.
Relevant theory or concepts	Associative sequence learning model or the ideomotor model of imitation	Social learning theory	Subtype of social support discussed in the physical activity literature	Normative focus theory	Social-categorisation theory	Normative focus theory	Subtype of social support. Implicit or explicit in many theories of deviant behaviour
Key theorists/useful reference	Iacoboni (2009)	Bandura (1977)	Maturo and Cunningham (2013); Prochaska, Rodgers, and Sallis (2002)	Cialdini et al. (1990)	Abrams et al. (1990); Turner et al. (1987)	Cialdini et al. (1990)	Brown et al. (2008); Maturo and Cunningham (2013); Prochaska et al. (2002)

1.1 Diffusion of innovations theory

Another potential mechanism of influence is information sharing. Information sharing along single ties ('communication channels'), from people who have adopted the behaviour to those that have not, is a key mechanism of change proposed by Diffusion of innovations theory (Rogers, 1983). However the behaviours considered in this thesis are not novel and it was considered unlikely that information sharing about these pro-environmental behaviours would be sufficient to lead to their adoption. There is substantial evidence that knowledge about the importance of environmental action is not sufficient to motivate action (Kollmuss & Agyeman, 2002). Nonetheless, the theory has a number of important concepts that may be useful for conceptualising diffusion processes.

First, diffusion of innovations theory proposes that the existing values and rules of the social system also influence uptake of an innovation. For example, the more an innovation is consistent with the values that are promoted within the social system the more likely it is to be adopted. Second, the theory also points to the role of individual differences in determining who is likely to adopt the innovation. For example, individuals can be characterised in terms of their openness to ideas, with innovators more open to new ideas and uncertainty, and late adopters more reliant on observing the impact of the intervention on others (Rogers, 1983). The potential role of individual differences in uptake, and the importance of the overall context led to the development of two additional foci for this thesis: normative information negotiated and communicated through conversations and the role of individual differences in shaping behavioural adoption.

1.2 Conversations and the construction of appropriate behaviour

Conversations are likely to be important for pro-environmental behaviour and how local and macro level norms around these behaviours develop and shift over time. Conversations

are central to verbal influence such as encouragement and may also influence behaviour through indirect methods not covered in Table 1.1. Indirect methods include sharing information, ideas and attitudes towards pro-environmental behaviour or shaping definitions of pro-environmental behaviour. They are indirect because they rely on a second intermediary step in which any changes in a person's knowledge, attitudes or conceptualisations of pro-environmental behaviour in turn influence that person's behaviour.

The only two studies to my knowledge to have investigated potential mechanisms of contagion in pro-environmental behaviour suggested that verbal influence is an important mechanism of contagion in pro-environmental behaviour. Bloodhart et al. (2013) found that the amount of electricity reduction by university halls related to the number of conversations environmental leaders had with their fellow students about electricity reduction, although not how many conversations they had with them about environmental issues more generally. Environmental leaders interviewed in Arnold et al. (2009) emphasised the role of friends and other peers in affirming their pro-environmental behaviour which is also be dependent in part on the content of their conversations.

Conversations may also be important for constructing ideas about what environmental degradation is, and what solutions should be promoted. Authors from a social constructionist perspective argue that the very meaning assigned to particular environmental actions is constructed through language. For example, Harré, Brockmeier, and Mühlhäusler (1999) argues that language is important for sharing information about the environment and for the development and negotiation of our attitudes towards the environment. A range of uncertainties and multiple perspectives on appropriate environmental action exist, opening up a range of possibilities for defining appropriate action (Dryzek, 2005). For example, it is difficult to objectively quantify the impact of some behaviours of the environment and many people perform pro-environmental behaviours for reasons unrelated to environmental

degradation. In a study of English adults (Whitmarsh, 2009) a greater number of participants reported that they buy organic food and walk or cycle for health reasons than for environmental reasons. Despite this, these actions are typically constructed as environmental actions.

Qualitative work with adolescents has attempted to elicit young people's *attitudes* towards environmental action (e.g. Connell et al., 1999; Hillcoat, Forge, Fien, & Baker, 1995; Prestin & Pearce, 2010) but has not considered how young people construct pro-environmental behaviours and norms in talk. Understanding how definitions of pro-environmental actions are developed and maintained in conversations should provide valuable information that cannot be obtained through survey methods which measure the existence or valence of people's perceptions of what others think is appropriate (i.e. injunctive norms).

The development and shifting of our understandings of appropriate environmental action has important implications for culture change around pro-environmental behaviours within a community. Behaviour change is unlikely to occur unless there are changes to what people consider appropriate behaviour. Thus the negotiation of what is acceptable behaviour may offer opportunities to alter the status quo of pro-environmental behaviour. However it may also work against efforts to change behaviour if interventions are unable to shift a prevailing construction of what is appropriate behaviour. As noted in Diffusion of innovations theory, values and social norms of the social system impact on the likelihood that a novel innovations are adopted (Rogers, 1983), and the same is likely to be true of the adoption of non-novel behaviours. Therefore exploring how behaviours and norms are constructed and negotiated provides useful contextual information for planning and developing a range of social as well as non-social interventions aiming to promote relatively novel pro-environmental behaviours that are not already common in a setting.

An investigation of how language creates and negotiates meaning around environmental action is underpinned by epistemological assumptions that our understanding of reality is at least partly socially constructed. It is important to note that this differs from epistemological assumptions underpinning the dominant paradigm in social psychology which imply that reality can be measured. I return to the subject of epistemology in Chapter 2.

1.3 Individual differences and pro-environmental behaviour

Obviously social influence is not the sole factor determining who undertakes pro-environmental behaviour. As diffusion of innovations theory (Rogers, 1983) notes, individual differences such as socio-demographic factors and personality traits influence whether an individual adopts a novel intervention. Whilst diffusion of innovations theory proposes that individual differences in innovativeness will lead to uptake of behaviours, it is also likely that other individual differences may facilitate the adoption of particular behaviours but may not be important for the adoption of others.

Prior research with adults has identified a number of characteristics which predict the likelihood of adopting pro-environmental behaviour. Pro-environmental behaviour is higher among people with strong moral norms, perceived behavioural control, pro-environmental attitudes (Bamberg & Möser, 2007), a strong environmental identity (e.g. Whitmarsh & O'Neill, 2010) and people with a future time orientation (Milfont et al., 2012). Demographic characteristics are also strongly predictive of pro-environmental behaviour (Gifford & Nilsson, 2014) and beliefs about whether climate change is real and caused by humans (Milfont, Milojev, Greaves, & Sibley, 2015).

Personality traits capture clusters of individual differences which appear to be related to engagement in pro-environmental behaviour. For example, a recent meta-analysis identified that a future time focus is consistently related to higher levels of pro-environmental engagement (Milfont et al., 2012) and a future time perspectives are stronger among people

high in Conscientiousness (Zhang & Howell, 2011). Further, Agreeableness and Honesty Humility are both thought to capture tendencies for social cooperation (Ashton & Lee, 2007; Hilbig, Zettler, Leist, & Heydasch, 2013) and many environmental problems are essentially a commons dilemma cooperation problem (Hardin, 1968).

Studies with adults have identified associations between personality and pro-environmental behaviour (Hilbig, Zettler, Moshagen, & Heydasch, 2013; Markowitz, Goldberg, Ashton, & Lee, 2012; Milfont & Sibley, 2012; Swami et al., 2011). Conscientiousness, Agreeableness, Openness to Experience and Honesty-Humility have all been found to predict pro-environmental behaviour, however each personality trait was related to pro-environmental behaviours in some studies but not others. Milfont and Sibley (2012) found that both Agreeableness and Conscientiousness were predictive of self-reported electricity reduction. In contrast, Swami et al. (2011) found that Conscientiousness but not Agreeableness was predictive of waste sorting behaviour.

Whilst studies in adults suggest that behaviour is related to personality, relationships between environmental behaviour and personality have not been investigated in younger samples. Thus the investigation of personality factors also offers an opportunity to expand the research on individual differences in pro-environmental behaviour in addition to developing understanding of individual differences which may impact on the effectiveness of environmental interventions, social or otherwise.

1.3.1 Research aims and chapter overview

To recap, there is an urgent need to reduce our impact on the environment (IPCC, 2014) and adolescents are important stakeholders in change initiatives (United Nations, 2010). Further, there is a growing body of evidence that these may be influenced by the people around us (Abrahamse & Steg, 2013) and this may be particularly true for adolescents. Research described in this chapter indicates that friends and social networks could be

important for adolescent pro-environmental behaviour but there is little empirical work verifying if and how this is the case. Understanding how behaviour varies across a social network, what contributes to this variation, whether contagion occurs and what mechanisms underpin any contagion is important for building theories related to the friend context of pro-environmental behaviour and designing peer interventions.

In this thesis I initially explore local social clustering, contagion processes in waste and transport behaviours within a school social network. It explores perceptions of the frequency of friends' behaviour, encouragement and co-participation as potential mechanisms of contagion on pro-environmental behaviour. I then explore the role of personality in predicting individual differences in behaviour and susceptibility to influence. Finally, I consider how young people construct their own and others' pro-environmental behaviour in conversation as this may have implications for the adoption of these behaviours.

This thesis aims to advance understanding of the social context and potential for friend influence on pro-environmental behaviour, in particular attending to the following high level research questions.

1. Do waste and transport behaviours tend to cluster in the school social network?
2. If, and how, do friends contribute to each other's transport and waste choices?
3. Which personality factors help explain which students engage in pro-environmental behaviour?
4. How do peer conversations construct particular pro-environmental behaviours as socially acceptable?

In order to achieve the main aims I utilise a relatively novel combination of research techniques. A broad overview of these research techniques are presented in Chapter 2. The chapter begins with a background in the research approach and the school where this research

is conducted. It then provides readers with a background to the social network techniques available and those selected for use here.

After outlining the methods in Chapter 2, Chapters 3 and 4 investigate social clustering in transport behaviour on the school social network. Chapter 3 provides an initial investigation of whether similarities exist in friends' school transport choices and the degree to which social clustering might be explained by secondary homophily factors such as gender and age. The chapter contributes to research questions 1 and 2 by testing whether cross-sectional relationships between friends' behaviour are consistent with friend influence on transport behaviour. The network-effects analysis investigates whether friends' behaviour predicts concurrent ego behaviour, statistically adjusting for a number of secondary homophily factors. In Chapter 2 I also investigate potential mediators of any contagion effects. Mediation tests are used to assess whether descriptive norms, encouragement or co-participation mediated similarities in friends' behaviour, however because this data was analysis was cross-sectional these results are inconclusive. This chapter provides the first indication (to my knowledge) that adolescent transport behaviour tends to cluster socially and that some of the clustering in transport behaviour is due to secondary homophily processes.

In Chapter 4 I extend the investigation of transport behaviour in the school social network using a repeated measures approach with data from Wave 1 and Wave 3 of the longitudinal survey. The repeated measures approach uses a residualised change network effects model to provide a more rigorous test of whether friends contribute to each other's transport choices or, conversely, whether social clustering is solely the product of homophily processes or shared environment (research question 2). The results are consistent with contagion of cycling behaviour among male students but not with contagion of other transport modes. Friends and other peers may also be influential in littering and recycling behaviour.

In Chapter 5 I perform a similar set of analyses, this time focusing on whether friends' influence changes in each other's littering and recycling behaviour. I investigate clustering in littering and recycling behaviour (research question 1) and whether friends' average behaviour predicted change over time in littering and recycling behaviour (research question 2) using data from Wave 1 and 2 of the longitudinal survey. Wave 1 and Wave 2 were used because this chapter was submitted for publication prior to the collection and analysis of Wave 3. I supplement the quantitative data with a thematic analysis of focus group conversations which provided novel information about the type of mechanisms which were likely to underpin influence (research question 2) and conditions which facilitate influence. The findings suggest that friends can influence littering and recycling behaviour and that students perceive that verbal communication around waste may be an important component of influence on littering behaviour.

In Chapter 6 I investigate individual differences in pro-environmental behaviour associated with personality traits. Drawing on data from Wave 3, I investigate which of the Big Five personality traits (plus Honesty-Humility) predict concurrent waste or resource conservation behaviours (research question 3). The analysis uses heteroskedasticity-adjusted linear regression models. Spatial versions of these models are used to cross-check these results and are reported in the Supplementary material. Chapter 6 addresses research gaps related to whether personality predicts pro-environmental behaviours in adolescence. Further, combined with existing research (Selfhout, Burk, Branje, Denissen, van Aken, & Meeus, 2010) and material presented in the Supplementary material for Chapter 8, the findings suggest that personality clustering may also contribute to social clustering in pro-environmental behaviours.

Finally, in Chapter 7 I explore how verbal communication may be important for creating and negotiating meaning and social norms around environmental action. This chapter focuses

on the way that “appropriate” environmental behaviour has been constructed in focus group discussions (research question 4). The focus group data are analysed using a discourse analytic approach (Edwards & Potter, 1992; Potter & Wetherell, 1987) which pays attention to the action orientation of talk. I argue that justifications and stereotypes marginalise environmentally-significant pro-environmental behaviours and contribute to the maintenance of the status quo of minimal engagement in pro-environmental behaviour.

Chapter 8 concludes the thesis with a summary of the key findings, implications, limitations and recommendations for future research.

1.3.2 Paper submissions associated with this thesis

Chapter 3 and 5 have been published as the following articles. Chapter 4 and Chapter 6 are manuscripts in preparation for submission to academic journals.

- Chapter 3: Long, J., Harré, N., & Atkinson, Q. D. (2015). Social clustering in high school transport choices. *Journal of Environmental Psychology, 41*, 155-165. The article is included in this thesis with permission from Elsevier.
- Chapter 5: Long, J., Harré, N., & Atkinson, Q. D. (2014). Understanding change in recycling and littering behavior across a school social network. *American Journal of Community Psychology, 53*(3-4), 462-474. This paper is included in this thesis with kind permission from Springer Science+Business Media B.V.

Chapter 2: Methodological background

This chapter provides a broad outline of the methodological underpinnings of this thesis, focusing on describing those methods not commonly used in psychology. It begins by providing an overview of the research approach and the school where the research was located then proceeds to give a broad overview of social network data collection, analysis and statistical models. The next section briefly introduces qualitative approaches to studying mechanisms of contagion, and the rationale for the analysis of discursive practices.

2.1 Overview of the research approach

The research presented in this thesis draws on social network analysis and a range of other methodological tools not commonly used within social psychology. In doing so it hopes to provide a rich perspective on the nature of friend influence on pro-environmental behaviours in a high school social network.

The research sought to draw on the advantages of quantitative and qualitative methodologies on the assumption that neither approach would be satisfactory for answering all of the proposed research questions. The programme of research is best described as a multi-strand method mixed design (Teddlie & Tashakkori, 2010). The exploration of research questions about friend influence in transport (Chapter 3 and 4) and personality (Chapter 6) employs quantitative data and realist assumptions. Questions about discursive practices rely on qualitative data and a relativist epistemology (Chapter 7). Investigation of the role of social influence in waste behaviours (Chapter 5) combines qualitative and quantitative methods concurrently and is underpinned by a realist epistemology and ontology. The mixing of methods in Chapter 5 aims for triangulation of results and elaboration on possible mechanisms and caveats on friend influence.

The research was an in-depth case study of a high school in Auckland, New Zealand. The rationale for the focus on a single school is outlined in Section 2.3.

2.2 *The research context*

The school where this research was conducted is a relatively affluent publicly-funded high school with a strong academic and creative focus. An indigenous language immersion unit is located on the edge of the school grounds and around 15% of the total school population are enrolled in this unit. Students from anywhere in the Auckland region are allowed to enrol in the language immersion unit. In contrast, enrolments for the main school require living within the school's local enrolment boundary.

A formal school commitment to sustainability related issues was initiated in 2007 when specific sustainability related objectives were introduced into the school charter. Since 2007 staff and a small group of students have been involved in environmental projects and awareness-raising activities. Each year, six Year 13² sustainability leaders³ were elected based on votes from staff and students. Younger students volunteered to work with them on sustainability promotion projects throughout the year. Since 2012, the leaders and some volunteers attended a camp designed to equip them with leadership skills and sustainability-related knowledge. During the school year the sustainability leaders, with help from the volunteers, organised activities designed to raise awareness and alter behaviour around waste and transport-related sustainability issues at this school. Students also had the option of taking environmental education as a curriculum subject in Year 12 (from 2011) and Year 13 (from 2012). Despite the existence of extracurricular and curriculum-based opportunities for

² Year 13 is the term used to refer to students in their final year of high school in New Zealand.

³ Whilst it is possible that the student leaders had a strong impact on their friends' pro-environmental behaviour I was unable to analyse this due to the small number of student leaders (six, some of whom did not participate in the survey at all time-points). These student leaders will likely be more central in the network, given that they were elected partly on the basis of student nominations. As expected, exploratory analysis also indicated that they tended to have better behaviour, however the small numbers meant it was difficult to assess the significance of this difference.

students to engage in sustainability-related activities, anecdotally the majority of students were disengaged or minimally engaged with sustainability projects or discussions at the school.

A large amount of the sustainability work at this school that occurred during the period of data collection focused on a new waste intervention. The waste intervention was introduced between Wave 1 and 2 of the longitudinal survey and was designed by the school in consultation with contractors, school staff and students. The primary aim of the intervention was to reduce the waste sent to landfill by increasing the volume of waste recycled and composted. Previous attempts to improve waste behaviour had been unsuccessful, in part due to ineffective systems for appropriately recycling sorted waste which in turn discouraged students from streaming their waste. Due to the school's interest in waste behaviour, and the intervention, I incorporated littering and waste sorting behaviour as a key focus of this thesis.

I focused data collection on a single school for three key reasons. First, social network analysis is performed on a single community. As discussed in Section 2.3, social networks from multiple schools cannot simply be added together. Second, I opted for depth rather than breadth of information given that there was little existing research upon which to base an examination of contagion in adolescent pro-environmental behaviour. Finally, the focus on a single school was a pragmatic decision. For the purpose of analysing a social network it is very important to have participation from the majority of students in the school (or certain school year levels). Due to this, and the need to de-identify names, social network data collection is time consuming and it would not have been possible to collect multi-wave social network data from additional schools without substantial time to develop relationships, collect and de-identify data. This and other issues related to the construction and analysis of social network data are discussed in more detail in the following section.

2.3 *Social network analysis*

Information about social network ties can facilitate an advanced understanding of social clustering and contagion of pro-environmental behaviour. Constructing and analysing social network data differs substantially from traditional survey data and analyses and thus deserves a brief overview in this chapter. Whilst social networks can include many types of social relationships, this thesis focuses on friendships, in keeping with the research questions and the theorised role of friends in adolescence. The following sections discuss some of the basic concepts behind social network data collection, social network reconstruction and analysis.

2.3.1 *Social network data collection*

In this section I explain various decisions made in the process of collecting data on a social network. I outline various options and justify which of these options I selected to reconstruct the elements of the school social network which I theorised would be influential on pro-environmental behaviour.

Before collecting social network data, a researcher must decide which people and types of relationships to sample. The world's population could theoretically be connected in a giant network if boundaries to the social network of interest are not defined. This connectivity was classically demonstrated in Stanley Milgram's 1960's letter writing study which coined the term "six degrees of separation". Participants who lived in Nebraska received a letter addressed to a different person living on the opposite side of the United States (Massachusetts). Participants were instructed to send the letter to a friend, relative or acquaintance that was more likely to know the addressee. On average, each letter passed between 6.5 people before reaching the target person (Milgram, 1967; Travers & Milgram, 1969). Recent research estimates that most of the world's population is now connected by between five and seven (on average) degrees of separation, depending on how estimates have

corrected for letter chains that were not completed (Dodds, Muhamad, & Watts, 2003). If most people can be reached by 5 to 6 connections through snowball sampling, then theoretically most of the world's population would be included in a social network that sought to sample every person who was linked to the actors in prior iteration of the social network. For this reason boundaries must be placed on who to include in a given social network.

To decide on an appropriate boundary it is important to consider what relationships are theoretically important for the specific domain of interest. Close friends should have more interaction time than acquaintances and their opinions should be more valued. Further, as a general rule behaviour and attitudes are more likely to be influenced by more immediate (Latané, 1981) or context-specific (Cialdini et al., 1990) relational actors. School friends are a good example of immediate, context-specific relationships for behaviours that are performed at school. Therefore within the possible continuum of friendship relations, I focused on close friends who attend the same school, as these are context-specific for pro-environmental behaviours performed at school. Studies using the Add Health social network dataset (e.g. Ali & Dwyer, 2009, 2010; Fujimoto & Valente, 2012b) relied on similar criteria and requested that students identify their five best male and five best female friends.

Decisions about social network data collection are also affected by practical considerations. Typically for a friendship to be included in a social network the researchers must receive information from both friends about the friendship attributes of relevance to the study. In a school setting data integration, confidentiality and de-identification processes make it difficult to track down, invite and match friends from different schools. Thus social network studies almost exclusively restrict friendship nominations to friends attending the same school due to data collection practicalities and the requirements of social network analysis. Previous studies that have collected data on a number of schools still typically

assess each school population as a separate social network (e.g. de la Haye et al., 2011b; Goodreau et al., 2009), presumably due to the need to set a fixed boundary on the network in order to conduct many social network analysis techniques.

Next a researcher must identify an accurate yet feasible method to collect information about the social relationships of interest. Friend nominations can be collected using guided recall or free recall procedures and may either ask participants to make a limited or an unlimited number of friendship nominations.

In a guided recall nomination procedure participants are asked to select friends from a complete list of potential actors within the social network boundary (i.e. a list of students attending their school). The selection of friends from an existing list limits the impact of memory processes on nominations and works well for a small number of actors, such as a single classroom or year level. When there are hundreds of actors in a social network it is not feasible to ask participants to trawl through a list of possible names without direct assistance from a researcher or sufficient time for participants to explore the list.

Free recall procedures are often selected as a more feasible alternative for collecting friendship nominations when the social network is large (e.g. Dijkstra, Berger, & Lindenberg, 2011; Poulin, Kiesner, Pedersen, & Dishion, 2011). In a free recall procedure, rather than providing a list of possible names to nominate, social network questionnaires contain spaces to record the names of people who meet the criteria presented by the researchers.

In both guided and free recall procedures, participants may be asked to either nominate a limited or unlimited number of friendships. From a statistical perspective, particularly when a researcher is interested in social network structure, unlimited nominations are preferred as they should minimise the amount of missing network ties and gather information on all relevant friends (Kossinets, 2006). However the number of friendships recorded in an unlimited scenario may not accurately reflect the number of friends a person as they may be

based on individual differences in concerns about appearing popular. Further, pilot testing suggested that recalling and recording friends' names took a very long time for some students. If participants were asked to list an unlimited number of friendships some students would be unlikely to complete other questions in the survey in a reasonable time. Guided procedures with spaces for between five and ten friendships have been used in a number of studies (e.g. Ali & Dwyer, 2010; De Irmencio lu, Urberg, Tolson, & Richard, 1998; Dijkstra et al., 2011). Based on these studies and an initial piloting with 10 spaces, the present research adopted a free recall procedure with spaces for seven nominations of "close friends" who attended their school.⁴ They were also asked to circle a single best friend and to name siblings who went to the same school, however this data was not directly relevant to the key research questions and therefore was not analysed as part of the present thesis.

Once friendship or other types of nominations have been collated and de-identified, these are typically arranged into an edge-list which specified one nomination in each row. In the friendship-based edge-list presented in Figure 2.1, the left-hand column typically identifies the participant who made the nomination (the *ego*) and the right hand column identifies the person they nominated (the *alter*). The edge-list can then be converted into a social network matrix or "friendship matrix" (e.g. top right of Figure 2.1).

Social network graphs (e.g. bottom right of Figure 2.1) can be constructed from a matrix or edge-list representation of the social network. The graphical layout of the network can be specified using range of algorithms which decide how actors and their ties are arranged in two-dimensional space. Within this thesis I use a Fruchterman-Reingold force-directed algorithm which balances "forces" that pull linked actors together with forces pushing actors away from one another. I manipulated friendship nominations into edge-lists, matrices and graphs using a combination of the *network* (Butts, 2008) and *igraph* (Csardi & Nepusz, 2006)

⁴ Only around one third (31.0%) of participants in Wave 1 used all seven possible spaces for friend nominations.

packages in R, an open source language for statistical computing. Software dedicated to social network analysis, such as UCINET, Pajek and Gephi, can also be used to manipulate social network data into various formats.

Edgelist

Ego	Alter
A	E
B	D
B	E
B	J
C	F
C	I
D	B
D	H
E	A
E	G
E	J
F	B
F	C
G	F
H	D
H	F
I	A
I	C
I	H
J	E

Friendship matrix

	A	B	C	D	E	F	G	H	I	J
A	0	0	0	0	1	0	0	0	1	0
B	0	0	0	1	1	1	0	0	0	1
C	0	0	0	0	0	1	0	0	1	0
D	0	1	0	0	0	0	0	1	0	0
E	1	1	0	0	0	0	1	0	0	1
F	0	1	1	0	0	0	1	1	0	0
G	0	0	0	0	1	1	0	0	0	0
H	0	0	0	1	0	1	0	0	1	0
I	1	0	1	0	0	0	0	1	0	0
J	0	1	0	0	1	0	0	0	0	0

Social network graph

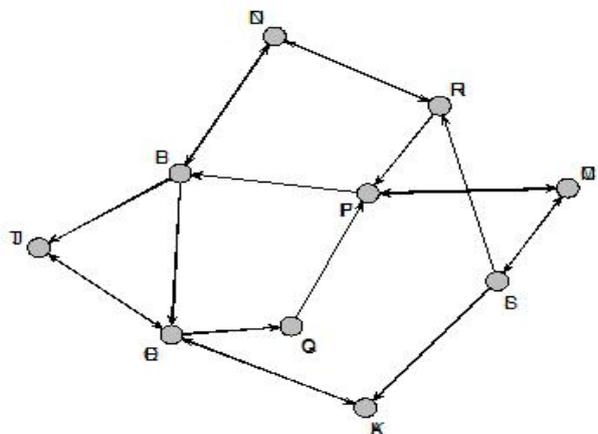


Figure 2.1. A 10 person hypothetical social network represented as an edge-list (left), friendship matrix (top right) and social network graph (bottom right).

When an ego (focal individual) nominates another actor (alter) in the network, the alter may also specify the ego as a friend (reciprocated tie) or not (unreciprocated tie). Within this thesis it is assumed that both reciprocated and unreciprocated friendships represent actual friendships and that nominations were not reciprocated because the alter did not prioritise the ego within the top seven friendships or the ego was not recalled at the time of the survey.

An important decision is whether to remove some of the friendship nominations from the dataset. Friendships that are not reciprocated can be dropped to produce a reciprocated matrix. However there is mixed evidence about whether reciprocated or unreciprocated friendships are more important (Brechtwald & Prinstein, 2011). For example, Fujimoto and Valente (2012b) found that drinking behaviour was similarly predicted by reciprocated and unreciprocated friends and similarly predicted by the friends they nominated as by friends who nominated them. Importantly for the analysis in this thesis, considering only reciprocal friendships would greatly reduce the number of ties per person and thus the information available to investigate whether how common a behaviour was among friends predicted changes in ego behaviour.

Information about which actor nominated the other can be retained using a directed matrix. However this means that, in the analyses described later in this thesis, reciprocated ties are effectively counted twice whereas unreciprocated friendships would only be calculated once. Information about the direction of nominations can also be collapsed to identify a tie regardless of whether both actors nominated each other (a symmetric or “undirected” matrix). A symmetric matrix⁵ was chosen for the present research because it counts both reciprocated and non-reciprocated ties twice, and thus they receive equal status. This symmetric approach assumes that a nomination by either actor represents a real friendship and that the direction is irrelevant. Symmetric matrices also retain all of the

⁵ This is referred to as an “undirected matrix” in Chapter 5.

nominations in the network thus maximising the number of friends who are included in estimates of contagion and homophily.

2.4 *Analytical approaches*

Hoping to exploit some of the potential advantages of social network analysis (i.e. its ability to model non-independent data and consider social network structure), I spent considerable time exploring which social network methods to apply to my data. However most of the prototypical social network methods were deemed unsuitable, either due to limitations in the participation rates of my data, or due to their inability to address the key research questions of this thesis. The sub-sections that follow outline the analytical methods considered for this thesis.

2.4.1 Dependence assumptions and social network structure

From a methodological and conceptual perspective, social network analysis's key point of departure from traditional statistical approaches is its focus on the interdependence of social actors (Marsden & Friedkin, 1993). This differs from common statistical approaches model actors as discrete independent units (Robins & Kashima, 2008). However in instances where participants interact with one another, assumptions of independence may be violated. Social network analysis focuses on the relational ties that represent interdependencies between participants as important units of analysis (Marsden & Friedkin, 1993).

Many social network analysis methods seek to describe or explain the structure of a social network by analysing patterns of relational ties (Hards, 2011). Network structure refers to information about how actors in the network are connected to one another and which actors are positioned centrally. A person who is central in the network is theorised to be useful for receiving information and spreading it to other parts of the network, although many of these theories downplay how the type of information flow through either single or multiple ties

may impact on what type of centrality and connectivity is most valuable (Borgatti, 2005; Centola & Macy, 2007).

There are a number of ways to measure network centrality and connectivity. One of the simplest measures is the indegree of actors. Indegree captures the number of people who nominated the ego and provides a measure of local popularity and local connectivity. Local interconnectivity can also be measured by the proportion of friends that are also connected to one another. This is referred to as the ego's local transitivity.

Other indices such as eigenvector centrality and betweenness centrality take into account connections with all other actors in the social network. Eigenvector centrality measures interconnectivity using information about the indegree of the ego, the ego's friends, the friends of those friends and so on. Betweenness centrality is a measure of how much an actor bridges parts of the network that would otherwise be relatively unconnected. This is calculated based on the total number of most direct paths between all possible pairs of actors in the social network that pass through that person. Researchers have also been interested in blockmodeling methods which are used for identifying groups or clusters of actors in a network, often according to the similarity of their connections to other actors (Borgatti & Everett, 1992; Doreian, Batagelj, & Ferligoj, 2005).

Social network analysis is a vast and growing field, and numerous other types of analyses exist. Social network theory argues that information about social network structure can be used to identify who is likely to be important for influence or information flow in a network. However the incomplete nature of our data and focus of my research questions means that the analysis in this thesis did not focus on social network structure. Measures of social network structure can be strongly influenced by missing data in the social network. For example, estimations of network structure can be heavily altered if an actor who connects otherwise disparate parts of the network or is connected to many other ties is omitted from the social

network due to survey non-completion. The bias in estimates increases according to the proportion of missing information (Borgatti, Carley, & Krackhardt, 2006).

Due to the potential biases generated by the degree of missing data on my network I limited consideration of social network structure to an exploratory analysis, rather than incorporating social network metrics into the main analysis. I examined correlations between four common measures of social network structure (degree, local transitivity, eigenvector centrality and betweenness) and littering, recycling and transport behaviour (see the Supplementary material for Chapter 2). In most cases, the behaviours of interest were not related to the social network indices however cycling was negatively related to in-degree and eigenvector centrality was related to all behaviours. The relationship between eigenvector centrality and behaviours is somewhat counter-intuitive as it was negatively correlated with two behaviours that are negatively correlated with one another (littering and recycling). Thus the correlations may be an artefact of missing data rather than representing a negative relationship between popularity and both these behaviours. Given that we cannot assess the bias generated by the missing data, further research is needed to assess how pro-environmental behaviours may relate to social network structure.

This overview of social network structure has been brief due to its peripheral role in the current research. A more in-depth discussion of social network analysis, including methods that focus on social structure can be found in Butts (2008b); Carrington, Scott, and Wasserman (2005); Robins (2013); Snijders (2011b); Wasserman and Faust (1994).

I now turn the discussion to analyses more directly relevant to my central research questions, starting with an overview of methods used to assess the degree of similarity in linked actors attributes (i.e. social clustering).

2.4.2 *Quantifications of social clustering*

As noted in Chapter 1, friends tend to be more similar in a range of attributes and these similarities may represent the outcome of contagion processes, homophily processes (manifest, secondary and latent), exposure to similar events, or a combination of these processes. Similarities in the scores of neighbouring actors are known as social clustering in a network context. These may represent the outcome of contagion or homophily (see Chapter 1 for a discussion) and can have implications for influence dynamics and intervention design regardless of the origin of these similarities. Relatively simple descriptive analyses that measure the strength of social clustering in a social network include Moran's *I* and join count statistics. Moran's *I* statistics test whether the similarity in scores between neighbouring actors are greater than would be expected based on variance in the overall sample (Cliff & Ord, 1981)

Moran's *I* calculations assume that variables are normally distributed and therefore cannot be used to calculate clustering in binary or categorical variables. Join count statistics calculate whether the ties (or "joins") linking actors tend to connect people with the same score on a categorical or binary variable (Cliff & Ord, 1981). In the case of a binary variable the two possible values are assigned a B and W so that the three types of links are described as BB, WW and BW. I utilise Moran's *I* to assess social clustering for relatively likert scale variables and join count statistics for binary and count variables. Given that distribution of likert scale variables were often not normal, I used permutation tests to assess the significance of these statistics. Permutation tests compare the observed statistic with values obtained when the statistic is calculated on permutations of the network. These permutations use values with an identical distribution which should make these less sensitive to violations of normality than standard test-statistics.

Increases in computing power have contributed to the development of more complex statistical techniques. Exponential Random Graph Models (ERGMs; Hunter, Handcock, Butts, Goodreau, & Morris, 2008) can be used to assess social clustering indirectly by assessing how well similarities in attributes predict the likelihood of a tie. More generally, ERGMs model the likelihood of tie between two actors based on structural properties of the network and attributes of the actors in the network. The probability of a tie can be predicted by structural configurations of the network, tie attributes (e.g. the quality of the relationship) or actor attributes (Hunter et al. 2008). Structural configurations of interest might include actor indegree or measures of local transitivity. Tie attributes of interest might include the reciprocity, strength or length of the relationship between two actors. As mentioned, an ERGM would test for social clustering by estimating the increase in the probability of a tie between two actors based on how similar they are on an attribute of interest.

Unfortunately ERGM models suffer from degeneracy⁶ (Hunter et al. 2008), are complex to compute, and are superfluous to understanding whether clustering exists. Given the complexity relative to the additional utility, Moran's *I* and join count statistics provide a better "fit-for-purpose" descriptive measure of social clustering. However neither an ERGM or the simpler techniques provide information about whether social contagion processes are likely to generate, or partially generate social clustering.

2.4.3 Social network analysis suited to assessing contagion

A number of different models were considered in planning how to best model and estimate contagion of pro-environmental behaviour in this school's social network. One of the key criteria for model selection was the capacity to estimate or cancel out aspects of

⁶ Degeneracy describes scenarios when the markov chain monte carlo algorithm used to develop model parameters converges on networks that are empty or complete, rather than a graph that is feasible (Handcock, 2003, December 31).

similarities in friends' behaviour that arose from homophily processes or exposure to similar events.

My initial plans for assessing contagion processes focused on the Stochastic actor-oriented model (SAOM; Snijders, Steglich, & Schweinberger, 2007). This appeared to be the most advanced social network analysis technique for investigating influence and contagion in social networks. The SAOM model utilises data on friendships and behaviour at multiple time points (at least two) to estimate contagion and homophily processes, while accounting for the other process and aspects of social network structure (Snijders, van de Bunt, & Steglich, 2010). Stochastic actor-oriented models have been used to estimate contagion and homophily processes in adolescent depression (Kiuru, Burk, Laursen, Nurmi, & Salmela-Aro, 2011), physical activity (de la Haye et al., 2011b), delinquency (Weerman, 2011) and a number of other behaviours. Substantial work has gone into assessing model biases (e.g. Huisman & Steglich, 2008; Kossinets, 2006) making this a relatively well-established method.

However, like ERGM models, stochastic actor-oriented models often suffer from degeneracy and often fail to converge (Huisman & Steglich, 2008; Kossinets, 2006). When more than 40% of social network actors are missing from the sample estimates produced by stochastic actor-oriented models differ greatly from estimates based on complete social network data (Huisman & Steglich, 2008; Kossinets, 2006).

Keeping the proportion of missing data below 40% (i.e. achieving a participation rate exceeding 60%) is difficult in a longitudinal dataset because the effects of non-participation at each wave are cumulative. The participation rates in each wave of data collection for this thesis ranged from 66 -74%. However, due to the cumulative effects of non-response at each

wave⁷, the overall proportion of participants for which there was complete data across waves was 36.4% of Year 9-12⁸ students enrolled at Wave 1 (see Figure 2.2). The observed participation rate of 36.4% would likely generate substantial bias or non-convergence in the estimation of friend effects using a stochastic actor-oriented modelling approach, therefore I sought alternative methods to investigate contagion of friends' pro-environmental behaviour.

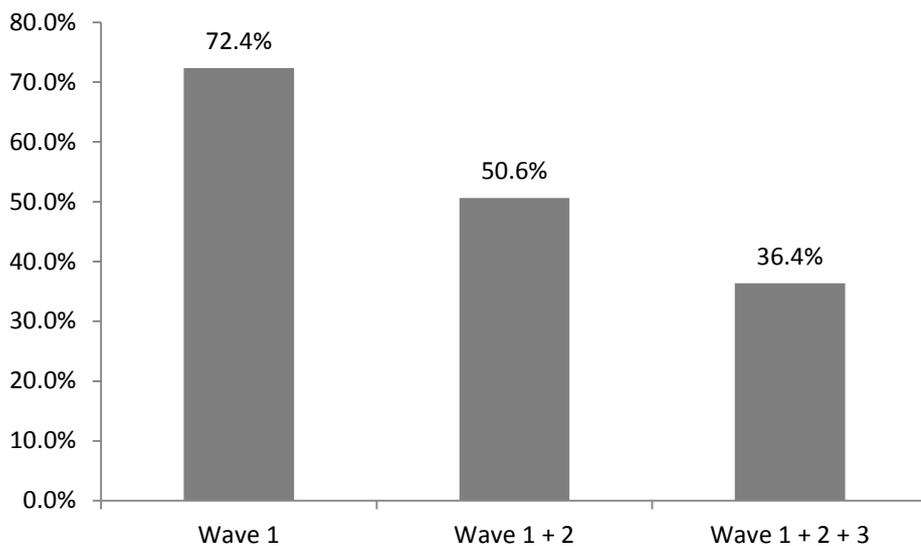


Figure 2.2. Cumulative participation rates as a percentage of Year 9-12 enrolments at Wave 1.

Searching for other possibilities, I investigated the auto logistic actor attribute model (ALAAM; Daraganova & Robins, 2013) as a possible method for examining contagion. The ALAAM model is also designed specifically for modelling social network data. The model predicts behaviour as a function of network attributes including network structural terms and

⁷ Simulation of possible non-participation scenarios suggests that a unique group of students chose not to participate at each wave in order to achieve such a low response rate, given the individual response rates to the survey.

⁸ Year 13 students were not included in this calculation as they were no longer at the school at the time of Wave 3. Given that we did not store a list of details about enrolled students at the school for each wave it is not possible to calculate the individual statistics for each wave. Instead participation rates are calculated as a percentage of those who were enrolled in year 9-12 at Time 3 (making it likely that they would be enrolled at the school in the following year when wave 3 was conducted).

actor attributes. Conceptually, the model is similar to ERGMs but differ in that the dependent variable is behaviour rather than a network tie and the network structure is treated as exogenous (Daraganova & Robins, 2013). However the particular biases of this model do not appear to have been well explored. In particular, I suspect that the assumption of exogenous network structure would be violated if behaviour influences the development of ties, however this does not appear to be discussed in the background material (e.g. Daraganova & Robins, 2013). Further whilst missing information is known to be a key issue for social network analysis which include social structure there did not appear to have been any published analysis of the effects of missing information on ALAAM models.

The next section presents a brief overview of alternative regression-based methods, starting with a discussion of spatial econometric models before presenting network exposure models and potential modifications for these models that could minimise any biases generated by non-independence or homophily.

2.4.4 Spatial econometric and network exposure models

Spatial econometric models offer a number of approaches for estimating peer effects. These models were originally designed to analyse variables which are influenced by geographical locations. Nonetheless they can be adapted for social network datasets by exchanging the matrix of information about geographical neighbours with information about social network neighbours (Leenders, 2002). Many of the spatial models use the matrix to assess the degree of similarities in variables, or the error in model fitting between neighbours. This is done by calculating an aggregate of neighbours' scores, or their residuals, and including this as a term in the model. Using an aggregate of friends' scores will produce higher friend scores if behaviour is common among friends. This is consistent with common theories of social influence which argue that influence is greater when more people perform the behaviour (e.g. Cialdini et al., 1990; Latané, 1996a).

Simultaneous spatial autoregressive lag models (spatial lag) can be used to predict ego's behaviour from friends' independently-reported behaviour using a spatially-lagged dependent variable (i.e. a variable that represents the scores of cases connected in space, as specified in the geographical or social network matrix). The formula for the estimation of the spatial lag model is as follows.

$$\text{Spatial lag model } y = \rho W y + \beta X + \varepsilon$$

Where y represents a vector of the dependent variable, W the friendship (or spatial weights) matrix, X a matrix of exogenous covariates and ε a vector of residuals. ρ represents the coefficient on the spatially lagged dependent variable and β represents the coefficients on the exogenous variables.

The spatial lag model is fit using optimization with a maximum likelihood estimator. This fitting method is preferred to more common fitting methods such as ordinary least squares as it reduces the likelihood of bias in the models due to simultaneity between the spatially-lagged dependent variable or error term and the dependent variable (Anselin, 2001).

Spatial properties of relevant unmeasured covariates will be captured in the spatial error term of spatial autoregressive error models (spatial error models). These models essentially account for similarities in friends' scores on the error term which have been identified through the spatial weights (or friendship) matrix. The formula for the spatial error model is presented below.

$$\text{Spatial error model } y = \beta X + u \text{ where } u = \lambda W u + \varepsilon$$

Where y represents a vector of the dependent variable, W the friendship (or spatial weights) matrix, X a matrix of exogenous covariates and ε a vector of residuals. β represent the coefficients on the exogenous variables.

Spatial lag and error terms can also estimate within a single model known as a "Cliff-ord type" model or "Kelejian-Prucha" model. The formula for this model is depicted below.

Cliff-ord type model $y = \rho W y + \beta X + u$ where $u = \lambda W u + \varepsilon$

Where y represents a vector of the dependent variable, W the friendship (or spatial weights) matrix, X a matrix of exogenous covariates and ε a vector of residuals. ρ represents the coefficient on the spatially lagged dependent variable and β represents the coefficients on the exogenous variables.

A researcher should consider whether a lag or error component is theoretically relevant to inform the choice of the most appropriate spatial model (Leenders, 2002). Where a researcher suspects that an actor's attribute influences their friends' attribute (as would be expected in a contagion process), a spatial lag model is appropriate (Leenders, 2002). Where a researcher suspects that an important unmeasured variable contained in the error term is spatially clustered, a spatial error model is most appropriate. Where both are theorised to be important then a Kelejian-Prucha model is likely to be the superior choice (Elhorst, 2010). Lagrange Multiplier tests may also be used to assess whether spatial lag or spatial error are observed in a linear regression version of these models.

Spatial lag and error models have been extensively used in other disciplines yet extensions that would allow me to explore mechanisms of contagion, repeated measures data or binary data are under-developed. Statisticians are currently grappling with how to estimate a spatial lag model with a binary dependent variable (e.g. Calabrese & Elkind, 2014), and a procedure for estimating a Kelejian-Prucha model with binary data does not seem to be available. Further, some longitudinal specifications of spatial regression suffer from identification problems and others are novel and do not appear to have been widely implemented (see Elhorst, 2010, pp. 24-26). Finally it is unclear whether processes for assessing mediation of a relationship can be applied to these models. Nonetheless spatial lag, error and Kelejian-Prucha models are useful for assessing normally distributed cross-

sectional data when no mediation or repeated measures analysis is required, as is the case for models in Chapter 6.

Similar to spatial lag models, “network exposure” models (e.g. Fujimoto & Valente, 2012b) adapt regression models by including a term that represents the average of friends’ scores on the dependent variable as an independent variable. The independent variable which represents the average of friends’ scores on the dependent variable is calculated using a social network matrix which identifies friendship relationships. Each tie identified in the friendship matrix is replaced with the attribute score for the dependent variable and then averages are calculated across rows of the matrix to produce a term that represents friends’ average score for each participant. The friend average is then used as an independent variable in models predicting ego behaviour or change in ego behaviour. The formula for calculating the friend average is presented below.

$$F_{avg_i} = \frac{\sum_{j=1}^n W_{ij}y_j}{\sum W_{i>0}}$$

Where W = a NxN binary friendship matrix where $W_{ij} = 1$ indicates a friendship between i and j and $W_{ij} = 0$ no friendship, and y is an $N \times 1$ vector of attribute values.

Network exposure models rely on adaptations of standard regression techniques and therefore are relatively flexible in their application. However this flexibility comes at a cost. These models do not necessarily account for non-independence and the impact of endogeneity between the network and behaviour. This introduces two potential types of bias in the model. The first is that if people influence each other’s scores then they are clearly not independent of one another. This non-independence violates assumptions of traditional regression models and can generate biased standard error estimates (Heagerty, Ward, & Gleditsch, 2002; Krackhardt, 1988; Sainani, 2010). The impact on the standard error, and thus probability estimates, can be addressed using robust sandwich variance estimators of

standard errors. The procedure for computing these errors is described in greater detail in Lumley and Hamblett (2003). The second is endogeneity that can arise from simultaneity between the dependent variable (ego behaviour) and friends' behaviour. Simultaneity may bias the estimation of friends' behaviour on ego behaviour if the ego influences friends and the model does not account for any reciprocal effects that operate between the ego and friends' behaviour.

Although network exposure models have often been applied to cross-sectional data, such data cannot identify causal relationships, particularly those involving contagion or homophily processes. In a number of longitudinal or repeated-measures models, such as residualised change models, prior behaviour acts as a baseline which accounts for shared variance between the dependent variable and the independent variables at a given time point. As discussed below and in more detail in Chapter 4, this can help to control for homophily processes that occur prior to Time 1.

A residualised change model predicts Time 2 ego behaviour from Time 1 ego behaviour and Time 1 covariates. Including Time 1 ego behaviour and Time 1 friend behaviour as independent variables should allow us to account for similarities which exist between friends' Time 1 behaviour and the ego's Time 1 behaviour. Secondary and manifest homophily factors should also be accounted for, provided they have a similar impact on change in behaviour and on Time 1 behaviour. Common external causation should not affect relationships between change and Time 1 friend behaviour because Time 1 ego and friends' scores cannot be affected by events that happen between the two measurement points. Including Time 1 scores as a covariate has the added advantage of accounting for regression to the mean effects which may otherwise bias estimates of change (Finkel, 1995). This model may also help address issues of simultaneity because ego behaviour at Time 2 cannot influence friends' behaviour at a prior time point.

In Chapter 3 I use a network exposure model corrected using a linearization estimator to explore cross-sectional data. In Chapters 4 and 5 I apply these same techniques to a repeated measures case using a residualised change specification. Whilst missing data has a large impact on analyses which are based on measures of social network structure, the main impact of missing data on these analyses should be in restriction of range. In all quantitative analyses I use list-wise deletion of cases to deal with the missing data.

2.5 *Qualitative approach*

Not all questions about the possible role of friends in pro-environmental behaviour can be adequately answered by relying solely on quantitative data (Cameron, 1967). Hence Chapter 5 and 7 investigate students' perceptions of the peer context and verbal constructions of pro-environmental behaviour using qualitative data and analytical techniques.

Qualitative data offers a number of advantages when research questions relate to the role of language in shaping particular phenomena. Quantitative measures such as how often conversations occur and how many times a particular word is used offer a very limited analysis of the role of conversations. These measures are unable to capture the richness and context of each utterance.

In Chapter 7 I used qualitative data to explore how pro-environmental behaviour was constructed and negotiated during focus group conversations. To do so I drew on analytical techniques utilised in discursive psychology (Edwards & Potter, 1992). Discursive psychology focuses on specific conversational techniques which manage the interests of the speaker (Edwards & Potter, 1992). Given that many aspects of environmental degradation are intangible and contested (Dryzek, 2005), discourse approaches which investigate how meaning is constructed may be particularly informative.

In addition, friend influence in real-world scenarios is complex and difficult to capture through questionnaire measures or measures of other behaviours. For example, mechanisms

of contagion may not be measured because they were not theorised or because it is just not possible to measure everything. When theories and previous work do not provide a strong indication as to how influence is occurring, exploratory work using qualitative data can provide a broad set of possible things to focus on in future quantitative studies. Qualitative data may also be used to triangulate findings from quantitative data that are tentative or to uncover alternative explanations from these findings.

In Chapter 5 I integrate qualitative findings with quantitative data about friends' influence. The ability to integrate qualitative and quantitative data was thus a key consideration in the selection of data analysis for this chapter. Thematic analysis was selected as it does not require that the researcher adopt a particular theory or focus (Braun & Clarke, 2006, 2012). This means that, unlike some other forms of qualitative analysis, it can be approached from a realist epistemology which assumes that reality can be known and measured or a relativist epistemology which assumes that knowledge about the world is socially constructed. Like many qualitative analytic techniques it involves looking for coherent, repeated patterns in qualitative data. The process of thematic analysis involves data familiarisation and systematic coding, grouping codes into themes, followed by iterative processes of recoding and regrouping (Braun & Clarke, 2006, 2012). In the Chapter 5 participants' perspectives on the social context are grouped into themes relating to how and when friends and other peers may be influential in these behaviours.

Most chapters in this thesis, including the mixed methods chapter (Chapter 5), are underpinned by a positivist methodological framework which assumes that a reality exists outside of language which is knowable or observable, at least in theory. This differs from the social constructionist assumptions commonly adopted in qualitative research which propose that the world and our assumptions of it are constructed in social interactions.

However Bhaskar (1978) argues that conflating assumptions about the nature of the world (ontology) and the nature of knowing (epistemology) is an “epistemic fallacy”. He and others (e.g. Maxwell, 2012; Sayer, 1992) have proposed a third philosophy known as critical realism which argues that whilst a reality exists, our knowledge, and other people’s knowledge of it is socially constructed. Thus critical realism maintains an ontological realism and an epistemological relativism. Variations on critical realism have been developed. Weak forms of critical realism draw on Bhaskar’s proposal that social phenomena are part of the whole rather than the sum of reality (Carolan, 2005). To explore language use in Chapter 7 I adopt a weak form of critical realism informed by the work of Bhaskar (1978); Maxwell (2012); Sayer (1992).

Critical to the analysis of qualitative data is a willingness to critique and scrutinise one’s processes, data collection, analysis and interpretation to identify where the researcher has brought their own personal ideas, biases and influences to the research process (Finlay, 2002). Through reflexive thinking, researchers actively reflect on and attend to questions such as; What alternative explanations are there for this piece of data? What reasons led me to choose this interpretation? Are those reasons valid? How have my own ideas informed the explanations that were provided? Have I acknowledged alternative possibilities? How does my relationship with the research participant’s impact on their responses? Whilst these questions are also relevant to other branches of science, reflexive practice involves a more explicit and deeper reflection than is often included in disciplines which assume that objective science is possible.

Focus groups were selected as the primary method of qualitative data collection in this thesis. These were chosen as they capture more of the social context than individual interviews but do not require the substantial time investment involved in ethnographic research. Focus groups are attended by a small group of people who are encouraged to talk

amongst themselves drawing on questions and prompts from the moderator (Wilkinson, 1998). This facilitates opportunities to explore the language young people use to describe environmental concepts, pro-environmental behaviour and the context of these behaviours to one another. A copy of the semi-structured focus group questions is presented in the data collection materials appendix.

2.6 Ethics

Two ethics forms were collated and were granted approval by the University of Auckland Human Ethics Committee. The first related to the repeated-measures survey (*reference 2011/167*) and the second covered the focus groups (*reference 8259*). A copy of the information sheets sent to the School Principal is provided in the Appendix B: Selected data collection materials appendix.

2.7 Data collection stages

Data for this research was collected through three waves of questionnaire administration and 10 focus groups held at a single school. A pilot study was also conducted to inform the design and measures used in the questionnaire. Figure 2.3 provides an overview of the methods and associated chapters.

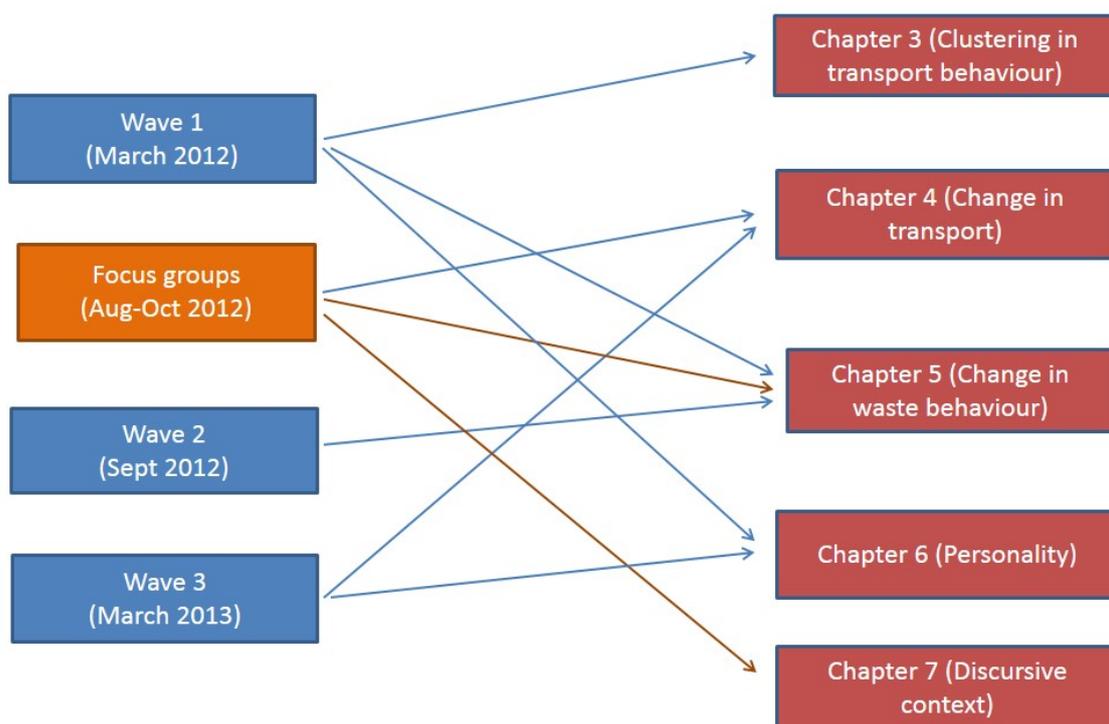


Figure 2.3. Data collection points (left) used for the results-focused chapters (right).

Chapter 3: Social clustering in high school transport choices

3.1.1 Publication reference

Please note that Chapter 3 has been published as the following article: Long, J., Harré, N., & Atkinson, Q. D. (2015). Social clustering in high school transport choices. *Journal of Environmental Psychology, 41*, 155-165. The article is included in this thesis with permission from Elsevier. The text is identical to its published format with the exception of adjustments to the numbering of title, figure and table headings.

3.2 Abstract

Active transport offers opportunities to reduce the environmental impacts of car travel and improve health. During adolescence, friends and parents may influence transport mode to school. Using a social network survey of 934 high school students we investigated whether students' walking, cycling, bus and car travel to school were predicted by their friends' transport behaviour, accounting for parent encouragement, ride availability, distance to school, gender, school unit and age. In addition, we examined whether descriptive norms, friend encouragement or co-travel requests mediated the effect of friends' active transport behaviour. We found that friends' transport behaviour predicted ego behaviour, particularly for cycling. Descriptive norms and co-travel requests, but not friend encouragement, approached significance as mediators of friends' active transport similarities. Parent encouragement for active transport was a particularly strong predictor of transport mode. Implications for future research and interventions are discussed.

3.3 Introduction

3.3.1 Rationale

Transport generates a substantial portion of greenhouse gas emissions, comprising nearly 23% of the world's energy related emissions (International Energy Agency, 2009). Private car use produces substantially more greenhouse gases per passenger kilometre than public transport in most countries, whilst walking and cycling are virtually emission free (IPCC, 2007), replacing car journeys with alternative forms of transport also reduces traffic congestion and improves the overall safety of pedestrians, passengers and other road users. Active transport such as walking or cycling also provides an opportunity to increase regular physical activity (Wanner, Götschi, Martin-Diener, Kahlmeier, & Martin, 2012) which can in turn contribute to physical and psychological health (Garrard, Rissel, & Bauman, 2012). Local car trips that could be walked or cycled are an important and feasible target for change (Maibach, Steg, & Anable, 2009).

Adolescence may be a particularly important time for shaping adult transport patterns (e.g. Line, Chatterjee, & Lyons, 2012; Simons, Clarys, De Bourdeaudhuij, de Geus, Vandelanotte, & Deforche, 2013) and adult health outcomes (Lawlor & Chaturvedi, 2006). Peers are salient during adolescence and have been found to be influential for a range of behaviours (Brechtwald & Prinstein, 2011; Brown et al., 2008). Social interventions, including those involving peers, may increase participation in active transport (Orsini & O'Brien, 2006; Panter, Jones, van Sluijs, & Griffin, 2010) but little is known about the role of peers in adolescents' transport choices to and from school.

3.3.2 Clustering of behaviour within social networks

Social networks describe relationships between individuals in a given setting or community. Social network methods generally represent individuals as nodes in a network

and social relations (e.g. friendships, interactions, associations) as the links between nodes. Social clustering (also known as network autocorrelation) describes a situation in which linked individuals in a network are more similar on a given attribute than would be expected due to chance. To establish similarities in friends' attributes, each individual's behaviour is measured independently and mapped onto the network. People often assume others' behaviour is more similar to their own than it actually is (McPherson, Smith-Lovin, & Cook, 2001; Prinstein & Wang, 2005). Therefore using independent reports collated on a social network avoids a similarity bias or “false consensus effect” that can arise if individuals are asked to estimate the behaviour of their friends.

Social clustering can arise from a combination of processes that can be broadly categorized as social contagion, homophily or secondary homophily. Social contagion captures processes whereby an individuals' behaviour is influenced by the behaviour of their peers. In contemporary work, the term social contagion is used synonymously with socialisation, friend influence and peer effects (e.g. Brechwald & Prinstein, 2011; Christakis & Fowler, 2008; Dishion & Tipsord, 2011; Eisenberg, Golberstein, Whitlock, & Downs, 2013; Shalizi & Thomas, 2011). The term has historically been used to describe a myriad of sub-types of influence, particularly subtypes of imitation (see Levy & Nail, 1993; Wheeler, 1966). In this paper we use social contagion as it is most commonly used in current literature, to describe processes in which friends influence the ego (focal individual) to behave in ways that are consistent with their own behaviour.

Homophily, refers to the predisposition to select people with similar traits as friends. Homophilic selection of friends may be based on the behaviour of interest (manifest homophily), which in our case would be transport choices (Shalizi & Thomas, 2011). Friendship selection may also relate to a trait that is associated with the behaviour of interest (secondary homophily when the trait is measured, latent homophily if the trait is unmeasured)

(Shalizi & Thomas, 2011). For transport behaviour, secondary or latent homophily could include selecting friends on the basis of gender or distance from school, or other traits likely to influence transport choices. For example, adolescents are more likely to select friends who live close by (Preciado, Snijders, Burk, Stattin, & Kerr, 2012) and who are the same age and gender (McPherson et al., 2001) which are all factors that have been linked to transport choices (Sirard & Slater, 2008). Features of the home environment such as parent encouragement and ride availability may also play a role here. For example, parent encouragement is known to correlate with transport choices (Panter, Jones, & van Sluijs, 2008) and may give rise to secondary homophily if students tend to form friendships with those whose parents have similar attitudes toward particular transport choices.

It can be difficult, if not impossible to conclusively differentiate between these three classes of explanation in social network surveys. Social contagion, homophily and secondary homophily are not mutually-exclusive processes (Brechwald & Prinstein, 2011; de la Haye et al., 2011b) and if homophily exists on the variable of interest this can contaminate estimation of social contagion unless very strong assumptions are made (Shalizi & Thomas, 2011). Nevertheless, simple tests for clustering of behaviour on a network can identify whether at least one of the three processes is likely to be present. Further, including potential secondary homophily variables in the analysis makes it possible to quantify their relative importance and may allow contagion effects to be ruled out. That is, if there is no clustering in transport behaviour after controlling for secondary homophily variables, this makes a contagion explanation unlikely. Conversely, incorporating variables linked to possible social contagion mechanisms into the analysis makes it possible to test the plausibility of these causal pathways and potentially provides indirect support for the role of contagion.

3.3.3 Mechanisms of contagion within social networks

When behaviours cluster, and we suspect there is some degree of social contagion present, we can ask what interpersonal mechanisms are likely driving this. Empirical work on the mechanisms underlying social contagion has been a gap in the literature on social contagion although more attention has been paid to these mechanisms in recent years (Brechwald & Prinstein, 2011).

One potential factor driving contagion effects is individuals' perception that a behaviour is common among their friends. According to normative focus theory (Cialdini et al., 1990) information about common behaviour (descriptive norms) may provide a short-cut to decision making, leading people to adopt the common behaviour in a particular context (Cialdini et al., 1990). People may also consciously adopt the common behaviour because they assume that these behaviours are likely to be rewarded by their friendship group (Brown et al., 2008) or, drawing on social categorisation theory, because the common behaviour may become part of their identity as group members (Turner et al., 1987). If people are consciously adopting the common behaviour then descriptive norms around what behaviours are most common should mediate similarities between the individual's travel mode choice and that of their friends. A Dutch study found that adult car use was related to perceptions of how often important others travel by car (Steg, 2005) and descriptive norms appear to be consistently related to physical activity (Maturro & Cunningham, 2013). No research to our knowledge has assessed whether descriptive norms predict adolescent transport behaviour, nor whether they underpin contagion processes if these are present.

A second mechanism potentially driving contagion effects involves reward and encouragement from peers. People may promote behaviours that match their own through verbal influence, requests and teasing (Brown et al., 2008) because conformity to in-group relevant norms increases positive emotions for the perceiver (Christensen, Rothgerber,

Wood, & Matz, 2004) and affirms the influencers' own behaviour. The term “encouragement” is often used to capture verbal influence, particularly within the health promotion literature.

Encouragement has consistently been found to predict physical activity in adolescence (Maturro & Cunningham, 2013) and friend encouragement of physical activity is also related to adolescent active transport (Deforche, Van Dyck, Verloigne, & De Bourdeaudhuij, 2010; Hohepa, Scragg, Schofield, Kolt, & Schaaf, 2007). One study of UK children found that friend encouragement for active transport related to whether students cycled to school, but only for students living close to school (Panter et al., 2010). No research to our knowledge has explored whether friend encouragement of active transport is related to transport choices for adolescents. If encouragement is important for active transport and people tend to encourage this behaviour when they do it themselves then encouragement may generate similarities in friends' behaviour.

Social contagion may also arise from opportunities to travel with friends. Transport with friends is likely to be more enjoyable than travelling alone or with parents and the time spent travelling together may also contribute to a sense of belonging, which Baumeister and Leary (1995) propose is a fundamental human motivation. Pre-adolescents in Scotland and New Zealand have reported that travelling to school can be a fun opportunity to socialise with friends and suggested that travelling with friends might boost active transport participation (Orsini & O'Brien, 2006; Panter, Jones, van Sluijs, & Griffin, 2010). Older adolescents also appear interested in co-travel: Belgian youth reported that opportunities to travel with friends altered their choice of transport mode or the distance they were willing to cycle for leisure journeys (Simons, Clarys, De Bourdeaudhuij, de Geus, Vandelanotte, & Deforche, 2013).

3.3.4 *The present study*

This study investigates similarities in friends' transport behaviour in a New Zealand high school social network. In particular it examines students' walking, cycling, car travel and bus travel choices at a single time point. First, we aim to identify whether adolescent transport behaviour to school shows social clustering. Second, we aim to test whether and to what extent this clustering holds when controlling for a range of demographic and context variables. These additional variables are primarily of interest because they may contribute to friend selection and could therefore explain any social clustering in terms of secondary homophily effects. Third, we explore indirect evidence for social contagion via social mechanisms that mediate similarities in friends' behaviour.

We test the following hypotheses:

1. Transport behaviour will cluster socially, such that pairs of friends will be more likely than randomly selected pairs to share the same transport behaviour and friends' average behaviour will predict the likelihood that the ego will typically use that mode. This will be true for walking (H1a), cycling (H1b), car travel (H1c) and bus travel (H1d).
2. The predictive power of friends' transport behaviour will hold even after controlling for demographic and context variables that may give rise to secondary homophily (H2a-d).
3. Descriptive norms (i.e. perceptions of friends' behaviour) will mediate relationships between ego and friends' behaviour (H3).
4. Friend encouragement of active transport will mediate relationships between ego and friends' behaviour (H4).
5. Active transport co-travel requests will mediate relationships between ego and friends' behaviour (H5a). As shared transport is likely to be a key mechanism of social

contagion or homophily, we also expect that the behaviour of friends who travel separately will not predict ego transport choices (H5b–e).

3.4 Method

3.4.1 Participants

Participants were students of a large relatively affluent co-educational public high school in Auckland, New Zealand. Students who live within the school “zone” are prioritised for enrolment at this school, however around 15% attend the indigenous language unit that permits students from outside the school zone.

All students present in their weekly administration class were invited to take part in the survey. Thirty seven consenting students were excluded as they did not provide friend nominations or an ID number required to link their data with that of their friends. The final social network dataset which was used for all analyses included 934 students (71% of enrolled school population). Slightly more males (54.5%) than females took part, consistent with school demographics (57.9% male). The average age was 14.7 years and ages ranged from 12 to 19 years. Chi-square tests indicated no evidence of a difference in the gender or school year between participants and students enrolled at the school. Fewer NZ European individuals took part in the survey than would be expected based on the ethnic makeup of the school population.

Participants provided informed consent prior to the questionnaire and parents of students under 16 years old were given the opportunity to opt their child out of the study. Friend nominations were separated from the rest of the questionnaire and de-identified with ID codes before being sent to the researchers. To encourage participation, students were offered the chance to win one of five \$20 (NZD) gift vouchers. The project was approved by the University of Auckland Human Participants' Ethics committee.

3.4.2 Measures

The questionnaire was part of a larger research project on sustainability. Only the items of interest to the current study will be presented here. Friends were identified by asking students to “*Please name [School name] students who are your close friends. You do not have to fill in all the spaces but we are providing space just in case anyone has this many close friends*”.

We used an aided recall free recall approach allowing seven spaces for friend names. Similar friend nomination approaches have been used previously (e.g. Poulin et al., 2011). We also asked students to tick a box beside each name indicating whether they “*often travelled to or from school with that person*”.

Transport to and from school was measured by asking participants to tick their major transport mode for each journey they made to or from school last week (a total of 10 journeys). Possible response boxes for each journey were; *Walk, Cycle, Motor scooter, Skate/scooter, Bus, Driven to school, I drive myself in a car, Other (please specify)*. Street name, suburb name and weeknights spent in each house were collected so that approximate distance to school could be calculated. No house numbers were collected to maintain student privacy. Students were also asked to report their age and gender and home number which was used to assess if they attended the language unit.

The remaining items were rated on Likert scales ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Verbal anchors were given for values 1 through 7 as this can increase the reliability of likert scale ratings (Weng, 2004). Likert scale items included active transport descriptive norms (“*My friends from [school name] often walk, cycle or skate to and from school*”) and active transport co-travel requests from friends (“*One or more of my friends sometimes asks me to walk, cycle or skate to or from school with them*”).

We also assessed active transport encouragement from friends (e.g. “*My friends from [school name] encourage me to walk, cycle or skate to and from school*”) and from a male or

female caregiver (e.g. “*My Mum (or a caregiver who acts like a mum) encourages me to walk, cycle or skate to and from school*”). Perceived encouragement from mothers and fathers was later combined to form a parent encouragement variable ($\alpha = .85$). Availability of rides from family members was assessed with two questions, one about the morning (“*A member of my family is able to drop me at school by car*”) and the other about the afternoon (“*A member of my family is able to pick me up from school by car*”). The ride availability questions were combined to form a single family ride availability variable ($\alpha = .76$).

Finally, we asked students about their age, gender and collected their home room number in order to assess whether they attended the main school or the indigenous language unit.

3.4.3 Procedure

Participants provided informed consent and then completed the survey during an administration class slot. The information sheet was summarised verbally prior to beginning the survey and in written form. Students took between 10 and 15 minutes to complete it. Survey completion was supervised by a teacher and in some cases a university research assistant was also present.

3.4.4 Analysis

Friend nominations were converted into an undirected friendship matrix which specified a friendship where at least one individual nominated the other individual. In line with previous studies (Long, Harré, & Atkinson, 2014; Wölfer, Cortina, & Baumert, 2012) we include all friend nominations to maximise the number of ‘close friends’ included in friends' behaviour scores. A second ‘separate-transport’ friendship matrix was produced for some analyses that included only ties where neither friend identified travelling with the other. Data manipulation was conducted using a combination of the *network* (Butts, Handcock, & Hunter, 2007),

spdep (Bivand, 2011) and *sna* (Butts, 2007) packages in *R*, an open source language for statistical computing (R Development Core Team, 2007).

Although they were asked to “*Tick only one option for each column that applies for the main part of your journey.*” some students ($n = 58$) did tick more than one option. Where two modes of transport were specified for a journey, passive modes (driving, followed by bussing) were prioritised and any active modes (walking, cycling, skateboarding and scootering) for that journey were removed, based on the rationale that a greater proportion of the journey was likely to be via the passive mode. We also assumed that active trips which would require travelling for over an hour were likely to be errors or would be supplemented with a passive mode for part of the journey. Thus, walking trips from distances which would involve walking for over an hour were recoded to 0, indicating the person did not walk for that journey ($n = 13$). No cycling, skateboarding or scootering trips were listed for distances that would require using these modes for over an hour. The total frequency of every transport mode was bimodal and thus frequencies were split at five trips per week to create a binary dependent variable for each transport mode.

Distances to school were calculated using the Google Distance Matrix application program interface based on walking routes which could travel through parks or alleyways but not down motorways. For most participants, distance to school was measured from the middle of the listed street to the front school gate. For long streets, distances were measured from the midpoint of that street within the suburb listed (1.6% of cases). When participants did not provide a street name we used the centre of the suburb. For students who listed two addresses, distance was calculated from the house they stayed at three or more nights, as this would determine the distance travelled most frequently. GIS type distance calculations have been used in other studies (e.g. Panter, Corder, Griffin, Jones, & van Sluijs, 2013) and have

been found to be similar to actual distances mapped using a GPS (Duncan & Mummery, 2007).

Similarities in friends' scores on continuous variables were tested using Moran's *I* statistics (Moran, 1950). Moran's *I* statistics assess whether the scores between neighbouring (linked) points (individuals) are more similar than would be expected by chance given the observed variation in scores. Values of Moran's *I* range from -1 to 1 ; positive values indicate social clustering and negative values indicate dispersion of traits.

Similarities in binary transport choices and gender were assessed through join count statistics. Join count statistics calculate the proportion of ties (or “joins”) linking actors with the same score on a categorical or binary variable (Cliff & Ord, 1981). In our analysis of each transport mode, each friendship tie will either a) link two people often using that mode, b) link two people not often using that transport mode or c) link a person who does use that mode with a person who does not. We use join count statistics to calculate the number of friendship ties between two people often using that mode or two people often not using each mode. We assess whether the join count and Moran's *I* values exceed what would be expected given the frequency of each score in the network through monte-carlo permutation of the data (keeping the network constant) with 10,000 simulations using the *joincount.mc* and *moran.mc* functions in the R package *spdep* (Bivand, 2011). Participants with missing data on a particular variable were dropped from that particular join count or Moran's *I* analysis.

Social network approaches to studying social similarities are varied in their choice of statistical techniques but all have weaknesses (Ali & Dwyer, 2010; Lyons, 2011; Robins, 2013; see Snijders, 2011a). In this paper we calculate an average friends' self-reported behaviour similar to methods used in *network exposure models* (e.g. Fujimoto & Valente, 2012a). In the first set of these models we predict ego behaviour from a single independent variable of friends' average self-reported behaviour for that transport mode. These regressions

expand on the joint count analysis by quantifying the degree of similarity between friends. We then run a second set of models that predict ego behaviour from friends' behaviour, adjusting for demographic and context factors that are also expected to influence transport behaviour and/or friend selection – distance to school (logged), gender, age, attendance at the school language unit, the availability of rides from family members, and parent encouragement to use active transport. School language unit is included as a predictor as students from the school language unit were likely to travel long distances to school and be friends with one another therefore enrolment in the language unit could account for social clustering in transport behaviour. Friends' walking was calculated by averaging the number of times each nominated friend reported walking to and from school per week. This was repeated for cycling, car travel and bus travel. Averaging was performed on the raw transport frequencies rather than the dichotomised version used for the dependent variables.

Separate logistic regressions were used to predict self-reported walking, cycling, car travel and bus travel. Log likelihood values were used to compare the fit of the full model with a model just including the demographic and context covariates to assess whether the addition of friends' behaviour improved the overall model fit.

In order to assess whether descriptive norms, friend encouragement and active transport co-travel requests mediated the relationship between friend and ego active transport we performed regressions testing the four steps for assessing mediation proposed by Baron and Kenny (1986). These regressions controlled for covariates (distance to school [logged], gender, age, attendance at the school language unit, the possibility of rides from family members, and parent encouragement to use active transport) in each regression. Survey questions about descriptive norms, friend encouragement and active transport co-travel requests asked students to combine their experience of all active transport modes therefore the role of these variables needs to be assessed using measures of friend and ego behaviour

that include all the active transport modes. Friends' active transport was calculated by averaging the number of times each nominated friend reported using active transport (number of walk, cycle, skate or scooter trips to and from school per week). Following the earlier analyses, friend averages were calculated on the raw active transport total score and dichotomised transport were used as the dependent variable in the relevant mediation related regressions.

These four criteria for assessing mediation outline by Baron and Kenny (1986) are as follows:

1. The causal variable (friends' behaviour) predicts the outcome (ego behaviour)
2. The causal variable (friends' behaviour) predicts the mediator (i.e. descriptive norms)
3. The mediator (i.e. descriptive norms) predicts the outcome (ego behaviour)
4. The causal variable (friends' behaviour) is not a significant predictor of the outcome (ego behaviour) when the mediator (i.e. descriptive norms) is included as a covariate.

If all four steps are met this is consistent with full mediation. If the data is consistent with steps 1–3 but not 4 then this is consistent with partial mediation. A range of criteria have been proposed for assessing the significance of the indirect effect. One of the approaches is simply to assess if Steps 2 and 3 are confirmed (Fritz, Taylor, & MacKinnon, 2012), another is to use the Sobel's Z (Sobel, 1982) test. Whilst the Sobel's Z test is conservative (D. P. MacKinnon, Warsi, & Dwyer, 1995) it is known to be suitable for use with dichotomous outcomes and thus is favoured in this analysis. We repeated the series of regressions needed to assess mediation for descriptive norms, then friend encouragement, then active transport co-travel requests. Finally we assessed whether similarities in friends' behaviour remained when we only considered the behaviour of friends who did not travel together. New friend averages were calculated on a second 'separate-transport' friendship matrix and regression models

were fit predicting each transport mode from the 'separately transport' friend average and the demographic and contextual covariates.

The non-independence of behaviour in a social network can generate biased standard error estimates (Heagerty et al., 2002; Sainani, 2010), similar to issues of autocorrelation present in time-series data. To overcome this problem, we used robust sandwich variance estimators of standard errors using the procedure described in Lumley and Hamblett (2003). Standard errors for all regression analyses were adjusted to account for the non-independence of nominated friends' scores. Odds ratio and beta confidence intervals and Sobel's Z scores were calculated using the adjusted standard errors. Listwise deletion of missing data was used and thus the number of participants differs between analyses.

3.5 Results

3.5.1 Prevalence of transport choices

To better understand the transport context, we first assess the prevalence of different transport modes used to get to and from school. In total 46.7% of participants reported travelling by walking five or more times on a typical week, 29.2% of participants travelled by bus, 19.8% by car, 7.8% by cycling and 1.9% by skateboarding or scootering. Approximately 10% used other modes or didn't use a single mode five or more times a week. The percentages do not add up to 100 because some participants (13.0%) travelled by two modes five times per week and 1.6% of participants did not provide complete transport mode information.

3.5.2 Social clustering in the network

We employed joint count statistics (*JC*) to assess whether the number of friendship ties between participants who both used (or did not use) each transport mode differed

significantly from chance. Join count tests identified 638 friendship ties between participants who both often walked and 823 friendship ties between participants who both did not. The total number of possible (symmetric ties) was 2604, thus there were 1143 friendship ties between a participant who often walked and one who did not. Join count statistics for friendship ties where both friends walked or both did not was significant at $p = .0001$, consistent with H1a predicting clustering in walking. Cycling also had significant join count statistics for both types of friendship ties (H1b). Similarly, consistent with H1c and H1d, the number of friendship ties between participants who both often travelled by car and who both often travelled by bus were also significant, although the number of friendships between participants who both didn't use these modes were not significant (see *Table 3.1*).

The p values quantify the probability of observing a greater number of friendship ties for random permutations of the variable across the same network and thus the significance of the statistic does not necessarily mirror the size of the join count value.

Table 3.1. Join count tests (JC) of spatial clustering in dichotomised transport scores
($n = 921$, total friendship ties = 2604)

	<i>JC</i>	<i>p</i>
Typically walk	638	0.0001
Typically don't walk	823	0.0003
Typically cycle	28	0.0001
Typically don't cycle	2291	0.0002
Typically use car	109	0.0054
Typically don't use car	1740	0.0582
Typically bus	267	0.0001
Typically don't bus	1327	0.2577

Note. The JC statistic refers to the number of friendship ties linking people with the same common transport mode.

Friends were also similar along dimensions that we expect contribute to transport choices. Moran's I analyses revealed similarities in friends' age, distance to school and parent

encouragement of active transport and join count analyses revealed similarities in gender and whether friends attended the school's language unit (see the Supplementary material for Chapter 3). Friends were not significantly similar in ride availability from family members.

Providing further support for H1a–d, friends' self-reported behaviour predicted self-reported ego transport choices. This was true for all transport modes (see *Table 3.2*). First, friends' walking significantly predicted ego walking. When no other variables were considered, a one unit change in friends' walking was related to a 24% increase in the odds of ego walking (OR = 1.24, OR CI = [1.14, 1.34], $p < .0001$). Second, a one unit increase in friends' cycling increased the odds of ego cycling by 71% (OR = 1.71, OR = [1.46, 2.01], $p < .0001$). Third, friends' car travel predicted ego's car travel. A one unit change in friends' car travel was related to a 28% increase in the odds of car travel (OR = 1.28, OR CI = [1.12, 1.46], $p = .0003$). Fourth, friends' bus travel predicted ego bus travel. A one unit change in the average frequency of friends' bus travel behaviour was related to a 25% increase in the odds of bus travel (OR = 1.25, OR CI = [1.14, 1.38], $p < .0001$).

Table 3.2. Logistic regression predicting odds of “often” walking, cycling, car travel or bus travel predicted from friends' behaviour (n = 821 ^b)

	Walk		Cycle		Car travel		Bus travel	
	OR	OR CI	OR	OR CI	OR	OR CI	OR	OR CI
(Intercept)	0.33***	(0.23, 0.48)	0.04***	(0.02, 0.05)	0.14***	(0.11, 0.19)	0.21***	(0.15, 0.29)
Friends' behaviour ^a	1.24***	(1.14, 1.34)	1.71***	(1.46, 2.01)	1.28***	(1.12, 1.46)	1.25***	(1.14, 1.38)

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

a Friend's behaviour on the dependent variable listed in the column heading (i.e. walk, cycle, car, bus).

b The data was subset to cases with complete data on the covariates included in *Table 3.3* to facilitate comparisons between these results.

Friend similarities in variables which contribute to transport may explain why friends are similar in their transport behaviour (i.e. these variables may constitute secondary homophily explanations for clustering). Therefore next we assess whether friends' behaviour predicts ego behaviour in a regression context which allows us to statistically adjust for demographic and contextual factors that may influence transport choices and contribute to similarities in friends' transport choices.

3.5.3 Social clustering controlling for secondary homophily explanations

Consistent with H2a–d, friends' self-reported behaviour continued to predict self-reported ego behaviour when demographics (age and gender) and context variables (distance to school, possible rides from family members and parent encouragement) were adjusted for (see Table 3.3).

This was true for all transport modes, although the odds were substantially lower than in models that just included friends' behaviour as predictors. Friends' walking significantly predicted ego walking; a one unit change in the average frequency of friends' walking behaviour was related to a 10% increase in the odds of walking (OR = 1.10, OR CI = [1.01, 1.21], $p = 0.035$) when demographic and context variables were included. Friends' cycling was a particularly strong predictor of ego cycling. A one unit change in the average frequency of friends' cycling behaviour was related to a 64% increase in the odds of cycling (OR = 1.64, OR = [1.36, 1.98], $p < .0001$) when demographic and context variables were included.

Table 3.3. Logistic regression predicting odds of “often” walking, cycling, car travel or bus travel predicted from friends' behaviour and covariates (n = 821 ^b)

	Walk		Cycle		Car travel		Bus travel	
	OR	OR CI	OR	OR CI	OR	OR CI	OR	OR CI
(Intercept)	1.68	(0.20, 14.12)	0.00***	(0.00, 0.01)	0.01***	(0.00, 0.07)	1.78	(0.35, 9.07)
Friends' behaviour ^a	1.10*	(1.01, 1.21)	1.64***	(1.36, 1.98)	1.19*	(1.04, 1.37)	1.17**	(1.05, 1.29)
Distance (logged)	0.19***	(0.13, 0.26)	0.91	(0.67, 1.24)	1.39***	(1.18, 1.63)	2.09***	(1.60, 2.74)
Age (years)	0.99	(0.87, 1.12)	1.1	(0.90, 1.33)	1.09	(0.97, 1.22)	0.95	(0.85, 1.05)
Ride availability	0.96	(0.87, 1.05)	0.94	(0.81, 1.11)	1.43***	(1.26, 1.62)	0.84***	(0.76, 0.92)
Language unit	0.56	(0.25, 1.27)	1.34	(0.39, 4.53)	0.92	(0.48, 1.76)	0.47*	(0.25, 0.88)
Gender (f)	0.72	(0.50, 1.03)	2.49	(0.99, 6.26)	1	(0.69, 1.44)	0.87	(0.61, 1.24)
Parent encouragement	1.40***	(1.22, 1.59)	1.90***	(1.46, 2.47)	0.86**	(0.77, 0.96)	0.72***	(0.65, 0.81)
Model LL		-374***		-148***		-338*		-387***

Note. Log likelihood tests tested whether each the full model fit better than a model with just friends' behaviour. * $p < .05$; ** $p < .01$; *** $p < .001$.

a Friend's behaviour on the dependent variable listed in the column heading (i.e. walk, cycle, car travel, bus travel).

b The data was subset to cases with complete data on the covariates included in this table to facilitate comparisons between the results for each transport mode.

Likewise, friends' car travel predicted ego's car travel. A one unit change in friends' car travel was related to a 19% increase in the odds of car travel (OR = 1.19, OR CI = [1.04, 1.37], $p = 0.014$) when demographic and context variables were included. Friends' bus travel predicted ego bus travel. A one unit change in the average frequency of friends' bus travel behaviour was related to a 17% increase in the odds of bus travel (OR = 1.17, OR CI = [1.05, 1.29], $p = 0.004$) when demographic and context variables were included.

Post-hoc tests found no interaction between friends' behaviour and age when predicting walking, cycling, bus travel or car travel behaviour thus providing no support for the possibility that friend influence on school transport choices differs by age.

Many of the demographic and context variables predicted each transport mode. Parent encouragement of active transport was a significant predictor of all transport modes; it positively predicted active transport (and walking and cycling) but negatively predicted car and bus travel (see Table 3.3). All transport modes (except cycling) were strongly predicted by distance from school. This was true in models with and without friends' behaviour. With each doubling of the distance from school, walking was 81% less likely (OR = 0.19, OR = [0.13, 0.26], $p < .0001$) but, interestingly, cycling behaviour was not predicted by distance (OR = 0.91, OR = [0.67, 1.24], $p = 0.567$). Distance to school strongly predicted car travel and bus travel. A doubling of the distance from school was related to a 39% increase in the odds of often travelling by car (OR = 1.39, OR CI = [1.18, 1.63], $p < .0001$) and a two fold increase in the odds of often travelling by bus (OR = 2.09, OR CI = [1.60, 2.74], $p < .0001$).

These findings are consistent with both parent encouragement and distance influencing transport choices, although causation cannot be established in a correlational study. In turn because these are also similar among friends (see the Supplementary material for Chapter 3),

these point to secondary homophily contributions to social clustering in students' transport behaviour.

Ride availability from family members predicted greater odds of car travel (OR = 1.43, OR CI = [1.26, 1.62], $p < .0001$) and lower odds of bus travel (OR = 0.84, OR CI = [0.76, 0.92], $p = .0002$) but was not related to walking (OR = 0.96, OR CI = [0.87, 1.05], $p = .336$) or cycling (OR = 0.94, OR CI = [0.81, 1.11], $p = 0.48$). This variable did not point to a secondary homophily process underpinning clustering in transport behaviour because it was not similar among friends (see the Supplementary material for Chapter 3). There were no age or gender differences in walking, cycling, car or bus travel to school in the presence of these demographic, distance and parent variables.

3.5.4 Investigating descriptive norms as a mediator of social contagion effects

To assess whether the social mechanisms (i.e. descriptive norms, encouragement and co-travel requests) we measured underpinned any social contagion we conducted a series of regression analyses exploring whether these variables mediated the relationship between ego and friends' behaviour. The survey questions about these mechanisms did not ask about walking or cycling separately therefore we summed these trips (along with skateboarding and skating) to form an active transport variable for these analyses.

First we assessed whether descriptive active transport norms (the perceived frequency of active transport among one's friends) mediated the relationship between friends' and ego's active transport using the four step approach proposed by Baron and Kenny (1986).

Figure 3.1 presents the path model estimating mediation of the relationship between friends' and ego's active transport by descriptive (active transport) norms, statistically adjusting for distance, age, gender, school unit, parent encouragement and ride availability in each analysis. The first three steps were met; (1) friends' behaviour predicted ego behaviour (B = 0.26, OR CI = [0.02, 0.51], $p = 0.031$), (2) friends' behaviour predicted descriptive

norms ($B = 0.28$, OR CI = [0.2, 0.36], $p < .0001$), (3) descriptive norms predicted ego behaviour with friends' behaviour as a covariate ($B = 0.23$, OR CI = [0.01, 0.45], $p = 0.043$). However the relationship between friends' behaviour and ego behaviour remained significant when descriptive norms was included as a predictor ($B = 0.21$, OR CI = [-0.04, 0.46], $p = 0.036$) indicating that this was only a partial mediator of the relationship between friends' behaviour and ego behaviour. The Sobel's Z test of an indirect effect through descriptive norms was marginally significant (Sobel's $Z = 1.94$, $SE = .013$, $p = 0.053$, $n = 817$). Given the conservative nature of the Sobel's Z test and the fact that the other criteria were met we conclude that our data are generally consistent with the hypothesis (H3) that the relationship between friends' active transport and ego active transport was mediated by descriptive norms.

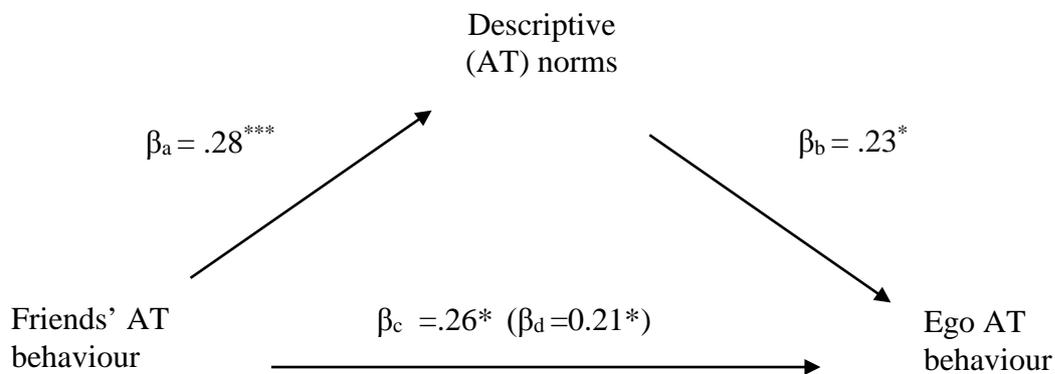


Figure 3.1. Standardised regression coefficients for the relationship between ego active transport (AT) behaviour from friends' AT behaviour mediated by descriptive norms ($n = 817$).

Note. The standardised regression coefficient for friends' AT behaviour on ego AT behaviour controlling for descriptive (AT) norms is in parentheses. All models statistically adjusted for parent encouragement, ride availability, school unit, gender, age and distance to school. * $p < .05$ ** $p < .01$, *** $p < .001$

3.5.5 Investigating friend encouragement as a mediator of social contagion effects

Next we assessed whether friend encouragement mediated the relationship between friends' and ego active transport. *Figure 3.2* presents the path model estimating whether friend encouragement mediated the relationship between friends' and ego active transport, statistically adjusting for distance, age, gender, school unit, parent encouragement and ride availability in each analysis. Step two was not met; friend encouragement was not significantly predicted by friends' behaviour ($B = 0.05$, OR CI = $[-0.02, 0.12]$, $p = 0.159$). This indicates that friend encouragement is not a potential mediator of similarities in friends' behaviour. Step three was also not met; friend encouragement was not a significant predictor of active transport ($B = 0.02$, OR CI = $[-0.21, 0.26]$, $p = 0.839$). Finally, and contrary to H4, Sobel's Z tests of the indirect effect confirmed that friend encouragement was not a significant mediator of the relationship between ego and friends' behaviour (Sobel's $Z = 0.260$, $SE = 0.003$, $p = 0.794$, $n = 818$).

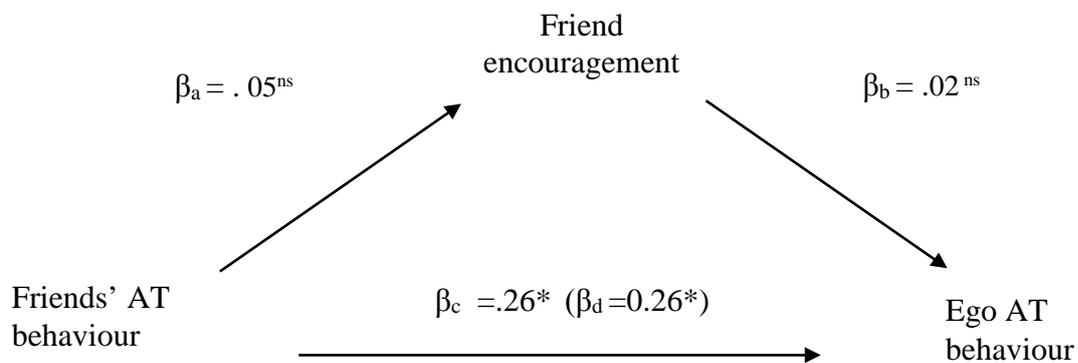


Figure 3.2. Standardised regression coefficients for the relationship between ego active transport (AT) behaviour from friends' AT behaviour mediated by friend encouragement ($n = 817$).

Note. The standardised regression coefficient for friends' AT behaviour on ego AT behaviour controlling for friend encouragement is in parentheses. All models statistically adjusted for parent encouragement, ride availability, school unit, gender, age and distance to school. * $p < .05$ ** $p < .01$, *** $p < .001$.

3.5.6 Investigating co-participation as a mediator of social contagion effects

Next we assessed whether active transport co-travel requests mediated the relationship between friends' and ego active transport. *Figure 3.3* presents the path model estimating mediation of the relationship between friends' and ego active transport by active transport co-travel requests, statistically adjusting for distance, age, gender, school unit, parent encouragement and ride availability in each analysis. The first three steps were met; (1) friends' behaviour predicted ego behaviour ($B = 0.26$, OR CI = [0.02, 0.5], $p = 0.034$), ¹ (2) friends' behaviour predicted active transport co-travel requests ($B = 0.14$, OR CI = [0.07, 0.21], $p < .0001$) and (3) active transport co-travel requests predicted ego behaviour with friends' behaviour as a covariate ($B = 0.22$, OR CI = [0.01, 0.43], $p = 0.038$). However the fourth step was not met as friends' behaviour continued to be a significant predictor of ego behaviour ($B = 0.23$, OR CI = [-0.01, 0.47], $p = 0.036$) indicating that active transport co-travel requests may be a partial rather than full mediator of the relationship between friends' behaviour. Further, Sobel's Z approached significance, tentatively consistent with H5a (Sobel's $Z = 1.84$, $SE = 0.006$, $p = 0.065$, $n = 820$).

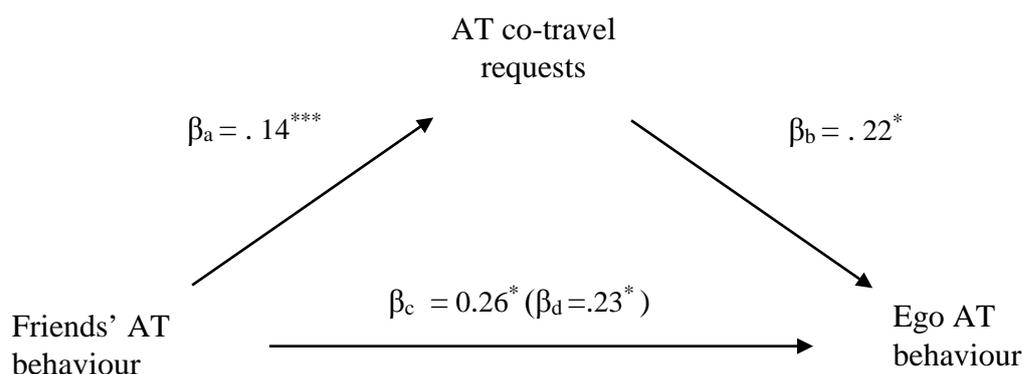


Figure 3.3. Standardised regression coefficients for the relationship between ego active transport (AT) behaviour from friends' AT behaviour mediated by AT co-travel requests ($n = 820$).

Note. The standardised regression coefficient for friends' active transport on ego active transport controlling for AT co-travel requests is in parentheses. All models statistically adjusted for parent encouragement, ride availability, school unit, gender, age and distance to school. * $p < .05$ ** $p < .01$, *** $p < .001$.

To further explore the role of co-travel in similarities we examined whether the self-reported behaviour of a subset of nominated friends who did not travel with the ego (*separately transporting friends*) predicted transport choices, statistically adjusting for demographics and context variables (i.e. potential secondary homophily explanations for social clustering) (see *Table 3.4*). The behaviour of friends who transported separately approached significance as a predictor of car travel (OR = 1.13, OR CI = [0.99, 1.28], $p = .062$) but did not significantly predict bus travel (OR = 1.00, OR CI = [0.90, 1.11], $p = .997$). Ego's walking was not predicted by the behaviour of friends who travelled separately (OR = 0.99, OR CI = [0.92, 1.08], $p = .852$). Interestingly, ego's cycling behaviour was significantly predicted (OR = 1.27, OR CI = [1.07, 1.50], $p = .005$). Overall, with the exception of cycling behaviour, the analysis thus supported the predictions (H5b, d–e) that friends' behaviour would not predict ego behaviour when only separately transporting friends' behaviour was considered.

Table 3.4. Logistic regression predicting odds of often walk, cycle, use car travel and use bus travel predicted by friend behaviour for separately transporting friends with covariates (not displayed)

	n	OR	OR CI	Model <i>LL</i>
Walking	795	0.99	(0.92, 1.08)	–362
Cycling	795	1.27**	(1.07, 1.50)	–156***
Car travel	795	1.13 [†]	(0.99, 1.28)	–332*
Bus travel	795	1.00	(0.90, 1.11)	–379

Note. All models statistically adjusted parent encouragement, ride availability, school unit, gender, age and distance to school. Log likelihood tests compared a model with and without friends' behaviour. * $p < .05$; ** $p < .01$; *** $p < .001$, [†] $p = .06$.

Transport sharing was common; at least one friend accompanied 59.3% of students who often walked, 37.5% of students who often cycled, 53.5% of bus travellers and 34.8% of car travellers (see the Supplementary material for Chapter 3 for further information). Whilst we

did not ask questions related to co-travel requests for bus or car trips we did assess whether participants travelled with the friends they nominated.

3.6 Discussion

3.6.1 Results interpretation

Walking, cycling, car travel and bus travel were not distributed randomly within the school community; instead transport choices were clustered, such that friends were more similar in transport choices than expected by chance. This result extends previous research noting friend similarities in smoking (e.g. Mercken, Candel, Willems, & de Vries, 2009), littering (Long et al., 2014), physical activity (de la Haye et al., 2011b) and a range of behaviours related to obesity (Burk, Vorst, Kerr, & Stattin, 2011; de la Haye, Robins, Mohr, & Wilson, 2011a). At least three high-level processes may have contributed to the clustering we found in transport behaviour; students may select friends with similar transport choices (manifest homophily), students may select friends with similar predispositions towards particular transport choices (secondary homophily or latent homophily) or friends may influence one another's transport behaviour (contagion). We discuss which of these three explanations were consistent with our results and the potential implications for programmes attempting to increase rates of active transport.

First, social clustering appears to be partly the result of people making friends with others who have similar demographic or contextual dispositions towards active transport. This was shown by friends' transport behaviour being much less predictive of ego's behaviour when demographic and context variables were included as covariates and because many of the demographic and context covariates were strongly socially clustered. Parent encouragement and distance to school were particularly predictive of transport choices, and were socially clustered. Friends were also similar in age, gender and whether they attended the schools'

language unit, but these latter factors did not predict most transport modes and thus do not appear to have contributed to observed social clustering in transport behaviour. Conversely, ride availability from family members was predictive of transport choices but did not appear to be clustered among friends and therefore did not contribute to social clustering in transport choices.

However, clustering in transport behaviour was not solely the result of secondary homophily on these factors; friends' behaviour predicted ego behaviour when these factors were included as covariates. However, relationships between ego and friends' behaviour were relatively small when these factors were controlled for. Cycling, as we will discuss later, maintained stronger associations despite the inclusion of these secondary homophily explanations.

In regards to mechanisms that may have explained contagion we found evidence that descriptive norms and active transport co-travel requests partially mediated similarities in friends' active transport behaviour. Descriptive norms (i.e. perceptions of friends' behaviour) predicted active transport and approached significance as a mediator of similarities in ego and friends' active transport behaviour. This implies that the relationship between friends' behaviour and ego behaviour may be partly dependent on people perceiving that their friends used active transport. One process that may explain this is a self-categorisation based influence. That is, young people feel like members of their friendship group and so are attracted to the behaviours that indicate group membership.

Likewise we found that active transport co-travel requests predicted active transport and mediated the relationship between ego's active transport and friends' active transport. This indicates that similarities in friends' active transport behaviour may also be partly generated by active transport co-travel requests. In other words, we find tentative evidence that active transport co-travel requests may contribute to social contagion of active transport.

The final set of analyses revealed that friends who did not travel together were similar in their cycling behaviour. For the other transport modes friend similarities were largely dependent on travelling together. There are two possible explanations for this. First, as mentioned above, friends may influence one another's behaviour primarily by getting those friends to travel with them. This explanation is consistent with Flemish adolescents' reports that interest in travelling with friends influenced their transport mode choice (Simons et al., 2013). We only assessed co-travel requests for active transport but it is possible that friends may ask each other to ride the bus with them or offer them a lift in a car and this may generate social contagion effects. However, we cannot rule out a manifest homophily explanation. Students may become friends due to opportunities to travel together, selecting other students as friends because they use the same mode of transport and can travel to school together. Similarly we cannot rule out the possibility that homophily on an unmeasured variable may be generating social clustering (i.e. latent homophily). Regardless of whether homophily or social contagion generates co-transport, travelling to and from school is clearly a social activity that is commonly shared with friends, and co-travel is an important factor in the social landscape of transport behaviour.

Friend encouragement did not appear to be involved in similarities between ego and friends' active transport behaviour. Friend encouragement did not predict ego behaviour, was not predicted by friends' behaviour nor did it mediate relationships between the two. This contrasts with previous research by Deforche et al. (2010) and Hohepa et al. (2007) which noted relationships between friend encouragement or social support and transport decisions. However these previous studies investigated encouragement of physical activity as a predictor of active transport. Relative to physical activity, active transport is likely to be a less interesting and less status-relevant subject of peer dialogue. Thus friend encouragement

for *physical activity* may have a greater influence on adolescent transport behaviour than friend encouragement for active transport per se.

Whilst friend encouragement did not predict transport choices, we found strong evidence that parent encouragement did. When parents encouraged students to travel via active transport, students were more likely to do so and less likely to travel by car or bus. It is notable that this encouragement effect still held even if participants indicated rides from family members were available, which was, unsurprisingly, a strong predictor of car travel. The fact that parent encouragement was clustered among friends and predicted transport behaviours indicates that it is likely to explain some of the similarities observed in friends' transport choices. It may be that effective encouragement of active transport leads to developing friendships with people who also use active transport. Alternatively, parent encouragement may reflect perceived safety in the immediate area or socioeconomic status, which may in turn influence transport choices and friendship development. The significant prediction of all modes by parent encouragement contrasts with studies which did not find significant relationships between active transport and parent encouragement of physical activity, parent perceptions of neighbourhood safety, or parents' own active transport (e.g. Babey, Hastert, Huang, & Brown, 2009; Deforche et al., 2010; Hohepa et al., 2007) for an exception. The greater effect of parent relative to friend encouragement also makes sense given that parents are around before school when students are making decisions about the travel journey. Together with these previous studies, our findings suggest that parent influence may be direct and targeted at transport whereas friends may motivate transport choices less directly, by encouraging fitness and health (e.g. Deforche et al., 2010; Hohepa et al., 2007).

In contrast to the other modes, friends' cycling behaviour remained strongly predictive when secondary homophily variables were accounted for and when only friends who didn't

travel together were analysed. Whilst it would be unwise to over interpret these findings given the relatively small sample size (only 72 participants often cycled) the results are consistent with prior research which indicates that cycling is the transport mode most likely to be subject to peer influence(Panter et al., 2010) noted that cycling was related to perceived encouragement from friends in UK children, albeit only from short distances to school. Further, qualitative work with avid adolescent cyclists described social interactions where they deliberately and unintentionally led to friends' adopting cycling as a means of transport to school (Orsini & O'Brien, 2006). The students interviewed in that study noted that deliberate influence on friends but not wider peers was considered socially acceptable. The robust friend effects we find in cycling behaviour corroborate the idea that friends may be an important target for cycling interventions and future research.

Overall, our results suggest a high degree of clustering in transport behaviour due to a combination of secondary homophily effects and possibly social contagion in friends' transport behaviour, particularly cycling behaviour.

3.6.2 Implications

Our findings have a number of implications for interventions. First, friendship groups should be considered in the design of transport interventions. Social clustering indicates that broad-brush attempts to reduce car use may find opposition in friendship groups where car use is common. The reverse is also possible; having friends who already use walk or cycle may support external attempts to encourage these modes. Successfully encouraging a few students to walk or cycle may have flow-on effects for that behaviour among a wider group of friends. Encouraging cycling behaviour is particularly important as cycling can be used to travel longer distances, increasing the number of people who can travel by active transport, and the range of places that can be reached without requiring the use of public or car

transport. Third, whilst distance to school and parent encouragement for active transport were not the focus of this paper, our results show they should be considered in intervention work. Parent encouragement for active transport accounted for a large amount of the variance in transport choices. Interventions targeting parent encouragement or underlying factors that may contribute to parent encouragement, such as neighbourhood safety, may help to increase rates of active transport. Where distances to school or the physical environment do not permit active transport then dual mode trips, car sharing and public transport should be important alternatives for reducing commuting-related greenhouse gas emissions.

Finally, whilst our cross-sectional questionnaire cannot establish causation, the dependence of similarities on co-transport journeys supports qualitative work (Kirby & Inchley, 2009; Orsini & O'Brien, 2006) indicating that peer walking, cycling or public transport co-travel interventions may be useful for reducing car use. For example, promoting shared travel (by walking, cycling or public transport) during “car free days” may help develop new co-sharing walking, cycling or public transport habits in places where physical climate, infrastructure and distances to school permit active or public transport. However these should be accompanied by an evaluation of the efficacy of co-travel approaches as we are unable to determine whether opportunities to share transport with friends has a causal effect on behaviour.

3.6.3 Limitations and further research

Cross-sectional data are a useful tool for the initial exploration of hypotheses about clustering and the mechanisms of friend influence underpinning any social contagion in behaviour. However, our study has a number of limitations. First, our study considers a single school in New Zealand. The generalizability of our results to other schools and other societies will depend on the pattern of barriers to different transport choices such as walking and

cycling infrastructure, climate and travelling distances, and how these correlate with processes of friendship formation and transport choices.

Second, we could not conclusively separate contagion and homophily explanations, particularly latent homophily effects. As argued by Shalizi and Thomas (2011) it may simply not be possible to claim that social contagion exists in the presence of latent homophily. There are latent homophily factors that we did not account for in this study and a range of other social influence mechanisms are possible that we did not explicitly measure in this study. For example we only asked about potential influence mechanisms specific to active transport, yet perceptions and interactions, such as co-travel, may target other transport modes, or may differ between different active transport modes. Further, the mediation analysis does not completely discriminate between homophily and social contagion explanations.

Longitudinal or intervention studies are needed to assess whether friends' behaviour, active transport co-travel requests or descriptive norms have a causal role in transport choices and determine whether behaviour similarities arise from contagion, homophily, or other secondary homophily processes that were not measured in this study. Our own research at the school involves longitudinal data collection which we hope will be able to answer some of these questions in the future.

Future research should also pay particular attention to possibilities of social contagion or influence in cycling behaviour. Cycling is relatively infrequent among adolescents in many countries (Garrard, 2009) and researchers will need to ensure their sample size contains sufficient instances of cycling behaviour to obtain statistical power.

3.6.4 Conclusion

This study provides an important first step in exploring how transport behaviours may cluster in a social network and the social predictors of transport choices to school. Our findings demonstrate that social clustering exists in transport behaviour within a New Zealand high school social network, with particularly strong clustering in cycling behaviour. Our data are consistent with the idea that descriptive norms or co-travel requests may generate contagion, however further research using longitudinal datasets is required to test whether unmeasured homophily explanations do not explain the remaining similarities in friends' transport behaviour. Cycling behaviour was consistent with stronger social contagion effects and future research should pay particular attention to the role of friendships in cycling. Finally, parent encouragement was strongly predictive of transport behaviour and may be a particularly effective target to increase rates of active transport among adolescents.

Chapter 4: Do high school friends influence each other's transport to and from school? Investigating change processes over one year

4.1 Abstract

Adolescent transport choices are important for health and the environment. These choices may be influenced by the transport choices of other people including friends via a process known as contagion. In this study we test for contagion of transport behaviour by examining whether friends' transport behaviour predicts change in adolescent transport behaviour over one year. Participants were 502 New Zealand high school students (54.5% male, aged 12-17 years, $M = 14.1$ at Time 1) who completed two questionnaires conducted one year apart. The questionnaire asked about walking, cycling, car travel and bus travel to school, as well as friendships, descriptive transport norms, friend encouragement, co-travel requests, and other possible influences including parental encouragement. The results indicated that, for males, cycling and possibly walking may be "contagious" between friends. However we found no evidence of contagion in car or bus travel and no evidence that descriptive norms, friend encouragement or co-travel requests predicted residualised change in total active transport (walking, cycling, skateboarding and scootering trips). Further, parent's encouragement of active transport predicted increases in walking behaviour indicating that parents continue to exert influence over changes in walking behaviour during adolescence.

4.2 Introduction

Active forms of transport such as walking or cycling are good for people's physical health and the health of the planet. Around a fifth (21%) of greenhouse gases produced in New Zealand and in the United States arise from household mobility which includes fuel for cars, aircraft fuel and resources used in the production of vehicles (Hertwich & Peters, 2009). When people replace car trips with walking and cycling this can reduce greenhouse gases and help to curb insufficient physical activity which is one of the top five causes of mortality globally (World Health Organisation, 2009).

In this paper we are interested in adolescent transport choices in a social network. Adolescents' transport choices predict car use during adulthood (e.g. Line et al., 2012) and are correlated with concurrent fitness (Alexander, Inchley, Todd, Currie, Cooper, & Currie, 2005; Sandercock & Ogunleye, 2012) and fitness in middle-age (X. Yang, Telama, Hirvensalo, Tammelin, Viikari, & Raitakari, 2014). Features of the physical environment such as street walkability, weather and public transport infrastructure play an important role in the transport modes people use to get from place to place (Van Acker, Van Wee, & Witlox, 2010) as do individual characteristics such as gender (Sirard & Slater, 2008), yet there is growing evidence that transport choices in adolescence and at other ages are also shaped by social factors (Willis, Manaugh, & El-Geneidy, 2015).

At least two papers have proposed that interventions to encourage pro-environmental behaviour should consider utilising peer influence (e.g. Orsini, 2006; Panter et al., 2010). Yet neither of these papers, or others we identified, demonstrated that friends or other peers are influential in transport behaviour. Orsini (2006) described a set of interventions which encouraged co-transport between peers, however the efficacy of the interventions was not evaluated. Further Panter et al. (2010) recommended enhancing parental and peer support as a way to promote active transport, yet did so by examining cross-sectional relationships

between friend encouragement and concurrent cycling behaviour. Interrelationships between these variables may arise due to unmeasured third variables, such as distance to school or being friends with other students who also cycle and thus encourage cycling behaviour.

Recent work looking at peer influence across a number of behaviours has focused on the possibility of contagion between peers connected through friendships (i.e. friends). Contagion describes a process by which individuals' behaviours influence the extent to which people they interact with engage in that behaviour. When contagion is strong, this can generate widespread uptake of that behaviour within a social network. Evidence of contagion has been noted for adolescent risk taking behaviours (Dishion & Tipsord, 2011), academic achievement (e.g. Blansky et al., 2013) and physical activity (e.g. de la Haye et al., 2011b). Assessing whether contagion occurs in transport behaviour is important because it would provide more robust evidence in favour of particular peer interventions in transport behaviour. However, assessing whether contagion occurs is challenging because it requires ruling out a number of other processes which also generate similarities in friends' behaviour.

In addition to contagion, similarities in transport behaviour may also be driven by homophily processes or shared exposure to events. Homophily is the tendency for people to preferentially make friends with people who are similar to themselves (Brechwald & Prinstein, 2011; Lazarsfeld & Merton, 1954; McPherson et al., 2001). The tendency can be divided into three types; *manifest homophily* involving friend selection on the variable of interest (in this case transport behaviour), *secondary homophily* involving friend selection on measured factors that are related to the variable of interest (such as gender in the current study) and *latent homophily* involving friend selection on unmeasured factors related to the variable of interest (Shalizi & Thomas, 2011). In the current study household income would be an example of latent homophily as we did not measure this variable but it could be related to friendship selection and influence transport choice. All three types of homophily can create

similarities in friends' behaviour that are difficult to distinguish from similarities in friends' behaviour which are due to contagion. External events that friends experience, such as attending a health promotion programme may also generate similarities in friends' behaviour (Shalizi & Thomas, 2011).

For transport behaviour, very little research has looked into the possibility of contagion of transport mode choice between friends. A cross-sectional study of a sample of New Zealand adolescents found that their transport choices were similar to their friends transport choices, a phenomenon that would be expected if students influenced each other's behaviour (Long, Harré, & Atkinson, 2015). Similarities in friends' behaviour were particularly strong for cycling behaviour. However it is unclear whether these similarities were generated by contagion as it is not possible to rule out other processes that produce patterns that resemble contagion in cross-sectional data.

4.2.1 Potential mechanisms of contagion

In addition to identifying whether contagion occurs, it is important to understand what causes people to adopt behaviours undertaken by the people they are connected to. There are a number of cognitive or communicative "mechanisms" that underpin contagion or other forms of influence⁹. First, friends' transport choices could become similar because people may conform to the behaviour they perceive is common among their friends. Similarities in behaviour could also arise because people sometimes model behaviour they observe, with or without conscious awareness of doing so (Iacoboni, 2009). Perceptions of what transport modes friends commonly use (i.e. descriptive norms) is related to concurrent transport behaviour (Emond & Handy, 2012; Long et al., 2015), which is consistent with conformity or

⁹ Contagion processes result in increased similarities in friends' behaviour yet friends' may influence students to adopt behaviours they themselves do not perform. For example, friends may promote car use through their discussions of car types or it's associations with independence but this would not generate increased similarities in their behaviour if they do not travel by car themselves.

modelling of transport behaviours. Second, friends' encouragement of active transport (i.e. transport journeys that involve physical activity, such as walking and cycling) may also promote these modes of travel. However cross-sectional evidence suggests that whilst friends' encouragement of physical activity predicted adolescents' use of active transport in some studies (Hohepa et al., 2007; Leslie, Kremer, Toumbourou, & Williams, 2010) whereas Long et al. (2015) found that friends' encouragement of active transport did not. A third possible mechanism of contagion is that a desire to spend time with friends may cause adolescents to choose the same mode of transport so they can travel together. Adolescents report that they will change transport modes so they can travel with friends (Simons et al., 2013). Further Long et al. (2015) found that students were more likely to often travel by active transport if their friends' frequently ask them to travel with them via active transport.

4.2.2 Demographic and contextual influences

Individual differences and aspects of the physical environment may also impact on transport behaviour. Active transport more common for people living close to school (Sirard & Slater, 2008) and among males (Sirard & Slater, 2008). Rates of cycling tend to be particularly low for females in countries where relatively few people cycle (Garrard, Rose, & Lo, 2008; Heesch, Sahlqvist, & Garrard, 2012). Age does not have a clear relationship with active transport - some studies have found active transport was more common among older students, and others have noted older rates among younger students (Sirard & Slater, 2008).

During childhood, parents have a key role in how their children get from place to place (Panter et al., 2008) however there is mixed evidence about the role of parents in adolescent transport choices. Parental influence may need to be focussed to be effective: parent encouragement of active transport was related to adolescent transport behaviour (Long et al., 2015) but parental encouragement of physical activity was not (Hohepa et al., 2007). The

contrast between these results may be because parent encouragement of physical activity tends to be directed towards sports-related physical activity whereas perceived encouragement of active transport is more likely to be directed to provision of logistic support and direct verbal encouragement to use active transport modes. Both of these latter studies were conducted in New Zealand, albeit in schools of different socio economic status. Unfortunately, similar to research on peer influence, this evidence relies on cross-sectional data. Thus these studies have not established whether parent encouragement of active transport actually causes more young people to ride bikes or walk. Variables such as these may confound estimates of contagion if they are influential and similar among friends unless they are accounted for in the estimation of contagion.

4.2.3 The present study

In this study we utilise repeated measures social network data to investigate first whether friends' behaviour at Time 1 predicts change in ego's (i.e. the focal individual's) transport behaviour over one year. Two waves of data were collected, one year apart, as part of a larger longitudinal study in a high school located in Auckland, New Zealand. Cross-sectional analysis of Wave 1 data is presented in Long et al. (2015).

We assess if friends' behaviour predicts change in how adolescents travel to school. We predict egos' self-reported behaviour at Time 2 from their friends' self-reported behaviour at Time 1, taking account of ego Time 1 behaviour and other variables related to the behaviour in question. Including ego Time 1 behaviour as a covariate adjusts the estimation of the relationship between Time 1 friends' behaviour and ego behaviour to account for a number of possible homophily processes that generate similarities between ego behaviour and friends' behaviour at Time 1.

The residualised change analyses are repeated for the dominant modes used to get to and from school: walking, cycling, car travel and bus travel. Variables identified as socially clustered in this school population by Long et al. (2015) and which also predicted residualised change in transport behaviour were included as covariates (parent encouragement, distance to school, gender and school language unit¹⁰). The second part of this study examines whether descriptive norms (students' perceptions of the frequency of their friends' behaviour), friend encouragement and co-travel requests for active transport predict residualised change in active transport behaviour. We assess active transport in this section set of analyses because questions about mechanisms related to active transport rather than specific modes of transport.

Based on the results of existing cross-sectional research we expect that students' transport choices are likely to become more like their friends' transport choices over time for walking (H1), cycling (H2), car travel (H3), and bus travel (H4). Further we expect that students' change in active transport will be predicted by what they perceive their friends are doing (H3a) and requests to travel together via active transport (H3b). We expect that change in active transport should not be predicted by friend encouragement of active transport but include this in order to draw comparisons with the previous literature (H3c).

4.3 Method

4.3.1 Participants

Participants were recruited from a public high school in Auckland, New Zealand.

Enrolment at the school is mostly limited to adolescents who have at least one parent living

¹⁰ We included school language unit because students tend to be friends with other people from the school language unit (Long et al., 2015) these students often live outside the school zone (i.e. further from school) and school language unit may have a unique peer culture around transport modes.

within the school “zone”. However, an indigenous language unit, which makes up approximately 15% of the student population, enrolls students from all over the city.

Questionnaires were administered on March 27 2012 and March 5 2013, during the second month of the New Zealand school year. March is in autumn (fall) in New Zealand and the weather in Auckland is typically mild at this time, hence cycling and walking are not generally hindered by weather.

School students present in class during the survey administration were invited to take part in the study. Questionnaires were returned by the majority of students enrolled at each time point (74.1% at Time 1, $n = 971$; 66.9% at Time 2, $n = 885$). Students who handed in a questionnaire but did not complete any friend nominations at Time 1 ($n = 13$), or provide an ID number needed to connect them in the social network (Time 1 $n = 24$; Time 2 $n = 17$) could not be included in the present study. Eleven students’ parents requested they did not take part.

The repeated measures analysis relied on a sample of 502 students who completed both questionnaires, including social network information at Time 1. This represents 46.4% of enrolled students in Year 10-13 at Time 2. Students in Year 9 at Time 2 did not attend the school at Time 1 and thus were not included in this study. The calculation of Time 1 friends’ behaviour utilised responses from all friends who handed in a questionnaire, regardless of whether the friends participated at Time 2 in order to minimise the impact of participant non-response on estimates of friends’ behaviour.

The repeated measures sample included slightly more males (54.5%) than females, reflecting a greater proportion of males in school enrolments (57.6% male at Time 2). The mean age of participants was 14.1 and ages ranged from 12 to 17 years at the first wave of the survey. Non-participation appeared to be related to transport scores. Completing the survey at both time points was related to greater walking and less bus travel at Time 1, relative to

students who only participated at Time 1 (see the Supplementary material for Chapter 4). Individuals with missing data were dropped from the related analysis leading to varying sample sizes for each statistical test.

4.3.2 Measures

A range of questionnaire items were asked as part of a larger programme of research. Only questions related to the present analysis are described below. All questions were asked at both Time 1 and Time 2.

Friendship information was collected by asking students to nominate up to seven close friends who attended their school and to indicate whether or not they often travelled to or from school with each friend. Transport behaviour was assessed by asking students to tick which transport mode they used for each trip to or from school in a typical week (a total of 10 journeys). Possible transport mode response options were; *Walk, Cycle, Motor scooter, Skate/scooter, Bus, Driven to school, I drive myself in a car* and *Other (please specify)*.

Likert scale items asked about active transport descriptive norms (“*My friends’ from [school name] often walk, cycle or skate to and from school*”) and active transport co-travel requests from friends (“*One or more of my friends sometimes asks me to walk, cycle or skate to or from school with them*”). We also assessed active transport encouragement from friends (e.g. “*My friends from [school name] encourage me to walk, cycle or skate to and from school*”) and from a male or female caregiver (e.g. “*My Mum (or a caregiver who acts like a mum) encourages me to walk, cycle or skate to and from school*”). Perceived encouragement from male and female caregivers was later combined to form a parent encouragement variable ($\alpha = .85$). We also assessed whether students were able to access rides from household members (“*A member of my family is able to drop me at school by car*” and “*A member of my family is able to pick me up from school by car*”). These items were rated on Likert scales ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Participants were also asked to report the street name and suburb for up to two houses they lived in during weeknights, and the number of weeknights spent in each house so that approximate distance to school could be calculated. The street number of these houses was

not collected to maintain student privacy. Students were also asked to provide their gender, age and home room number which identified whether they were enrolled in the school language unit.

4.3.3 Procedure

Students and teachers were given information sheets prior to the study and provided written consent before participating in the study. Parents were provided with an information sheet as part of the school notices and were given the opportunity to opt their children out of the study by contacting the researchers. Questionnaires took approximately 10 to 20 minutes to complete. Questionnaire completion was supervised by a classroom teacher and occasionally a university volunteer as well. Participation was encouraged by offering students the opportunity to win one of five \$20 (NZD) gift vouchers. To maintain anonymity, friend nominations were separated from the rest of the questionnaire and de-identified with ID codes before being sent to the researchers.

4.3.4 Variable construction

Distances to school were calculated using the Google Distance Matrix application based on walking routes for whichever location they identified as being their residence for three or more weeknights on a typical a week. Distance to school was measured from the middle of the listed street to the front school gate, although suburb-based street midpoints were used for long streets (1.6% of cases) and central suburb locations were used when no street name was provided. Relationships between distance and transport choices were non-linear and a log to the base 2 transformation was applied to the distance variable. A “language unit” variable identifying whether each student attended the main school or the schools’ indigenous language unit was generated from home room numbers supplied in the survey responses.

Whilst the questionnaire instructions asked students to select only one transport mode for each journey, some students ticked more than one mode per journey. In these cases we prioritised passive modes (car travel, followed by bus travel) and removed any active modes (walking followed by cycling, skateboarding and scootering) for that journey. Our rationale is that a passive mode is likely to account for most of the distance on a dual-mode journey. Walking trips which indicated that a person travelled over one hour were assumed to be errors and were recoded to zero indicating the person did not walk for that journey ($n = 13$). No participants reported a cycling, skateboarding or scootering trip that would take over one hour.

Friend nominations at Time 1 were used to construct a binary undirected friendship matrix. In an undirected friendship matrix, a friendship is identified when either individual nominates the other. We had a number of reasons for choosing a symmetric matrix rather than a matrix that specifies the direction of ties (a “symmetric matrix”) or a matrix which includes only friendship nominations that were reciprocated (“reciprocal friends matrix”). There is debate over whether reciprocated or unreciprocated ties are associated with greater influence (Brechwald & Prinstein, 2011, p.173) and unreciprocated ties could also be the result of our questionnaire limiting the number of friendship nominations to seven. For example, an alter may also consider the ego a friend but may not fall within their top seven friendships or the ego may not be recalled at the time of questionnaire completion. This means that a reciprocal friends matrix may omit important information. Likewise, a reciprocal matrix counts reciprocated friends twice, once from ego to alter and once from alter to ego. Given that evidence is equivocal about whether reciprocated friendships should be privileged, and both potentially omit or reduce the consideration of other friendships, there is little reason to adopt a directed matrix. In this study undirected friendship matrices were

developed using the *network* (Butts, 2008a), *sna* (Butts, 2007), and *igraph* (Csardi & Nepusz, 2006) packages in *R*, an open source language for statistical computing.

These matrices were used to store friendship information so that friends' behaviour could be extracted from the questionnaire responses. Similar to the network exposure models used in other papers (e.g. Fujimoto & Valente, 2012b), friends' behaviour was calculated by taking an average of friends' behaviour at Time 1 as shown in the following equation:

$$Favg_i = \frac{\sum_{j=1}^n W_{ij}y_j}{\sum W_{i>0}}$$

Where $W = a N \times N$ binary friendship matrix where $W_{ij} = 1$ indicates a friendship between i and j and $W_{ij} = 0$ no friendship, and y is an $N \times 1$ vector of attribute values.

4.3.5 Conceptual overview of contagion, homophily and residualised change models

A number of analytical methods have been used to explore questions of contagion, yet none of these methods provide an ideal solution for estimating contagion in real world settings (see Ali & Dwyer, 2010; Lyons, 2011; Robins, 2013; Snijders, 2011b). In this study a residualised change model was selected as it offered opportunities to mitigate many of the potential biases in the analysis of contagion. A residualised change model controls for Time 1 ego behaviour when predicting Time 2 ego behaviour from the Time 1 focal variable (i.e. friends' Time 1 behaviour, descriptive norms and covariates).

A logistic regression specification was used due to the binary nature of our dependent variable.

$$\ln(p/(1-p)) = y_{iT1} + Favg_{i\ T1} + \beta_1 X_{1T1} + \beta_2 X_{2T1} + \beta_3 X_{3T1} + \beta_4 X_{4T1} + \beta_5 X_{5T1} + e$$

Where p is the probability that the ego uses that transport mode at Time 2, y_{iT1} is the ego's behaviour at Time 1, $Favg_i$ is the average behaviour reported by friends at Time 1, and X_{T1} refers to the demographic and contextual covariates measured at Time 1 and e represents the error captured by the residuals.

When Time 1 friends' behaviour is the focal variable the Time 1 ego behaviour covariate effectively "controls for" shared variance between Time 1 ego behaviour and Time 1 friends' behaviour. This should control for any effects of manifest homophily (friend selection on the variable of interest) as manifest homophily would be reflected in similarities in ego and friend behaviour at Time 1. It should also control for any secondary or latent homophily processes that are influential by Time 1. For example, if friends have similar family income levels and these income levels relate to transport choices, this will account for some of the similarity in their behaviour at Time 1. By controlling for Time 1 behaviour, we therefore control for such latent homophily as well as secondary and manifest homophily processes.

It is important to point out however, that latent or secondary homophily may only become influential between Time 1 and 2 and thus will not be controlled for by accounting for Time 1 ego behaviour.¹¹ Imagine, for example, that Johnny and Jim become friends because they live in the same street. Johnny chooses to ride a bike to school because he thinks it will take too long to walk but Jim chooses to walk that distance. However a year later Jim has also decided that the distance and time taken to walk is too long and has decided to cycle instead but this decision was not influenced by Johnny's behaviour. In this case distance is similar among friends and important for the degree of change made by Jim, however the impact of distance on the change to cycling is not accounted for by controlling for ego T1 behaviour (i.e. Jim's prior walking behaviour). If distance was not included in the analyses it would (incorrectly) look like Johnny's behaviour had influenced the change. Thus, instead of simply looking at the correlation between potential covariates and Time 1 behaviour to decide which were of relevance, we used residualised change models to assess which of these potential covariates should be included. We know from the analysis included in Long et al. (2015) that

¹¹ Manifest homophily cannot become influential later because any friendship selection on the variable of interest happens prior to Time 1 otherwise the friendship could not have been nominated at Time 1.

distance, language unit attendance, age, gender and parent encouragement tend to be similar among friends at this school (i.e. they are socially clustered). These variables may potentially confound estimates of contagion if the variables also predict residualised change but are not accounted for as covariates in our analysis.

Residualised change models are also useful because they rule out shared exposure to an event as an explanation for the relationship between friends' behaviour and change in ego behaviour. Events that occur prior to Time 1 will generate similarities in ego and friend behaviour at Time 1 and thus will be statistically adjusted for by the inclusion of Time 1 ego behaviour. Events that occur between Time 1 and Time 2 cannot affect relationships between the independent variables (including friends' behaviour) and the dependent variable because the independent variables are measured at Time 1, prior to such events. Including Time 1 ego behaviour as a covariate should also account for regression to the mean effects which may otherwise bias estimates of change (Finkel, 1995).

Residualised change models are also employed to explore variables that may act as potential mechanisms of contagion (i.e. descriptive norms, friend encouragement, co-travel requests). Relationships between ego behaviour and descriptive norms, encouragement or co-travel requests could be due to the fact that people adjust their estimates of these potential mechanisms based on their own behaviour. This is particularly true of relationships between self-reported behaviour and descriptive norms because people tend to overestimate similarities between their own and others' behaviour (McPherson et al., 2001; Prinstein & Wang, 2005). The residualised change models account for this possibility because the Time 1 ego behaviour covariate should account for shared variance between ego's self-reported behaviour and variables measuring potential mechanisms of contagion¹².

¹² Time 2 behaviour cannot be projected onto (or otherwise influence) the earlier Time 1 estimates of descriptive norms, friend encouragement, co-travel requests.

Unfortunately, adjusting for similarities at Time 1 also means that these models will adjust for any concurrent impacts of Time 1 variables (whether these be friends' behaviour, mechanisms or other covariates) on Time 1 behaviour. Thus the residualised change models assess which Time 1 variables have a delayed impact on change over time but they cannot estimate the strength of any impacts of Time 1 variables on concurrent behaviour.

4.3.6 Summary of the analyses

Prior to the main analysis we used residualised change logistic regression models to assess which of the measured demographic and contextual covariates should be included in our models. The residualised change models predicted Time 2 ego behaviour from each of the potential Time 1 demographic and contextual covariates (friends' behaviour, parent encouragement, distance (logged), gender, age, school language unit), statistically adjusting for Time 1 ego behaviour in each regression. These analyses were repeated for each main transport mode (walking, cycling, car travel and bus travel).

The first part of the analysis used residualised change logistic regression models to predict Time 2 ego behaviour from Time 1 friends' behaviour, statistically adjusting for Time 1 ego behaviour as well as Time 1 demographic and contextual covariates that predicted change in at least one transport mode. These analyses were repeated for each main transport mode (walking, cycling, car travel and bus travel). We include covariates that predicted change in other transport modes for consistency across the analysis of each transport mode. In the second part we assessed whether the potential mechanisms of contagion (descriptive norms, co-travel requests and friend encouragement) measured at Time 1 predicted Time 2 ego active transport behaviour, adjusting for Time 1 ego behaviour and Time 1 demographic and contextual covariates that predicted change in at least one transport mode.

Standard errors and significance estimates may be biased by non-independence of friends' scores if friends are influencing each other's behaviour. To correct for this we applied a robust sandwich variance estimator (Heagerty et al., 2002; Lumley & Hamblett, 2003) to the standard errors of the residualised change regressions. This estimator adjusts the covariance matrix used to calculate the standard errors based on similarities between friends' scores and assumes all other participants are independent (Heagerty et al., 2002; Lumley & Hamblett, 2003). Confidence intervals for the odds ratios and p values of each parameter were calculated based on these standard errors. Typical methods of model fit comparison such as AIC estimate degrees of freedom based on the number of participants and thus are likely to overestimate model fit if friends' scores are not independent. Likelihood ratio tests do not include the number of participants and therefore these were chosen as a more suitable method to assess whether including friends' behaviour or mechanisms variables improved model fit relative to an equivalent baseline model without this term (i.e. Time 2 ego behaviour from Time 1 ego behaviour and covariates). Moran's I tests for relationships between the residuals of the regression revealed that no significant clustering remained in the error of the models, with the exception of the model predicting bus transport ($I = .076, p = 0.015$), suggesting that the coefficients of this model may be biased by spatial clustering not accounted for in the model terms.

Post-hoc analyses used to explore the results of the main analysis are outlined in the following section.

4.4 Results

4.4.1 Common transport choices

As shown in Table 4.1, walking was the most common form of transport at Time 2 (49.1% often walked), followed by bus travel (25.3%), car travel (15.3%), cycling (6.1%).

The transport breakdown of the four main modes was similar at Time 1. The percentages do not add up to 100 because some participants travelled by two modes five times per week, used other modes, did not use any mode at least five times a week or did not provide complete transport mode information.

Female participants were more likely than male participants to walk (55.6% of female participants' walked vs 43.7% of males, $W = 33452.5$, $p = .008$) and male participants were more likely that girls to cycle (9.3% or males cycled vs 2.2% of females, $W = 27764.5$, $p = .001$). However the number of male participants and female participants using a form of active transport, travelling by car or travelling by bus five or more times per week was no different (see *Table 4.1*).

Table 4.1. Proportion of Time 2 participants using each transport mode five or more trips a week at Time 2 and Wilcoxon sign ranked test of gender differences

	All students	Test of gender differences			
		Male	Female	Wilcoxon value (W)	<i>p</i>
Walking	49.1%	43.7%	55.6%	33452.5	0.008
Cycling	6.1%	9.3%	2.2%	27764.5	0.001
Car travel	15.3%	14.2%	16.6%	30603	0.460
Bus travel	25.3%	26.1%	24.2%	29313	0.629
Total active transport ^a	56.0%	54.9%	57.4%	30643.5	0.572

^a Active transport is calculated from a total of walking, cycling, skate boarding and scootering trips

4.4.2 Investigating potential covariates

We first assessed which of the demographic and contextual variables predicted residualised change in ego behaviour (i.e. which potential covariates impacted on the degree of change beyond their impact on Time 1 behaviour). Table 4.2 presents the results of 20 separate residualised change regressions. Each regression predicted the frequency of either walking, cycling, car travel, bus travel and active transport at Time 2 from ego's frequency

of that mode at Time 1 and one of; Time 1 parent encouragement, distance (logged), gender, age (years) or school language unit.

Demographic and contextual variables predicted the odds of often performing some transport modes at Time 2. Students whose parents encouraged them to walk or cycle to school at Time 1 were more likely to often walk at Time 2 (OR = 1.35, OR CI = [1.11, 1.65], $p = 0.003$) and were less likely to often travel by car at Time 2 (OR = 0.82, OR CI = [0.67, 1.00], $p = 0.048$) over time. Living further from school was related to higher probability of often travelling by bus at Time 2 (OR = 1.68, OR CI = [1.26, 2.24], $p = 0.0004$) and a lower probability of walking to school (OR = 0.69, OR CI = [0.50, 0.94], $p = 0.20$). Being male strongly predicted Time 2 cycling behaviour (OR = 4.14, OR CI = [2.26, 7.57], $p < .0001$). Attending the school language unit predicted lower odds of often walking at Time 2 (OR = 0.11, OR CI = [0.04, 0.30], $p < .0001$, and higher odds of often using a bus at Time 2 (OR = 3.75, OR CI = [1.48, 9.54], $p = 0.005$). Age was not related to residualised change in any transport mode. The full coefficient output for each regression is provided in the Supplementary material for Chapter 4.

Table 4.2. Odds ratios (OR) from separate residualised change regressions predicting Time 2 binary transport scores from demographic and contextual variables, statistically adjusting for Time 1 ego behaviour

Time 1 independent variable	Walk OR	Cycle OR	Car OR	Bus OR
1. Parent encouragement	1.35**	1.08	0.90	0.82*
2. Distance (logged)	0.69*	0.64	1.17	1.68***
3. Gender	0.80	4.14***	0.61	1.18
4. Age (years)	0.93	0.90	1.06	1.06
5. School language unit	0.11***	1.05	2.08	3.75**

Note. Intercept values for each regression are omitted from the table * $p < .05$; ** $p < .01$; *** $p < .001$
^a Friends' behaviour on the dependent variable listed in the column heading (i.e. walking, cycling, car travel and bus travel)

4.4.3 Friends' Time 1 behaviour as a predictor of residualised change in transport modes

Friends' Time 1 walking behaviour significantly predicted the probability of often walking at Time 2 (OR = 1.18, OR CI = [1.07, 1.3], $p = 0.001$). When other variables were not taken into account, an average of one extra day of walking by friends at Time 1 was associated with an 18% increase in the odds of often walking at Time 2, statistically adjusting for Time 1 ego walking behaviour. Whilst the odds ratio for friends' cycling was high, friends' behaviour did not significantly predict the probability of often cycling at Time 1 (OR = 1.24, OR CI = [0.95, 1.62], $p = 0.117$). Friends' behaviour also did not predict residualised change in ego car travel and bus travel (see Table 4.3).

Table 4.3. Odds ratios (OR) from separate residualised change regressions predicting Time 2 binary transport scores from friends' Time 1 behaviour, statistically adjusting for Time 1 ego behaviour

	Walk	Cycle	Car	Bus
Time 1 independent variable	OR	OR	OR	OR
Friends' behaviour	1.18**	1.24	1.04	1.16

Note. Intercept values are omitted from this table. * $p < .05$; ** $p < .01$; *** $p < .001$
^a Friends' behaviour on the dependent variable listed in the column heading (i.e. walking, cycling, car travel and bus travel).

The relationships between friends' behaviour and residualised change presented in Table 4.3 may be the result of correlations between friends' behaviour and other variables which predicted residualised change (i.e. these variables may represent secondary homophily

processes generating similarities in friends' behaviour). Thus to assess the unique effects of friends' behaviour on change, we repeat models predicting residualised change in each transport mode (i.e. Time 2 behaviour, adjusting for Time 1 behaviour) from friends' Time 1 behaviour, this time including all Time 1 demographic and contextual covariates related to residualised change in at least one transport mode so that the analyses would be comparable between transport modes.

Table 4.4 and Table 4.5 show the results from residualised change analysis predicting the frequency of either walking, cycling, car travel, bus travel and active transport at Time 2 from Time 1 ego behaviour frequency of that mode, Time 1 friends' behaviour and statistically adjusting for Time 1 parent encouragement, distance (logged), gender, age (years) and school language unit.

Showing some support for H1, friends' Time 1 walking behaviour approached significance as a predictor of the odds of the ego often walking at Time 2 (OR = 1.10, OR CI = [0.99, 1.23], $p = .067$), although we found no evidence of a difference in fit relative to a model with only the covariates ($LL\ covariates\ with\ friends'\ walking = -174.7$, $LL\ covariates\ only = -176.0$, $\chi^2 [1, N = 442] = 2.56$, $p = .110$).

Consistent with H2, friends' Time 1 cycling behaviour was predictive of Time 2 ego cycling behaviour. Time 1 friends' behaviour predicted the odds of ego often cycling at Time 2 when the models statistically adjusted for the effects of Time 1 ego behaviour and parent encouragement, distance, gender and school language unit (OR = 1.30, OR CI = [1.03, 1.64], $p = .025$, see Table 4.4). The odds ratio of 1.30 indicates that each day that friends cycled at Time 1, on average, is associated with a 30% increase in the odds of often cycling at Time 2. However the inclusion of friends' cycling behaviour only marginally improved the fit of the overall model relative to a model with only the covariates ($LL\ covariates\ with\ friends'\ cycling = -51.7$, $LL\ covariates\ only = -53.2$, $\chi^2 [1, N = 442] = 3.13$, $p = .077$).

Contrary to predictions H3 and H4, friends' Time 1 behaviour was not predictive of the odds of the ego often travelling by car (OR = .98, OR CI = [0.79,1.20], $p = .810$) or bus at Time 2 (OR = 1.08, OR CI = [0.89, 1.31], $p = .462$, see Table 4.5).

Table 4.4. Logistic regression predicting Time 2 walking and cycling from Time 1 friends' behaviour and covariates, statistically adjusting for Time 1 ego behaviour (n =442, 442)

	Walking			Cycling		
	OR	OR CI	<i>P</i>	OR	OR CI	<i>p</i>
Intercept	0.04	(0.01, 0.18)	<.0001	0.01	(0.00, 0.13)	0.001
Friends' behaviour	1.10	(0.99, 1.23)	0.066	1.30	(1.03, 1.64)	0.025
Time 1 ego behaviour	1.42	(1.31, 1.54)	<.0001	1.59	(1.40, 1.82)	<.0001
Parent encouragement	1.34	(1.08, 1.65)	0.007	1.04	(0.62, 1.73)	0.893
Distance (logged)	0.88	(0.63, 1.23)	0.440	0.64	(0.33, 1.24)	0.189
Gender (male)	0.89	(0.51, 1.54)	0.673	4.94	(2.71, 9.02)	<.0001
School language unit	0.25	(0.08, 0.80)	0.019	1.49	(0.53, 4.18)	0.450
Model <i>LL</i>			-175			-51.7 [†]

Note. Log likelihood tests compared the log likelihood of a model with and without friends' behaviour. * $p < .05$; ** $p < .01$; *** $p < .001$, [†] $p = 0.077$

^a Friends' behaviour on the dependent variable listed in the column heading (i.e. walking, cycling)

Table 4.5. Logistic regression predicting Time 2 car and bus travel from Time 1 friends' behaviour and covariates, statistically adjusting for Time 1 ego behaviour (n = 442, 442)

	Car travel			Bus travel		
	OR	OR CI	<i>p</i>	OR	OR CI	<i>p</i>
Intercept	0.10	(0.02, 0.48)	0.004	0.04	(0.01, 0.20)	<.0001
Friends' behaviour	0.98	(0.79, 1.20)	0.810	1.08	(0.89, 1.31)	0.426
Time 1 ego behaviour	1.46	(1.33, 1.62)	<.0001	1.51	(1.37, 1.67)	<.0001
Parent encouragement	0.94	(0.75, 1.18)	0.605	0.91	(0.74, 1.13)	0.405
Distance (logged)	0.99	(0.65, 1.53)	0.981	1.43	(1.02, 2.03)	0.041
Gender (male)	0.64	(0.37, 1.11)	0.109	1.35	(0.69, 2.66)	0.385
School language unit	2.20	(0.90, 5.34)	0.082	1.80	(0.61, 5.35)	0.290
Model <i>LL</i>			-140			-133

Note. Log likelihood tests compared a model with and without friends' behaviour. * $p < .05$; ** $p < .01$; *** $p < .001$

^a Friends' behaviour on the dependent variable listed in the column heading (i.e. car travel, bus travel)

The fact that friends' Time 1 cycling behaviour was not predictive of Time 2 ego cycling behaviour when other Time 1 covariates were not included (see Table 4.2) indicates that one of the covariates included in the second analysis is suppressing part of the variance in friends' cycling that is not related to Time 2 ego cycling. A re-analysis of the model predicting Time 2 cycling behaviour which excluded gender, found that friends' cycling behaviour was no longer significant¹³, indicating that gender is likely to be a suppressor variable (see the Supplementary material for Chapter 4). Adjusting for gender makes it possible to detect the relationship between friends' Time 1 cycling behaviour and Time 2 ego cycling behaviour. By controlling for gender we are able to remove the variation accounted for by gender from the variation explained by friends' behaviour.

Due to the apparent suppressor relationship caused by gender, we reanalysed the main results separately for female and male participants across all transport modes. Friends' Time 1 cycling behaviour was a strong predictor of Time 2 ego cycling behaviour for male participants. For male participants friends' cycling behaviour predicted a 40% increase in the odds of the ego cycling at Time 2 (OR = 1.40, OR CI = (1.11, 1.76), $p = .005$, see Table 4.6). There was also a significant improvement in model fit when friends cycling was added to a model predicting male participants cycling at Time 2, statistically adjusting for other covariates (*Log likelihood (LL) of a model with covariates and friends' behaviour predicting cycling among males* = -43.9, *LL covariates only* = -46.0, $\chi^2 [1, N = 244] = 4.08, p = .043$).

Similarly, male friends' Time 1 walking behaviour was a significant predictor of the odds that the ego often walked at Time 2 (OR = 1.17, OR CI = (1.02, 1.35), $p = 0.026$, see *Table*

¹³ Removing other covariates did not alter the significance of friends' Time 1 cycling behaviour.

4.6). There was also a marginally significant improvement in model fit when friends' Time 1 walking behaviour was added to the model predicting the odds of often cycling at Time 2 for males (LL of a model with covariates and friends' behaviour predicting walking among males = -108.8, LL covariates only = -110.7, χ^2 [1, N = 244] = 3.83, $p = .050$).

For female participants, friends' Time 1 behaviour was not associated with the odds of using any transport mode at Time 2 (see Table 4.6). Models predicting the relationship between friends' Time 1 cycling and the odds of the ego cycling at Time 2 did not converge, likely because cycling was too uncommon among female participants (only five female participants cycled at Time 2). The low rate of cycling among female participants is also likely to produce the suppressor effect which drives the non-significant cycling relationship in models where gender is not accounted for.

For bus and car travel, friends' Time 1 behaviour was not a significant predictor of Time 2 ego behaviour for male or female participants (see Table 4.6 and Table 4.7).

Table 4.6. Logistic regression predicting male participants' Time 2 walking, cycling, car travel and bus travel from Time 1 friends' behaviour statistically adjusting for Time 1 ego behaviour, parent encouragement, school language unit and distance (n = 244)

	Walking			Cycling			Car travel			Bus travel		
	OR	OR CI	<i>p</i>	OR	OR CI	<i>p</i>	OR	OR CI	<i>p</i>	OR	OR CI	<i>p</i>
Intercept	0.04	(0.01, 0.20)	0.0002	0.05	(0.00, 0.69)	0.026	0.03	(0.00, 0.26)	0.002	0.13	(0.02, 0.79)	0.027
Friends' behaviour	1.17	(1.02, 1.34)	0.027	1.40	(1.11, 1.76)	0.005	0.99	(0.76, 1.29)	0.947	1.06	(0.82, 1.39)	0.644
Time 1 ego behaviour	1.37	(1.25, 1.50)	<.0001	1.54	(1.34, 1.77)	<.0001	1.44	(1.26, 1.64)	<.0001	1.45	(1.29, 1.64)	<.0001
Parent encouragement	1.28	(1.00, 1.65)	0.050	0.98	(0.61, 1.58)	0.930	1.09	(0.81, 1.47)	0.564	0.78	(0.60, 1.00)	0.053
Distance (logged)	0.89	(0.62, 1.27)	0.516	0.58	(0.30, 1.14)	0.117	1.23	(0.64, 2.37)	0.527	1.55	(1.04, 2.31)	0.031
School language unit	0.50	(0.16, 1.60)	0.245	1.84	(0.67, 5.07)	0.237	1.16	(0.29, 4.65)	0.838	1.90	(0.69, 5.19)	0.212
Model <i>LL</i>			-109 [†]			-43.9*			-74.3			-77.9

Note. Log likelihood tests compared a model with and without friends' behaviour * $p < .05$; ** $p < .01$; *** $p < .001$, [†] $p = .051$

Table 4.7. Logistic regression predicting female participants' Time 2 walking, cycling, car travel and bus travel from Time 1 friends' behaviour statistically adjusting for Time 1 ego behaviour, parent encouragement, school language unit and distance (n = 198)

	Walking			Cycling			Car travel			Bus travel		
	OR	OR CI	<i>p</i>	OR	OR CI	<i>p</i>	OR	OR CI	<i>p</i>	OR	OR CI	<i>p</i>
Intercept	0.04	(0.00, 0.62)	0.022	0.33	(0.04, 2.74)	0.303	0.01	(0.00, 0.08)	<.0001	0.02	(0.00, 0.49)	0.017
Friends' behaviour	0.99	(0.84, 1.17)	0.916	0.97	(0.71, 1.32)	0.830	1.12	(0.89, 1.41)	0.345	1.01	(0.85, 1.22)	0.878
Time 1 ego behaviour	1.54	(1.32, 1.81)	<.0001	1.55	(1.32, 1.83)	<.0001	1.68	(1.42, 2.00)	<.0001	1.68	(1.39, 2.02)	<.0001
Parent encouragement	1.37	(0.94, 2.00)	0.103	0.78	(0.55, 1.11)	0.164	1.18	(0.84, 1.67)	0.341	1.28	(0.84, 1.96)	0.253
Distance (logged)	0.93	(0.49, 1.77)	0.833	0.70	(0.41, 1.21)	0.202	1.34	(0.65, 2.77)	0.432	1.15	(0.61, 2.20)	0.664
School language unit	0.07	(0.01, 0.29)	0.000	4.99	(1.89, 13.18)	0.001	2.12	(0.18, 24.53)	0.547	0.07	(0.01, 0.32)	0.001
Model <i>LL</i>			-63.4			-63.1			-52.5			-58

Note. Log likelihood tests compared a model with and without friends' behaviour. None of the change in model LL were significant.

4.4.4 Potential mechanisms of contagion

Questionnaire items assessing potential mechanisms of contagion did not ask about walking or cycling separately, therefore it was necessary to calculate total active transport by summing all active transport modes reported by each participant (walking, cycling, skateboarding and scootering) at the relevant time points.

Table 4.8 shows the results of residualised change analysis predicting active transport at Time 2 from Time 1 ego active transport, either descriptive norms, friend encouragement or co-transport requests, statistically adjusting for Time 1 parent encouragement, distance (logged), gender, age (years) and school language unit.

Perceptions of friends' behaviour, as measured by our Time 1 descriptive norms variable did not significantly predict the odds of the ego often using active transport at Time 2, statistically adjusting for ego Time 1 behaviour, parent encouragement, distance, gender and school language unit (OR = 0.88, OR CI = [0.69, 1.12], $p = .316$), contrary to H5a. Including descriptive norms alongside Time 1 ego behaviour and Time 1 demographic and contextual covariates did not improve the model fit (*LL of a model with covariates and descriptive norms predicting active transport* = -165.7, *LL covariates only* = -166.4, $\chi^2 [1, N = 441] = 1.18, p = .277$).

Requests from friends to travel together via active transport was a marginally significant predictor of reduced odds of the ego often using active transport at Time 2 (OR = 0.82, OR CI = [.66, 1.02], $p = 0.082$), contrary to H5b which predicted that requests would be related to increased odds of often using active transport. Change in model fit relative to a model without requests approached significance (*LL of a model with covariates and co-travel requests predicting active transport* = -162.8, *LL covariates only* = -164.7, $\chi^2 [1, N = 441] = 3.86, p = .050$).

Consistent with H5c, perceived encouragement from friends to use active transport was not a significant predictor of Time 2 ego active transport (OR = 0.84, OR CI = [0.68, 1.04], $p = .108$). Change in model fit with the inclusion of friend encouragement approached significance (LL of a model with covariates and friend encouragement predicting active transport = -165.2, LL covariates only = -166.8, $\chi^2 [1, N = 440] = 3.10, p = .078$) indicating that this term captures aspects of Time 2 ego active transport not explained by the other covariates.

A reanalysis for males and females separately did not alter the conclusions regarding these mechanisms. The odds associated with all the cognitive covariates trended in a negative direction but none approached significance.

Table 4.8. Logistic regression predicting Time 2 active transport from Time 1 descriptive norms, co-travel requests or friend encouragement statistically adjusting for Time 1 ego behaviour and covariates (n = 439, 441, 440)

	Descriptive norms			Co-travel requests			Friend encouragement		
	OR	OR CI	<i>p</i>	OR	OR CI	<i>p</i>	OR	OR CI	<i>p</i>
Intercept	0.10	(0.02, 0.57)	0.010	0.11	(0.02, 0.51)	0.005	0.07	(0.02, 0.33)	0.001
Friends' behaviour a	0.88	(0.69, 1.12)	0.316	0.82	(0.66, 1.02)	0.082	0.84	(0.68, 1.04)	0.108
Time 1 ego behaviour	1.48	(1.33, 1.63)	<.0001	1.48	(1.33, 1.66)	<.0001	1.47	(1.33, 1.63)	<.0001
Parent encouragement	1.30	(1.04, 1.62)	0.020	1.37	(1.10, 1.70)	0.005	1.39	(1.09, 1.77)	0.008
Distance (logged)	0.91	(0.62, 1.33)	0.612	0.85	(0.59, 1.24)	0.410	0.92	(0.63, 1.34)	0.660
Gender (male)	1.33	(0.75, 2.37)	0.327	1.26	(0.71, 2.22)	0.428	1.30	(0.73, 2.30)	0.371
School language unit	0.29	(0.08, 0.96)	0.043	0.28	(0.07, 1.08)	0.065	0.27	(0.07, 0.95)	0.042
Model <i>LL</i>			-166			-163*			-165 [†]

Note. Log likelihood tests compared a model with and without the cognitive mechanism. * $p < .05$; ** $p < .01$; *** $p < .001$, [†] $p = 0.078$

^aThe influence mechanism listed in the column heading (i.e. descriptive norms, co-travel requests, friend encouragement)

4.5 Discussion

This paper set out to investigate whether friends' behaviour predicts change in how adolescents' travel to school. Previous work showed that friends' transport choices predicted concurrent walking, cycling, car travel and bus travel frequency (J. Long et al. 2015). However, similarities amongst friends may be the result of homophily or shared experiences. Therefore in this paper we assess if individuals change over time to become more like their friends and we attempted to eliminate likely sources of homophily to focus on contagion. We have done this by using repeated measures data, with Time 1 ego behaviour and other covariates that should allow us to account for homophily-related shared variance between the variables and friends' behaviour.

The repeated measures analysis revealed that having a group of friends who cycled more frequently at Time 1 predicted increases on students' cycling the following year. This finding is consistent with the possibility that cycling behaviour is "contagious" between friends. Specifically, the more common cycling was among close friends the greater the likelihood that those individuals would cycle more frequently the following year. The strength of the relationship was relatively strong; each additional day in friends' average cycling behaviour was related to a 30% increase in the odds of often cycling, accounting for the students' prior behaviour. However the change in model fit was only marginally significant so we cannot conclude that friends' behaviour explained additional variance beyond the baseline model.

Further exploration of the data indicated that friends' cycling was predictive of change for male participants but not female participants. When change in male participants' cycling was analysed separately, each additional day in friends' average cycling behaviour was associated with a 40% increase in the odds of often cycling to school at Time 2. At this school, cycling is far more common among males (9.3% of males cycled vs 2.2% of females at Time 2).

consistent with low rates of cycling among females in other studies (Garrard et al., 2008; Heesch et al., 2012). The low rates of cycling among female participants means that it is unlikely that contagion had successfully promoted cycling among these students. However we were unable to explicitly confirm the absence of contagion due to the low rates of cycling. A lack of fit between female identities and cycling may act as a barrier both to cycling and contagion in cycling behaviour among female students. Steinbach, Green, Datta, and Edwards (2011) noted that in London cycling aligns better with a male than female identity due to the visibility of cycling behaviour among males, and the physical exertion and constraints on clothing options which make cycling an unattractive option for females. Another possible explanation for the lack of contagion in females behaviour is that girls' transport behaviour is more affected by safety concerns (Beecham & Wood, 2014; Garrard et al., 2008; Schintler, Root, & Button, 2000).

As with cycling, friends' walking predicted change in male students' walking, but not change in females'. However the change in model fit was only marginally significant suggesting that the significant coefficient effect does not demonstrate additional value of friends behaviour but may be due to the way that variance is assigned to these terms in the model fitting process. Further the size of the odds ratio was much weaker than for cycling behaviour, consistent with the weak or non-significant relationships between friend's behaviour or encouragement noted in other studies (Long et al., 2015; Panter et al., 2010),

In relation to gender, the lack of possible contagion amongst girls for walking may be the result of the impact of safety concerns on change in female transport choices. Alternatively it may be a side-effect of the gendered pattern of cycling behaviour which may make transport choices socially relevant among male students, facilitating greater opportunity for influencing these students' transport behaviour.

Evidence indicative of contagion did not extend to bus and car travel. These modes may be more determined by distance and logistical constraints leaving less opportunity for friends to influence participation in these modes. Given that friends' car and bus travel did not even approach significance as a predictor of change in these modes, cross-sectional similarities in bus and car travel noted in Long et al. (2015) are likely to be due to manifest homophily (students selecting friends that use the same mode), secondary homophily (students selecting friends that live close to them) or latent homophily (students selecting friends with unmeasured predispositions towards the transport modes). It is also possible that the similarities are the product of concurrent influence of friends' behaviour on car and travel behaviour which were not able to be captured by residualised change models used in this paper.

Contagion is only one possible way to consider influence between friends' and even when it is present it happens through more specific mechanisms of contagion. Long et al. (2015) found that perceptions of friends' behaviour and requests to travel together via active transport predicted concurrent active transport, however the repeated measures analysis in this study provided no evidence that these variables predicted change in behaviour. In this study, co-travel requests and friend encouragement approached significance as negative predictors of change in active transport. At first glance this is puzzling. However it may be that students who do not walk or cycle are more often encouraged to do so or invited to do so by their friends, as those who do walk or cycle are not perceived by their friends to need encouragement. Invitations to travel together at Time 1 may turn sharing car travel at Time 2 if one of the friends' gets access to a car. It is also important to note that our mechanism questions asked about 'active transport', combining walking and cycling, but influence towards walking is unlikely to impact on cycling and vice versa. If we asked about these separately we may have identified influence specific to each behaviour.

A number of other mechanisms that were not accounted for in the present model may underpin contagion in male participants' cycling behaviour. As alluded to previously, cycling behaviour may become part of the identity of the friendship group and in turn generate self-categorisation motivated conformity. Social categorisation theory predicts that people are motivated to conform to group identity out of a desire to enhance the groups' positive distinctiveness by pursuing group uniformity in this behaviour. Conforming to identity-related group norms should in turn increase their own self-esteem related to membership of that group (Abrams et al., 1990; Tajfel & Turner, 1986; Turner et al., 1987). Second, being friends with students who cycle may generate conversations which emphasise the benefits of cycling and may in turn help to initiate or sustain this behaviour. It is possible, but less likely that walking is a strong conversational point. A study of eco-reps in university halls of residence Bloodhart et al. (2013) suggested that conversations may be an important part of any contagion of pro-environmental behaviour. Identity-related and communication mechanisms may also help to explain gendered differences in the contagion of behaviour. For example it is possible that conversations or identity mechanisms only tend to occur within male friendship groups. Further research is needed to investigate both potential mechanisms underpinning contagion and the origins of gendered differences in contagion of transport behaviour.

Whilst not a key focus of the present study, parent encouragement for active transport predicted change in walking behaviour but not changes in other transport modes. This extends the results of prior cross-sectional studies which found that parent encouragement for active transport is correlated with transport behaviour (Long et al., 2015). However parent encouragement did not predict change in cycling, car travel or bus travel. This suggests that cross-sectional relationships noted in Long et al. (2015) are likely to represent non-causal relationships or causal effects that were not detectable in this study. Whilst we control for

distance to school it is also possible that parent encouragement reflects how easy it is to walk or cycle from the students' home or the affordability of other forms of transport for that household.

Change in bus travel was weakly predicted by longer distances to school but none of the other demographic and contextual covariates predicted change in bus travel. School language unit was (negatively) predictive of change in walking, possibly because it captures impacts of distance not perfectly captured by the log of distance measure. Alternatively it may be predictive of walking because peer culture around transport may operate at the level of the school language unit and continue to effect change over time. Other variables may have a relatively constant impact on change in behaviour, which would explain why they were not predictive of residualised change. Our models only identified variables as significant if they had a delayed effect above and beyond any effect they had on concurrent behaviour.

4.5.1 Implications and limitations

Our results indicate that male participants' transport choices are likely to be influenced by the transport choices of friends. This is consistent with general findings from qualitative studies that friends are important for transport choices (Simons et al., 2013) and the general proposition that friends' and peer relationships could be utilised to encourage active transport behaviour (e.g. Orsini, 2006; Panter et al., 2010). Our results extend earlier findings by quantifying the effect size using a more rigorous repeated-measures design that adjusts for many instances of homophily and by identifying that contagion effects may differ between male and female students.

Our results indicate that interventions promoting cycling behaviour in a small group of students at this school may lead to increases in the cycling behaviour of immediate male friends. It is also possible that encouraging walking in a small group of students may generate

change in the walking behaviour of their male friends however our results were tentative regarding the possibilities of contagion in walking behaviour. Our results suggest that flow-on effects occurred when the common behaviour in a group is altered, however it is also possible that a single friend's behaviour may be sufficient to motivate change however this was not specifically tested in this paper. Our results indicate that motivating bus or car travel in a group of students at this school is unlikely to have implications for changes in their friends' behaviour over the following year.

Friends are not the only source of social influence on transport behaviour. For walking, parent encouragement was a useful predictor of change and may be an important component of interventions attempting to encourage walking behaviour. The wider peer group, media figures, teachers, siblings and other people could also impact on transport behaviour, but their influence was not examined in this study.

The results also suggest that the gendered nature of transport behaviour should be considered in interventions seeking to increase transport behaviour. It was unclear whether peer interventions will be successful with female students if the overall rate of cycling behaviour was higher among this group. Previous research suggests that safety (Beecham & Wood, 2014; Garrard et al., 2008; Schintler et al., 2000) and identity barriers (Steinbach et al., 2011) may limit cycling behaviour among females, and addressing identity or safety barriers may be a more useful target for increasing cycling to school behaviour among female students.

These implications need to be interpreted in the context of the key study limitations. First, our analysis attempted to account for manifest, secondary and latent homophily, common external causation and regression to the mean. However it is impossible to completely account for homophily confounds (Shalizi & Thomas, 2011) particularly if unmeasured variables influence change to a greater extent than they influence initial scores. Our analysis

does not account for instances where unmeasured variables that are similar among friends (latent homophily variables) and impact on change in transport more than they impact on Time 1 transport behaviour. For example, latent homophily on socio-economic status would not be accounted for by a residualised change model if socio-economic status had a greater impact on how transport behaviour changes between time-points relative to its impact on transport behaviour at Time 1. Further, it is likely that ego behaviour impacts on friends' behaviour as well as vice versa therefore endogeneity between these variables may have also biased our estimates of odds ratios. Nonetheless we could not identify a suitable model that accounted for endogeneity and could also predict residualised change with a binary dependent variable.

Our findings may also be the result of error in the estimation of individual behaviour at Time 1. Individual behaviour may vary slightly from week to week and thus change models may capture some of this error. An average of friends' behaviour is less likely to be affected by this variation. Participants were asked to record their behaviour on a typical week which reduces the likelihood that this form of bias affected our results. Model fitting processes may be associated with shared variance between ego and friends' behaviour on the coefficient of interest therefore our odds ratios may overestimate the strength of the relationship between ego and friends' behaviour. This also means that the significant change in model fit was critical to concluding that our results are consistent with contagion of cycling behaviour for male students and indicate that the results are only tentative for walking behaviour among male students.

Other aspects of the methodology may mean that our results are relatively conservative estimates. The analysis only had the ability to detect lagged effects which meant that it would not detect relationships between any variables which only acted simultaneously. Friends' behaviour, descriptive norms and co-travel requests were all related to concurrent behaviour

(Long et al., 2015) therefore it is possible that these had a causal effect on simultaneous behaviour. Unfortunately we cannot directly test for a simultaneous causal effect given the inability to isolate causal processes with cross-sectional data. In addition, change was assessed over a relatively short time period (one year) and the friends' behaviour was measured rather crudely using an average of nominated friends. Dropout from the survey was associated with less walking and more bus travel at Time 1 which may also generate conservative estimates through restriction of range.

Finally, data was collected from a single school. Many students at this school lived close enough to use active transport, the weather is typically mild enough to travel outdoors and the surrounding area was relatively safe. Where the physical environment, distance from school or climate prohibit walking or cycling we would not expect friends' behaviour to necessarily be influential. Rates of cycling among females were very low at this school and it is possible that there may be greater opportunities for contagion in cycling behaviour between female students if the overall rate of cycling among female students is higher.

4.5.2 Conclusion

This study provides a unique test of friend influence on adolescent transport behaviour utilising repeated measures social network data. The use of a residualised change model means that the relationships observed are unlikely to be the result of selecting friends or environments that match transport preferences. Thus this study provided an important extension on existing cross-sectional studies. Our results tentatively indicate that increasing cycling behaviour in a subset of students may have flow on effects for the cycling behaviour of their male friends and parent encouragement for active transport may also be a useful target for increasing walking behaviour.

Chapter 5: Understanding change in recycling and littering behavior across a school social network

5.1.1 Publication reference

Please note that this chapter has been published as the following article: Long, J., Harré, N., & Atkinson, Q. D. (2014). Understanding change in recycling and littering behavior across a school social network. *American Journal of Community Psychology*, 53(3-4), 462-474. This paper is included in this thesis with kind permission from Springer Science+Business Media B.V.

The text is identical to its published format, with the exception of adjustments to the numbering of title, figure and table headings and the use of italics. Given that the paper was published prior to the completion of the other chapters in this thesis it contains a number of terms which are synonyms of those used in other chapters. The synonyms are as follows: friend selection (homophily in other chapters), conditional change (residualised change in other chapters) and undirected matrix (symmetric matrix in other chapters) and influence (referred to as contagion in other chapters when it describes influence that leads to greater similarities in behaviour). This chapter is also written using American spelling due to the American focus of the journal in which the text was published.

5.2 *Abstract*

Understanding how communities change requires examining how individuals' beliefs and behaviors are shaped by those around them. This paper investigates behavior change across a large social network following a recycling intervention in a New Zealand high school community. We used a mixed methods design, combining focus group data with social network analysis from two waves of a questionnaire that measured friendship networks; recycling and littering behaviors; perceived behavioral norms; and teacher, friend, and parent encouragement for these behaviors. Recycling behavior increased significantly over the course of our study. Supporting the importance of social networks in this context, both littering and recycling behavior showed clear social clustering. Further, the degree of change in an individuals' littering and recycling behavior across time was predicted by friends' prior behavior. Focus group data provided insight into students' perceptions of social interactions and how these contributed to littering and recycling behavior.

5.3 *Introduction*

Social relationships and interpersonal influence shape communities and behavior in complex ways. Social network analysis is a promising approach that helps us to understand this complexity (Foster-Fishman & Behrens, 2007; Luke, 2005; Trickett, 1996, 2009). In doing so, social network analysis can inform interventions and their evaluation (Gest, Osgood, Feinberg, Bierman, & Moody, 2011; Hawe, Shiell, & Riley, 2009; Luke, 2005) and align empirical work with ecological and systems conceptualizations of communities (Luke, 2005; Trickett, 2009). Among adolescents, school friendships are known to be an important socialization force (Brechwald & Prinstein, 2011). Longitudinal social network data indicates that school friends are influential across a spectrum of health, academic and antisocial behaviors (Brechwald & Prinstein, 2011; Dishion & Tipsord, 2011; Salvy et al., 2012) but little is known about the role of these friendships in behavior with implications for environmental issues.

The current study uses a longitudinal design to investigate the relationship between friendship ties and littering and recycling behavior in a school community. We also take advantage of a whole-of-school recycling intervention to investigate the role of social influence in behavior change following the intervention.

The intervention aimed to reduce waste going to landfill by 50% over the course of a year. This was done through the implementation of visible, clearly marked “waste stations” for separating landfill, recycling and compost. These replaced a system of multiple bins complemented with a small number of waste stations that allowed for waste streaming but were not clearly labelled. Information about waste and the new system was provided through school notices, assembly presentations, posters, and through information sessions for staff. The new system was launched with a week of class quizzes, prize draws for students correctly using the bins, and waste sorting competitions. School staff and students were

periodically informed of progress towards the waste reduction target and student leaders were involved in running litter clean-ups and other activities. Of interest to this study, we assessed if responsiveness to the intervention, measured by increases in recycling, was influenced by the pre-intervention behavior of an individual's friends.

5.3.1 Literature review

Relationships with friends are considered particularly important during adolescence and may impact on behavior in a number of ways (Brechwald & Prinstein, 2011). Observing other people provides cues about the relative utility of behaviors in novel settings (Cialdini et al., 1990; Denrell, 2008) and creates opportunities for imitation (Cialdini et al., 1990). Social modelling, social rewards, punishment and vicarious reinforcement via observational learning may cause individuals to adopt new behaviors (Social learning theory: Bandura, 1977). Peer-related social motivations for behavior are particularly strong in adolescence (Brechwald & Prinstein, 2011) and may be most relevant in school playground settings where friends and other students are highly salient. To develop effective peer leadership strategies it is important to understand how behaviors spread and are maintained in the target situation. For example, is observing the behavior of others sufficient to encourage behavior change, or are more active forms of influence involved? Unfortunately, little is known about how social influence occurs among adolescents due to researchers' focus on outcomes of the influence process (Brown et al., 2008).

Existing research suggests that what others are doing (descriptive norms) and what they consider morally appropriate (injunctive norms) are relevant to littering and recycling behavior (Cialdini et al., 1990; Kallgren et al., 2000; White & Hyde, 2011). For example, manipulating the amount of litter in an area increases the proportion of people who drop litter in this same area (Cialdini et al., 1990). However studies of littering and recycling norms

have generally been conducted with adults in controlled field experiments and little is known about how such norms operate with adolescents in the complexity of everyday social life (see Mason, Conrey, & Smith, 2007 for a similar argument regarding the failure to consider real world complexity in other social influence scenarios). For example, an individual may be exposed to competing norms from a variety of sources. This includes peers (Harris, 1995), and parents who continue to have substantial influence on attitudes and behavior inside and outside the home (Collins, Maccoby, Steinberg, Hetherington, & Bornstein, 2000). Teachers are also an important socialisation force in educational behavior, motivations and outcomes (Wentzel, 1998) and assume some responsibility over students' behavioural conduct during school. The complexities of how each of these groups influence individuals cannot be captured in field or laboratory experiments.

It is also possible that people actively set out to influence one another's littering and recycling behavior, in order to improve in-group homogeneity or to facilitate positive environmental outcomes. This can be through peer pressure, aggressive behaviors such as teasing and bullying, praising others for existing behaviors, and through setting up opportunities that encourage a particular behavior (Brechwald & Prinstein, 2011; Brown et al., 2008).

Another consideration is that the actual behavior of one's peers and other influential people may not be completely aligned to the perceived behaviour of these individuals. For example, people often overestimate the similarity between their own and the group's behavior (Brechwald & Prinstein, 2011; Prinstein & Wang, 2005). Further, it is not necessarily the case that normative behavior needs to be understood as such in order for it to be influential. That is, an individual may not perceive a particular behavior as normative, but may still conform to the behavior, possibly through direct mimicry that by-passes conscious awareness (Cialdini & Goldstein, 2004). Thus descriptive norms (what others are doing) and

perceived norms (what others are judged to be doing) are not necessarily completely aligned. In the current study we measure what individuals are doing via their self-reports but also measure what our participants perceive their peers to be doing, to ascertain which is the more influential.

Essentially, social network analysis provides a social “map” that shows how attributes and behavior are distributed within a particular community in relation to the relationships between members. Recent studies reveal similarities or “clustering” in physical activity (Macdonald-Wallis, Jago, Page, Brockman, & Thompson, 2011), weight (de la Haye, Robins, Mohr, & Wilson, 2010), drinking and smoking behavior (Fujimoto & Valente, 2012b). Demographics such as ethnicity, gender and age have also been shown to cluster socially (McPherson et al., 2001).

Three key processes may generate social clustering. The first, social influence, occurs when one person’s behavior influences the behavior of others, such as through conformity or imitation processes (Marsden & Friedkin, 1993). Research indicates that social influence contributes to friend similarities in physical activity (de la Haye et al., 2011b); smoking behavior (Mercken, Steglich, Sinclair, Holliday, & Moore, 2012) and a variety of behaviors related to obesity (Ali, Amialchuk, & Heiland, 2011). Secondly, social clustering may arise by selecting friends with similar attributes (friend selection or “homophily”). Thirdly, social clustering occurs as a result of friends being exposed to similar physical or social contexts (see Manski, 1993; Shalizi & Thomas, 2011). For example, a group of friends may be exposed to a teacher’s enthusiasm for recycling, which influences their behavior simultaneously, and in doing so contributes to social clustering.

5.3.2 The current study

Teasing apart the influence from friend selection and shared social or physical contexts is difficult but crucial for understanding how other's behavior shapes beliefs and behavior. In this study we attempt to account for friend selection or shared contextual factors using conditional change models (i.e. Finkel, 1995). We predict an individual's Time 2 behavior from the average of their friends' behavior at Time 1, statistically adjusting for that individual's Time 1 behavior. We adopt the term "ego" commonly used in social network analysis to refer to the focal individual of an analysis. Time 1 ego behavior should portion out the effects of relationships between friend and ego behavior that are attributable to shared contextual factors, at least at the starting point. Similarly, Time 1 ego behavior should account for friend selection on this behavior. A number of alternative approaches have been used in an attempt to differentiate social influence from friend selection and shared physical and social contexts however even the most sophisticated of these have their weaknesses (see Ali & Dwyer, 2010; Lyons, 2011; Robins, 2013; Snijders, 2011a). Questions in our survey included perceived encouragement from parents, which provided an opportunity to check whether the results may be explained by influence from home contexts. We also controlled for teacher encouragement by checking whether friends were exposed to similar teachers' influence, as teacher encouragement could have led to clustering in the target behaviors. We also included measures of perceived norms and perceived encouragement to see if these were influential in any behavior change over time.

We combine quantitative analysis with qualitative research to help understand the processes underlying social influence. Qualitative research allows us to consider salient aspects of the wider context (i.e., local culture, physical resources) which may impact on social interactions and behavior (Trickett, 1996). We chose a focus group format as this allows participants to interact with each other as well as the moderator, thus generating accounts that are more representative of everyday conversation than individual interviews

(Wilkinson, 2004). Given that conversations may be an important part of interpersonal influence we believe that additional insight into these conversations is useful for intervention development.

This paper focuses on five research questions. First, does self-reported recycling and littering and ratings of the social context (e.g. friend encouragement, teacher encouragement, and perceived norms) change over time? Given the recycling intervention in the school, we predict that recycling behavior will increase from Time 1 (T1) to Time 2 (T2) (Hypothesis 1.1). We contrast this with littering which was not targeted by the intervention and should not change (H1.2). We predict that ratings of the social context of recycling will change (H1.3) in response to the recycling intervention. By contrast, perceived littering norms, encouragement related to littering and ratings of social encouragement for both behaviors outside of the school (i.e. parent encouragement of recycling) should not change (H1.4).

Second, we assess whether personal littering and recycling behavior, perceptions of others' recycling and littering (i.e. perceived norms) and encouragement cluster among friendship groups. We expect clustering only with regard to personal behavior and the perceived norms and encouragement of friends at both time periods (H2.1-2.5). There should be less, if any, clustering in perceived norms regarding the broader school community or parent or teacher encouragement (H2.6).

Third, we investigate whether T1 friends' behavior predicts change in an individual's behavior from T1 to T2. Central to questions of social influence we hypothesize this will be the case for both target behaviors (H3.1, H3.2). Fourth, we investigate whether friend encouragement and perceived norms at T1 predicts change in an individual's behavior from T1 to T2. We predict that T1 friend encouragement and perceived friend norms will predict T2 recycling behavior (H4.1, 4.2) and littering behavior (H4.3, 4.4). We did not measure friend encouragement for littering so we used recycling encouragement as a proxy for this in

the analyses, on the assumption that discouraging litter and encouraging recycling are likely to co-occur. Finally, we use focus groups to assess what social interactions students perceive as influencing their littering and recycling behavior and how these interactions may vary within the school social context.

5.4 Method

5.4.1 Participants

Participants were students at a state funded school in a relatively affluent area of Auckland, New Zealand. All students present in the weekly administration period were invited to take part. The majority of students agreed to participate (74.1% of enrolled students in Time 1 ($n = 971$) and 66.2% of enrolled students in Time 2 ($n = 854$). Students were excluded from the analysis if they did not provide any friend nominations (T1 $n = 13$; T2 $n = 20$) or the ID number needed to link them into the social network (T1 $n = 24$; T2 $n = 25$). The final social network dataset included 934 students in Time 1 (71% of enrolled school population) and 809 in Time 2 (62.7% of enrolled school population). Slightly more males (T1 = 54.5%, T2 = 55.6%) than females took part, consistent with school demographics (57.9% male). The mean age was 14.7 (T1) and 15.0 (T2), ages range from 12 to 19 years. Longitudinal analysis relied on a sample of 622 students that completed both questionnaires including social network information at least at Time 1. Individuals with missing data were dropped from the related analysis leading to varying sample sizes for each statistical test.

Comparisons of school enrolment in March relative to the longitudinal social network sample of 622 students revealed differences in the school year composition ($\chi^2 = 13.9$, $df = 4$, $p = 0.008$) and ethnicity ($\chi^2 = 14.89$, $df = 6$, $p = 0.021$) and marginally significant differences in gender composition ($\chi^2 = 3.19$, $df = 1$, $p = 0.074$) relative to the enrolled school population in September. A greater proportion of girls, younger students and slightly more indigenous or

Māori and ‘Other’ ethnicity students participated in the longitudinal sample relative to the enrolled school population at Time 2. Welch’s two sample t-tests revealed higher littering and lower recycling scores on average for students who completed only the Time 1 questionnaire (‘T1 only’) compared to those who completed both questionnaires (‘T1&T2’) (Littering $M_{T1\text{only}} = 2.51$, $M_{T1\&T2} = 2.20$, $t(528.9) = 3.56$, $p = 0.0004$; Recycling $M_{T1\text{only}} = 4.75$, $M_{T1\&T2} = 5.07$, $t(563.1) = -2.55$, $p = 0.011$).

Questionnaire participants provided informed consent prior to the completion of each questionnaire and parents of students under 16 years old were given the opportunity to opt their child out of the study. To maintain anonymity, friend nominations were separated from the rest of the questionnaire and de-identified with ID codes before being sent to the researchers. Students were offered the chance to win one of five \$20 (NZD) gift vouchers to encourage participation.

We sought a range of perspectives in the focus groups. Senior management were asked to nominate reliable students who were representative of different groups in the school, including some students who were enthusiastic about protecting the environment. For one focus group (“student leaders”), students involved in the environmental leadership program were specifically recruited. Parents provided consent where focus group participants were under 16 and all students gave personal consent. The age of focus group participants ranged from 13 to 18 ($M = 15.2$ years) and 52% were male. The project was approved by the University of Auckland Human Participants’ Ethics committee.

5.4.2 Measures

The questionnaire included a number of items as part of a larger project on sustainability. Only the items of interest to the current study will be presented here.

Recycling and littering behavior was assessed through agreement with the following statements “*I litter (e.g., leave rubbish on the ground)*” and “*I put my bottles and cans into the school recycling bins*”. As a measure of each student’s perceived recycling norms among their friends, we asked about the perceived frequency of friends’ recycling behavior - “*My friends put their bottles and cans into the school recycling bins*”. Similar questions were used to measure perceived school norms around recycling and perceived friend and school norms for littering but substituting “*My friends...*” with “[*School name*] *students...*”. Self-reported behavior and perceptions of others’ behavior was collected on Likert scales ranging from 1 (never) to 7 (always). Encouragement to recycle from each student’s friends, teachers, mother and father (or people who act in these roles) was assessed through items such as “*My friends encourage me to put my bottles and cans in the recycling*”. Encouragement questions were rated on Likert scales ranging from 1 (strongly disagree) to 7 (strongly agree). Encouragement from mother and from father was combined to form a parent encouragement variable ($\alpha = .79$ at Time 1; $\alpha = .88$ at Time 2). Where the student only answered for one parent, this was taken as the parent encouragement score. Except for parent encouragement, all measures were single items to minimize participant fatigue and allow time for questions related to the wider research project. Encouragement for littering was not measured. Students were also asked to report their school year level, age, gender and ethnicity.

Social network information was obtained by asking students to “*Please name [School name] students who are your close friends. You do not have to fill in all the spaces but we are providing space just in case anyone has this many close friends*”. Seven spaces were provided for names. A fixed choice free recall was considered most appropriate for this study given time restrictions and the large number of potential names to nominate (the school had over 1200 students). Similar friend nomination approaches have been used previously (e.g., Poulin, Kiesner, Pedersen, & Dishion, 2011). We focused on close friends because positive

close relationships have been found to be most influential in a number of behaviors (Brechwald & Prinstein, 2001) and we did not want to limit our analysis to “best friends” as we suspected that influence was related to group norms not just the behavior of their most important friend.

5.4.3 Procedure

Questionnaire completion was conducted in an administration-orientated form class (analogous to the “home room” class in the United States) and supervised by a teacher. In some cases a university research assistant was also present. Students took between 10 and 15 minutes to complete the questionnaire. The Time 1 questionnaire was conducted in week nine of the school year (March) and the Time 2 questionnaire in week 28 (September). The waste intervention was launched in week 21 (end of May).

We assembled nine focus groups, arranging students by gender and age (junior students vs senior students). Our aim was to ensure that opinions of boys and girls and younger and older students were represented in the data and to minimize reactivity or power differentials within the groups. Student leaders met in a separate focus group as we suspected that other participants would defer to their opinions.

Focus groups were conducted in a quiet room on the school property during lunch time and lasted between 35 and 50 minutes. The first author moderated the focus groups and later transcribed audio-recordings verbatim. Participants were informed that there were no right or wrong answers, answers were confidential and that it was “OK” to disagree with others. Participants were also asked to respect what everyone had to say. A range of questions related to environmentalism were asked as part of the wider research program. Relevant to this paper, students were asked why people litter, whether there are groups that litter and towards the end of the focus group were prompted with the question “Is your waste behavior affected

by your friends? If so, how?" to gather specific instances of behavior that may not have previously been mentioned.

Sections of the transcripts relevant to littering and recycling were analyzed using thematic analysis procedures outlined in Braun and Clarke (2006, 2012) focusing on the realities, meaning and experiences of littering and recycling for a range of students at this school. A parallel pairwise sampling scheme was used (c.f. Onwuegbuzie & Leech, 2007); all cases were compared to all others as we did not have confidence in achieving saturated themes or differences within gender or age. The first author and a graduate student coded all the transcripts using NVivo research software (QSR International, 2012) then discussed and agreed on points of difference to increase the rigor of the coding and coding framework. The second author also reviewed the transcripts. Items were assigned codes based on the literal (explicit) meaning of the participants' comments rather than on possible underlying concepts (c.f. Braun & Clarke, 2006), consistent with the realist assumptions of the quantitative analysis. Coded items were grouped into three key themes relating to (1) *observing their friends and other students' waste behavior*, (2) *direct verbal requests* and (3) *facilitators and barriers to peer influence*. Data saturation appeared to be achieved; a post-analysis check confirmed that 91% of the final themes and subthemes were present in the first two focus group transcripts. A reflexive journal was used to reflect on biases introduced during the focus group moderation and to examine emerging codes and themes against preconceived ideas.

5.4.1 Analysis

Paired sample two-tailed t-tests and Cohen's D scores were used to assess the average change in littering and recycling behavior, perceived friend and school behavior and social encouragement between Time 1 and Time 2. Paired sample t-tests do not account for reduced

variability in responses due to non-independence amongst friends' scores. Caution is therefore necessary when interpreting any p values that are close to $p = .05$ (i.e. $05 < p < .01$).

To reconstruct the social network we first created an "edge list" of de-identified friendship nominations and then converted this to an undirected binary friendship matrix specifying a friendship link where either individual nominated the other. The friendship network could be constructed in other ways, such as only considering reciprocal friendships. Here we consider all friend nominations in order to increase the number of friends in each individual's friend average scores. In a reciprocal friend matrix, each participant would have an average of 2.2 friends, which we suspect is not enough to capture overall friend behavior. The full undirected matrix contains 5.6 nominations per individual, on average. This provides a more realistic measure of an individual's social environment, as well as increasing statistical reliability of the friend average scores. Further, missing reciprocity may be the result of limiting the number of friends each participant could nominate. For example, one individual may overlook or fail to recall the other party or they may not quite fall within their top circle of friends. Other studies utilise undirected social network matrices for similar sets of reasons (e.g. Wölfer et al., 2012). Social network data manipulation was undertaken using a combination of the *network* (Butts, 2008b) and *igraph* (Csardi & Nepusz, 2006) packages in *R*, an open source language for statistical computing.

Using the social network data, we tested social clustering in behavior, perceived norms and encouragement using a Moran's *I* statistic (Moran, 1950). Moran's *I* statistics test whether the similarity in scores between neighboring points in the network (friend links) is greater than would be expected based on the variance in the overall sample (Cliff & Ord, 1981). If individuals' scores are completely clustered, Moran's *I* values will be 1, 0 at random and -1 if completely dispersed. Moran's *I* statistics were implemented through the *R* package *spdep* (Bivand, 2011) using Monte Carlo simulations to assess significance through

permutation tests (5000 simulations). Based on the network exposure model applied in Fujimoto and Valente (2012b) we averaged the scores of nominated friends to produce an average friend behavior score for each participant. Gaussian form generalized linear regressions were fitted using the iteratively reweighted least squares (IWLS) algorithm. We used a two wave conditional change design (i.e. Finkel, 1995) predicting Time 2 behavior from average friend behavior, controlling for an individual's Time 1 behavior and other covariates to assess whether friends' behavior at Time 1 predicts individual change in littering or recycling, consistent with a model of social influence. Perceived norms of friend recycling behavior frequency and friend encouragement for recycling were assessed as predictors of change in littering and recycling. This process was repeated for littering behavior using perceived friend norms about littering and friend encouragement for recycling (because friend encouragement for littering was not measured). The recycling dependent variable was square transformed to correct for non-normality.

The non-independence of behavior influenced by others in a social network potentially biases standard error estimates (Heagerty et al., 2002) and can therefore invalidate the results of standard regression techniques. To overcome this problem, we calculated robust sandwich variance estimators for the standard errors of regression coefficients, according to the procedure described in Lumley and Hamblett (2003). Standard errors are adjusted to account for the non-independence of nominated friends at Time 1. All pairs of individuals who did not specify one another as friends are assumed to be independent. This robust sandwich variance estimator is similar to those used in generalized estimating equations (GEE: Liang & Zeger, 1986) and is suitable when non-independence is sparse but complex in structure (Lumley & Hamblett, 2003), as is the case for our social network data. In these situations GEE and hierarchical linear modeling methods are not possible due to the overlapping nature of friendship clusters.

5.5 Results

Question 1: Did recycling and littering behaviors, perceived norms or encouragement change over time?

Paired sample t-tests displayed in Table 5.1 revealed that self-reported recycling increased ($d = .39, t(598) = -9.45, p < .0001$) but littering did not change ($d = .02, t(612) = -0.45, p = .65$), consistent with hypotheses H1.1 and H1.2. The Cohen's D score of 0.39 can be interpreted as a small-medium difference in recycling behavior between Time 1 (T1) and Time 2 (T2). Likewise, consistent with H1.3, perceived norms of friend and school recycling behavior increased between T1 and T2 ($d = .36, t(598) = -8.72, p < .0001$; $d = .30, t(597) = -7.40, p < .0001$) as did perceived encouragement from friends and teachers ($d = .24, t(602) = -5.76, p < .0001$; $d = .21, t(600) = -5.23, p < .0001$). As predicted in H1.4 there was no change in parent encouragement of recycling ($d = .01, t(556) = 0.30, p = 0.77$) and perceived norms of friend and school littering behavior ($d = .02, t(608) = .76, p = .45$; $d = .03, t(603) = -.40, p = .69$).

Table 5.1. Comparison of littering and recycling behavior, norms and encouragement from others between Time 1 and Time 2

	Mean (SD)		<i>d</i>	<i>n</i>	<i>t</i>	t test	
	Time 1	Time 2				<i>df</i>	<i>p</i>
Personal littering	2.30 (1.20)	2.28 (1.27)	0.02	612	-0.45	611	0.65
Friend perceived norms littering	3.29 (1.39)	3.24 (1.39)	0.03	609	0.76	608	0.45
School perceived norms littering	4.12 (1.24)	4.10 (1.23)	0.02	604	-0.40	603	0.69
Personal recycling	4.96 (1.73)	5.68 (1.51)	0.39	598	-9.45	597	<.0001
Friend perceived norms recycling	4.56 (1.48)	5.21 (1.37)	0.36	599	-8.72	598	<.0001
School perceived norms recycling	4.25 (1.22)	4.68 (1.11)	0.30	598	-7.40	597	<.0001
Friends encourage recycling	3.89 (1.67)	4.27 (1.64)	0.24	602	-5.76	601	<.0001
Teachers encourage recycling	4.84 (1.65)	5.28 (1.51)	0.21	600	-5.23	599	<.0001

Parents encourage recycling	5.48 (1.39)	5.48 (1.34)	0.01	556	0.30	555	0.77
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Question 2: Were recycling and littering behaviors and perceived norms or encouragement clustered among friendship groups?

Consistent with predictions H2.1 and H2.2, Moran’s *I* statistics indicate that recycling and littering behavior were clustered at T1 and T2 (see Table 5.2). Direct comparisons of Moran’s *I* values are not advisable as they are affected by the topology of the social network and the distribution of the variables. Nevertheless, *p*-values indicate that recycling may have become more clustered post intervention. Moran’s *I* statistics in Table 5.2 also reveal strong clustering in perceived norms of friends’ littering and recycling behavior and in recycling encouragement, consistent with H2.3 - 2.5. Hypothesis H2.6 was partially supported; perceived school littering was only clustered at T2 and perceived school recycling was not clustered at either time point. Teacher and parent encouragement for recycling were weakly clustered, slightly more so at T2.

Socially clustered parent or teacher encouragement may generate social clustering in friend’s behavior. However in the following regression analyses these did not alter the conclusions regarding friends’ average behavior and thus we present analyses without these variables to reduce duplication.

Table 5.2. Moran’s *I* clustering in reported behavior, norms and encouragement from others at Time 1 and Time 2

	Time 1			Time 2		
	<i>n</i>	<i>I</i>	<i>p</i>	<i>n</i>	<i>I</i>	<i>p</i>
Personal littering	905	0.19	0.0002	785	0.13	0.0002
Perceived friend norms littering	902	0.16	0.0002	783	0.16	0.0002
Perceived school norms littering	898	0.08	0.0002	778	0.02	0.22
Personal recycling	891	0.05	0.02	779	0.11	0.0002

Perceived friend norms recycling	888	0.10	0.0002	778	0.12	0.0002
Perceived school norms recycling	891	0.02	0.22	777	0.03	0.10
Friends encourage recycling	890	0.09	0.0002	780	0.16	0.0002
Teachers encourage recycling	887	0.04	0.03	780	0.06	0.007
Parents encourage recycling	831	0.05	0.02	739	0.08	0.002

Note. This table contains all students available at either time point and the n values are thus greater than the longitudinal sample of 622 students used for analyses in the other tables.

Question 3: Did friends' behavior predict change in individual behavior?

Consistent with prediction H3.1, friends' T1 average recycling behavior was a significant predictor of residualized (squared) change in T2 recycling scores when statistically adjusting for gender and school year ($\beta = 1.76$, $SE = .63$, $p = .005$) and remained significant when T1 perceived friend recycling norms or friend encouragement for recycling were entered (Models 2 and 3, Table 5.3). In other words, a one unit increment in friends' average T1 recycling score was related to a 1.33 unit increment in ego's T2 recycling score beyond what would be expected based on ego T1 scores, gender and school year (Model 1, Table 5.3).

Table 5.3. Friends' independent reports of recycling behavior, perceived friend norms and friend encouragement at T1 as predictors of T2 ego recycling behavior (n = 587)

	Model 1			Model 2			Model 3		
	β	SE	p	β	SE	p	β	SE	p
Intercept	8.60	4.32	0.05	7.78	4.46	0.08	6.74	4.32	0.12
T1 recycling	2.73	0.37	<.0001	2.41	0.49	<.0001	2.49	0.38	<.0001
Gender (female)	2.93	1.06	0.006	2.86	1.07	0.008	2.37	1.06	0.03
School Year 10	1.36	1.82	0.46	1.40	1.83	0.44	1.59	1.8	0.38
School Year 11	2.32	1.89	0.22	2.35	1.89	0.22	2.70	1.88	0.15
School Year 12	5.49	1.61	0.001	5.61	1.63	0.001	5.69	1.6	0.0004
School Year 13	6.97	1.75	<.0001	7.09	1.77	<.0001	7.11	1.75	<.0001
T1 friend recycling (independently reported)	1.76	0.63	0.005	1.72	0.61	0.005	1.73	0.62	0.006
T1 perceived friend norms recycling	-	-	-	0.56	0.5	0.26	-	-	-
T1 friend encouragement for recycling	-	-	-	-	-	-	0.84	0.32	0.009
AIC			4626.8			4627.5			4622.3
LL			-2304			-2303.8			-2301.2* ^a

Note. Likelihood ratio tests found no evidence that Models 2 fit better than Model 1.

^a This log likelihood was significantly different from the log likelihood of Model 1, $\chi^2(1) = 6.47$, $p = .011$.

Consistent with hypothesis H3.2, friends' T1 littering behavior, was a significant predictor of residualized change in T2 littering scores when statistically adjusting for gender and school year (Model 1, Table 5.4) and remained significant when T1 perceived friend littering norms or friend encouragement for recycling were entered (Models 2 and 3, Table 5.4). In other words, a one unit increment in friends' average T1 littering score was related to a .21 unit change in ego's T2 littering score beyond what would be expected based on ego Time 1 scores, gender and school year (Model 1, Table 5.4).

Table 5.4. Friends' independent reports of littering behavior, perceived friend norms and friend encouragement (for recycling) at T1 as predictors of T2 littering behavior (n = 600)

	Model 1			Model 2			Model 3		
	β	SE	p	β	SE	p	β	SE	p
Intercept	0.75	0.15	<.0001	0.66	0.15	<.0001	0.81	0.23	0.0005
T1 littering	0.48	0.05	<.0001	0.46	0.06	<.0001	0.48	0.05	<.0001
Gender (female)	-0.23	0.09	0.01	-0.21	0.09	0.02	-0.22	0.09	0.02
School Year 10	0.02	0.12	0.85	0.00	0.11	0.97	0.02	0.12	0.88
School Year 11	0.12	0.13	0.34	0.11	0.12	0.38	0.11	0.12	0.36
School Year 12	0.14	0.14	0.32	0.12	0.15	0.40	0.14	0.14	0.33
School Year 13	-0.09	0.15	0.55	-0.09	0.15	0.53	-0.09	0.15	0.54
T1 friend littering (independently reported)	0.21	0.07	0.002	0.20	0.07	0.004	0.21	0.07	0.003
T1 perceived friend norms littering	-	-	-	0.05	0.04	0.23	-	-	-
T1 friend encouragement for recycling	-	-	-	-	-	-	-0.01	0.03	0.594
AIC	1713.6			1713.3			1715.3		
LL	-847.8			-846.6			-847.6		

Note. Likelihood ratio tests found no evidence that Models 2 or 3 fit better than Model 1.

Question 4: Does friend encouragement or perceived norms predict change in behavior over time?

Perceived recycling encouragement from friends at T1 was a significant predictor of residualized (squared) T2 recycling behavior when statistically adjusting for gender, school year and friend's average behavior, relating to a .92 unit residualized change in recycling after accounting for other covariates, consistent with H4.1. Perceived norms of friends' recycling behavior at T1 was not a significant predictor of residualized (squared) T2 recycling behavior, nor did it improve model fit (Model 2, Table 5.3), in contrast to H4.1, 4.2.

Perceived friend littering norms and recycling encouragement at T1 were not predictive of residualized change in T2 littering when statistically adjusting for gender, school year and friend's average T1 behavior (see Table 5.3), contrary to H4.3, 4.4.

The conclusions regarding the prediction of T2 littering or recycling by friends' T1 behavior were the same when gender or school year were not included in the models.

Question 5: What interpersonal interactions and social factors do students perceive as influencing their littering and recycling behavior and how do these factors differ within the school social context?

Theme 1: Observing friends and peers waste behavior. Participants in all nine focus groups gave descriptions of noticing friends' or peers' littering or recycling. For example Charmaine comments that *"I will recycle but I think within my group there are people like, if they don't see someone else recycling they'll be like, "aw nah that's ok I'll just leave it on the ground this time"* (Focus group; Senior Girls). In six focus groups participants explicitly discussed that this probably provided a model for others to follow. Here Jayden confesses how it affects his own behavior: *"Well I saw other people doing it and it made sense, it's like oh it's just going to bio, you know degrade and it's just going to help the trees there, so"* (Focus group; Senior Boys 3).

Theme 2: Direct verbal requests. A second theme, labeled direct verbal requests, was noticed in two thirds of the focus groups. Requests to place rubbish in the bin were commonly described in response to questions about whether friends' influence their waste behavior or vice versa. Examples include: "You see someone else littering, you're like "bro, bro, that's not cool, put it in the bin" (Focus group; Senior Boys 3) and "If someone drops it on the ground like generally someone will be like 'hey what are you doing' and like make them pick it up" (Focus group; Senior Girls 1). These and other comments suggested that some individuals actively try to influence their friends' behavior, although this was not universal across all groups. Some of the verbal requests bordered on antagonistic; five students from four focus groups referred to mocking, teasing, bullying or shouting behaviors in their attempts to influence waste behavior.

Theme 3: Facilitators and barriers to peer influence. It was clear from most focus groups that peer influence was not universally positive, accepted, attended to or successful. Some focus group participants described a range of successful and unsuccessful attempts at influencing friends' behavior. For students at this school, campaigning for positive waste behavior runs the risk of being seen as "uncool" or being mocked by friends. Successful positive influence was described as more likely from a committed and respected individual, between immediate friends and when the group culture was otherwise supportive of positive waste behavior.

The focus groups suggested that active friend influence is *limited to immediate friendship groups and immediate surroundings*. Four focus groups indicated that telling people off who were not in their immediate friend group or cleaning up litter from other areas of the school was likely to be looked down upon, even by students such as Charlotte who had previously expressed frustration at her friends' littering behavior.

Beth: It's like you're not one of those people who just sees a piece of rubbish or sees someone drop rubbish, runs over, picks it up, puts it in the bin. You like, if it's like one of your best friends you like, joke around about it and then actually put it in the bin, but, if you just see rubbish you're not going to pick it up. Like but you care about it but you're...

Charlotte: Like I probably wouldn't go yelling at every person on the street who drops, (group laughter), like I'm not really like one of those people, I'm not going to follow them round (laughs)

Focus group; Junior Girls 1

While litter clean-ups may be imposed by the school this does not filter through into most students' idea of reasonable or socially appropriate behavior. That participants perceived friendship groups as the limit of influence may also help to explain why friends' tend to have similar waste behavior. In two thirds of the focus groups participants referred to particular aspects of their own friendship group or other friendship groups which helped to differentiate their waste behavior from that of others, often in response to questions about whether friendship groups differ in their waste behavior.

Moderator: So is your waste behavior affected by your friends?

Grant: Ummm, aw like, ahhh, yeah I guess, if I'm with, it depends on what friends I'm with if I'm with some friends they'd be like "aw, put that in the bin" or something

Moderator: And other friends aren't?

Grant: Yeah, other friends are just like, "chuck it"

Focus group; Senior Boys 2

These strong anti or pro-littering group norms may have an impact on the success of influence attempts by those that do not agree with the group norm. For example, Shaun describes unsuccessful attempts to change the behavior of his friends:

William: Wait do you guys sit over there?

Shaun: Yeah

William: That's the messiest place!

Shaun: I'm the only one there who's like "guys pick up your.. " and they're like "yeeehaaa YOLO¹⁴!" (waves arms as if throwing a bottle away)

Focus group; Senior Boys 3

Finally, having *a respected person who is willing to promote recycling* may also encourage positive waste behavior. Two thirds of the focus groups named people in waste-related leadership positions or other committed individuals that they noticed making a particular effort to encourage others to use the bins correctly. Nonetheless, only a couple were noted as being particularly effective at changing behavior "*[student name] is pretty well liked and she was super encouraging because she kinda gets into it I guess everyone started picking up rubbish*" (Focus Group: Senior Girls 1). These students are part of the environmental leadership group and were described as being both committed to waste reduction and well respected by their friends or peers.

In summary, focus group participants felt that other people's behavior and direct requests to put rubbish in the bin helped to shape immediate friends' waste behavior, particularly around littering. Respected role models and a supportive friend group norm could assist successful positive social influence. Throughout the focus groups, most comments referred to littering rather than using the bins to stream their waste correctly despite moderator questions referring to "waste behavior" or both littering and recycling.

¹⁴ YOLO stands for "You only live once" and has a similar meaning to the phrase Carpe diem.

5.6 Discussion

As expected, there was a positive change in self-reported recycling as well as perceived friend and wider school recycling norms over the course of the study. Participants also perceived a greater level of encouragement to recycle from friends and teachers at Time 2 in comparison to Time 1. This is likely to have been due to the waste streaming intervention that included a focus on recycling. Notably, the improvement in recycling is consistent with waste audits at the school that identified a 68% reduction in recyclable materials that were placed in landfill bins (from 124.95 kg to 40.43 kg for a single week). This is contrasted with littering behavior and perceived friend and school norms for littering which was not targeted by an intervention and did not change.

Also in keeping with predictions, the results demonstrated that friends' behavior plays an important role in predicting change in an individual's littering and recycling behavior over time. These two results are consistent with processes of local social network contagion or social influence which has been found across a range of adolescent behaviors, including physical activity and various forms of antisocial behavior (Dishion & Tipsord, 2011; Salvy et al., 2012). It is noteworthy that friends' self-reported Time 1 behavior was strongly predictive of change in both littering and recycling behavior at Time 2, whilst the perceptions of friends' behavior at Time 1 were not. Similarly, de la Haye et al. (2011b) also found that neither perceived or injunctive norms mediated relationships between the physical activity levels of friends over time. If perceived norms are not related to individuals' behavior change, this suggests that the impact of friends' behavior may not occur via conscious calculation of what is normative in their immediate peer group. Instead, it is possible that people simply imitate their friends via direct mimicry. It is also possible that perceived norms are in fact influential but due to methodological limitations, such as using a single item perceived norm measure, however, our quantitative results did not detect this. Supporting a methodological limitation

interpretation; many focus group participants reported that noticing friend's or other's litter made them less motivated to put their waste in the bin.

The finding that friends' behavior predicts change over time does not necessarily mean this change is due to social influence. Adjusting for ego Time 1 behavior should capture friend similarity effects present in both ego Time 1 behavior and friends' Time 1 behavior however, confounds may exist if a relevant characteristic for friend selection is related to how they are likely to respond to a school-wide intervention. For example, students who increased their recycling behavior may be particularly conscientious and responsive to adult requests and conscientious students may be attracted to each other. Predictions of change from friends' behavior may also be accounted for by shared contexts that contribute to behavior change over time, such as the friend group eating lunch close to one of the new bins. These two possibilities could not be ruled out with the current data.

Our quantitative analysis found that friends' encouragement to recycle was an important independent predictor of change in recycling, indicating that active forms of peer influence may support environmentally-relevant behavior. Unfortunately, we were unable to test the influence of friends' encouragement on littering as we did not ask participants to rate this. The role of encouragement is also supported by focus group comments identifying verbal requests to put rubbish in the bin as key modes of influence in friends' behavior.

The focus group data also generated insights into the content of verbal peer encouragement that may shape behavior. Participants suggested that young people talk about waste and this may influence the culture of particular groups and contribute to the school waste culture. For example, food scraps were described as biodegradable by some participants, and therefore dropping them in gardens was not "littering". Picking up of other students' litter was expected to be met by "put-downs" and could have created a perceived injunctive norm that littering was acceptable. Future research on social influence in schools

could consider multiple forms of influence in more detail. This could possibly draw on Brown's (2008) five modes of social influence which include social modelling of the target behavior; antagonistic behaviors such as teasing; peer pressure including active encouragement or persuasion; praise to reinforce target behaviors and structuring opportunities to make target behaviors more accessible or rewarding.

Overall, our findings suggest friends play a role in the uptake of interventions. We found that littering and recycling were socially clustered in the school network we examined and discussion from the focus groups indicated that while it was acceptable to influence friends in this regard, this was not the case with non-friends. Thus, it appears that friendship groups may define a natural limit to the influence most individuals can have on the community. Other focus group comments and the prediction of behavior change from average friends' behavior suggests that a strong group norm is also influential. The implication here is that those designing interventions would do well to consider targeting either whole friendship groups, or perhaps representatives of multiple friendship groups, depending on the type of behavior involved. With hard-to-shift behaviors, the former may be appropriate in order to disrupt within-group reinforcing processes. With relatively easy-to-shift behaviors, the later may be all that is needed.

In regard to the latter, an intervention study by Valente, Hoffman, Ritt-Olson, Lichtman, and Johnson (2003) indicates that leaders may be more effective when recruited from specific groups. Valente et al. (2003) contrasted two strategies for peer leader nomination; leaders randomly matched to groups of students were compared with leaders matched to a group of students that nominated them. The leader-group matching intervention was more successful at reducing attitudes towards smoking and intention to smoke compared to the randomly matched leader intervention. This type of approach may be particularly useful in situations such as ours when peer influence appears to be largely driven by immediate friends.

Interventions may also need to carefully identify the behaviors and contexts they seek to influence. Encouragement from adult figures within this intervention context (i.e. teachers) predicted behavior change whereas parents who were not present did not, possibly because they did not have the ability to sanction behavior in this context. Likewise change was limited to the target behavior (recycling) but related littering behavior did not change. Interventions are likely to be most successful if they identify and target the contexts that they wish to influence and the influential people in those contexts.

Both our data collection methods had their limitations. In relation to the focus groups, data collection, interpretation and analysis were subject to researcher interpretation. We limited the impact of preconceived ideas on the focus group data through researcher familiarity with the setting and a reflexive journal which examined emerging themes against preconceived ideas. The checking of all codes with a second coder increased the rigor of the coding. The students' responses were likely affected by the presence of other students, a recorder and an adult moderator. Focus groups varied between three and nine students, and each contained a mix of personalities leading to variation in the rapport between students and facilitation techniques used to encourage participation.

The limitations of the quantitative aspects of this study include self-report data, an incomplete social network, questionnaire limitations and the effect of dropouts between Time 1 and 2. Missing data is a major issue for social network analysis because it affects the estimation of structural network characteristics of the individuals and their neighbours (see Huisman & Steglich, 2008; Kossinets, 2006). This is less important for our analysis because we do not estimate structural network properties. Regardless, the incomplete social network and dropout issues are expected to generate a conservative bias in the data by limiting the number of individuals considered in estimates of friend scores and restricting the range of self-reported behavior. This suggests the effects may be larger than they appear, and may

explain why some of our hypotheses were not supported. In addition, non-random dropout also indicates that our results are relevant to people with lower than average littering and higher than average recycling behaviors and friends with similar tendencies, thus people with potentially less room to change. Our analysis may also not have captured the full impact of the intervention due to the relatively short interval between intervention implementation and Time 2 data collection (7 weeks). Further, our results may underestimate personal change in littering behavior related to friends' littering behavior or due to the intervention because the littering questions did not focus on school-specific littering behaviour, in contrast to the recycling questions. The use of single item measures may have lower reliability than multi-item measures further limiting our ability to detect statistical relationships. We also focused on "close friends" and did not privilege reciprocated friendships. While we had reasons for this, as explained previously, a range of other nomination procedures and friendship criteria exist.

Another key limitation was our focus on a single school. Peer culture, social network structure and its relationship to particular behaviors may differ between schools. For example, littering may be a salient topic of friend conversations in this school but not in others. Clearly too, some behaviors may be more readily influenced by friendship groups than others and more amenable to interventions that target social influence. Future work is needed to test these concepts beyond our single case study. Future social network data could also support analysis of the role of influential individuals and immediate friendship groups in change processes located in both schools and other community settings. Our results suggest that friends' behavior was a more reliable predictor of behavior change than broad age and gender categories. Future research may wish to examine whether targeting friendship groups may offer a useful complementary or supplementary focus to the more traditional focus on demographic divisions (e.g., age and gender).

Our findings point to the role of local sub-cultures within a setting. This is of great interest to the development of theories of community change and thus to the work of community psychology. Supplementing social network analysis with qualitative data added important insight into the local context and social interactions. Social network and qualitative methods are not new to community psychology, however, we believe that together they have much to offer in illuminating social interactions and processes of community change.

Chapter 6: Personality and adolescent pro-environmental behaviour

6.1 Abstract

Personality may have implications for which adolescents engage in pro-environmental behaviour and under what conditions. This study measured the Big Five personality traits plus Honesty-Humility, and four pro-environmental behaviours (waste sorting, littering and conservation of power and water) self-reported by 885 high school students (53.0% male, mean age 14.6 years). Openness to Experience and Agreeableness predicted less frequent littering. Agreeableness and (weakly) Conscientiousness predicted more frequent waste sorting. Honesty-Humility predicted greater water conservation and tentatively more frequent power conservation, and Conscientiousness predicted both. Unexpectedly, Extraversion predicted more frequent littering. The findings suggest that personality traits help explain individual differences in adolescents' pro-environmental behaviour but emphasise that different pro-environmental behaviours may each relate to a unique set of personality traits.

6.2 *Introduction*

Personal responses to environmental degradation differ; some people grow their own food, buy only local produce, use public or active transport, avoid unnecessary flights, conserve resources, retrofit their houses, sign petitions, participate in protests or boycott companies. Variation in these behaviours is partly accounted for by social norms and individual characteristics such as attitudes, behavioural control, intentions, and problem awareness (Bamberg & Möser, 2007). Social norms and many individual characteristics are influenced by experience or vary from situation to situation, potentially limiting their utility for predicting behaviour at a later time and in different contexts. Personality traits attempt to capture relatively stable cross-situational dispositions and thus are likely to be particularly useful for predicting pro-environmental behaviour (Markowitz et al., 2012).

Personality describes individual differences in cognitive, affective, motivational and behavioural dispositions (McCrae & Costa Jr, 2008). One common model of personality is The Big Five framework or 'Five Factor Model' which is based on the assertion that important cognitive, affective, motivational and behavioural dispositions can be grouped into five core traits (the 'Big Five') - Openness to Experience, Agreeableness, Conscientiousness, Extraversion and Neuroticism. The utility of these five traits for summarising key individual differences has been validated using a variety of methods and with a variety of cultures (McCrae & Costa Jr, 2008). More recently, a sixth core personality trait, Honesty-Humility, has emerged within a personality framework known as the HEXACO, which is similar to the Big Five framework with this addition (Ashton & Lee, 2007; Ashton et al., 2004).

In this paper we investigate whether these six personality dimensions capture important individual differences in how people respond to environmental problems. In particular we are interested in whether personality predicts engagement in pro-environmental behaviour during adolescence - a time when lifelong attitudes and behaviours are taking shape, but individual

motivations and barriers to engaging in pro-environmental behaviour may differ from adults. In what follows we contextualize our work by reviewing the literature linking these six personality dimensions to pro-environmental attitudes, then behaviour and highlight key gaps in the literature specific to adolescents.

Among adults, Openness to Experience is particularly useful for predicting pro-environmental attitudes and behaviour (Markowitz et al., 2012). Openness to Experience captures tendencies to be creative, imaginative and intellectual (Goldberg, 1999) and value aesthetic beauty (McCrae, 2007). These tendencies may help individuals adopt novel behaviours, appreciate the beauty of natural spaces and comprehend uncertain relationships between our daily behaviours and environmental degradation. High levels of Openness to Experience are related to a range of precursors to pro-environmental behaviour, including; environmental values, attitudes and ecological identity (Hirsh & Dolderman, 2007; Milfont & Sibley, 2012), environmental concern (Hirsh, 2010; Markowitz et al., 2012), environmental attitudes (Markowitz et al., 2012), the belief that climate change is real, willingness to make sacrifices for the environment (Sibley et al., 2011), and connectedness to nature (Nisbet, Zelenski, & Murphy, 2009) in adult samples.

Conscientiousness is another key candidate for explaining individual differences in pro-environmental behaviour. Conscientiousness describes tendencies to be dutiful, orderly and cautious (Goldberg, 1999). This may assist people to overcome time, motivation and attention barriers to pro-environmental behaviours (Tanner & Wölfling Kast, 2003) and to value long-term outcomes (Pahl, Sheppard, Boomsma, & Groves, 2014). Both these factors should be associated with pro-environmental behaviours that are inconvenient in the short term but have long term benefits. A recent meta-analysis identified that a future time focus is consistently related to pro-higher levels of pro-environmental engagement (Milfont et al., 2012) and future time perspectives are stronger among people high in Conscientiousness

(Zhang & Howell, 2011). Research suggests that people high in Conscientiousness are more concerned about the environment (Hirsh, 2010; Kim, Schmöcker, Bergstad, Fujii, & Gärling, 2014; Milfont & Sibley, 2012) and hold more pro-environmental attitudes (Hilbig, Zettler, Moshagen, et al., 2013). Potentially working in the other direction, the dutifulness and order sub-facets of Conscientiousness may discourage engagement in pro-environmental behaviours which are novel or which challenge the status quo (Markowitz et al., 2012).

Agreeableness captures tendencies to be warm, empathetic and cooperative (Goldberg, 1999). The trait may promote collective goals over self-interest particularly when one might otherwise be able to retaliate against others' non-cooperation (Ashton & Lee, 2007). Previous work has found that Agreeableness also correlates with a number of pre-cursors to pro-environmental behaviour, including; self-reported greater ecological identity, environmentalism (Hirsh & Dolderman, 2007), environmental concern (Hirsh, 2010), and environmental values (Milfont & Sibley, 2012) as well as lower levels of consumerism (Hirsh & Dolderman, 2007).

A fourth trait, Honesty-Humility, captures tendencies towards fairness, frugality and a low sense of personal entitlement (Ashton et al., 2004; Hilbig, Zettler, Moshagen, et al., 2013) and may also predispose people to cooperate, particularly in situations when it might be possible to exploit others (Ashton & Lee, 2007; Sibley et al., 2011). In turn, both of these tendencies should make it easier to engage in a number of pro-environmental behaviours. Honesty-Humility is associated with self-reported willingness to make sacrifices for the environment (Sibley et al., 2011). Further it's sub-facets of low materialism and frugality correlate with pro-environmental behaviour (Hurst, Dittmar, Bond, & Kasser, 2013; Kasser, 2005).

The final two key personality traits from the Five Factor and HEXACO models are less obviously related to pro-environmental attitudes and behaviour. Extraversion describes

tendencies to be assertive, gregarious and social (Goldberg, 1999), factors which do not seem to have any clear consequence for pro-environmental behaviour. Further, Extraversion has been found to correlate negatively with environmental concern (Sibley et al., 2011) but was not correlated with attitudes in other studies (e.g. Hirsh, 2010; Hirsh & Dolderman, 2007).

Neuroticism (and its HEXACO variant Emotionality) describes tendencies to be unstable, anxious and sad (Goldberg, 1999). Prior research suggests that people high in Neuroticism are more likely to be concerned about the environment (Hirsh, 2010) and believe that climate change exists (Sibley et al., 2011) but are less likely to value protecting the environment (Milfont & Sibley, 2012).

6.2.1 Existing literature on personality and pro-environmental behaviour

The theory and research outlined above provides a relatively strong case that Openness to Experience, Agreeableness, Conscientiousness and Honesty-Humility predict pro-environmental *attitudes*. Nonetheless it is important to consider the research specifically looking at pro-environmental *behaviour* because behaviours are also motivated or limited by factors other than pro-environmental attitudes (Gifford & Nilsson, 2014).

There are four papers to our knowledge which have looked at personality correlates of pro-environmental behaviour. The first two papers (Milfont & Sibley, 2012; Swami et al., 2011) measured self-reported engagement in relatively simple and common behaviours (waste behaviour and recycling). Milfont and Sibley (2012) studied the Big Five personality traits as correlates of self-reported electricity conservation among New Zealanders. This study found that both Agreeableness and Conscientiousness were predictive of self-reported electricity reduction. Swami et al. (2011) investigated whether Agreeableness and Conscientiousness as predictors of waste behaviour among London residents. They found that

Conscientiousness but not Agreeableness was predictive of waste sorting behaviour (after accounting for age, gender, political cynicism and Machiavellianism).

Two further papers by Markowitz et al. (2012) and Hilbig, Zettler, Moshagen, et al. (2013) collected information on a range of behaviours, including some difficult or uncommon behaviours (e.g. organic food purchases, transport alternatives) and self-reported engagement in these was combined to produce an average behaviour score.

Markowitz et al. (2012) investigated the Big Five as predictors of average pro-environmental behaviour in a US undergraduate sample¹⁵. Openness to Experience and Extraversion were the only two variables which predicted pro-environmental behaviour when other personality traits were accounted for. Markowitz et al. (2012) identified that the relationship between Openness to Experience and pro-environmental behaviour was fully mediated by participants' sense of connectedness to nature and ecological worldviews, as measured by the New Ecological Paradigm (NEP). The relationship between Extraversion and pro-environmental behaviour was not mediated by connectedness to nature or ecological worldviews and appeared to be predictive due its relationship with motivation to engage in activities more generally (Markowitz et al., 2012).

Hilbig, Zettler, Moshagen, et al. (2013) investigated the HEXACO personality traits as predictors of pro-environmental behaviours with a community snowball sample and a sample of German undergraduate students. This study also found that both Openness to Experience and Honesty-Humility predicted pro-environmental behaviour. The relationship between Honesty-Humility and pro-environmental behaviour was partly mediated by cooperation. Conscientiousness and Agreeableness were not reliably related to pro-environmental

¹⁵ Markowitz et al. (2012) also investigated correlations between personality and pro-environmental behaviour in a US community sample but we focus our discussion on the findings which accounted for other personality traits.

behaviour; each trait was only related to pro-environmental behaviour in one of the two studies reported in this paper (Hilbig, Zettler, Moshagen, et al., 2013).

Prior research on the links between personality and environmentalism has almost exclusively focused on adults yet personality may relate differently to environmentalism during adolescence for a number of reasons. First, regardless of interest, adolescents are exposed to information about environmental degradation and climate change through the schooling system. Thus individual differences in curiosity and intellect are less likely to determine knowledge about the environment in adolescence than in adulthood. This means that Openness to Experience may be less important for explaining individual differences in pro-environmental behaviour during adolescence.

Conversely, social context, social rewards and peers' opinions are particularly important during adolescence (Brechwald & Prinstein, 2011; Brown et al., 2008) which may alter the relevance of social gregariousness (Extraversion) for pro-environmental behaviour. As a result Extraversion should predict behaviours perceived to increase popularity and negatively predict behaviours perceived to decrease popularity with peers.

Another important consideration is that personality is not fully crystallised in adolescence (Caspi & Roberts, 2001; Roberts, Caspi, & Moffitt, 2001; Roberts & DelVecchio, 2000) and thus we might expect to find weaker associations with pro-environmental behaviour than have been noted in other studies.

Only two studies to our knowledge have investigated relationships between personality and pro-environmental attitudes in adolescence and neither measured pro-environmental behaviour. Boeve-de Pauw, Donche, and Van Petegem (2011) surveyed a sample of Belgian adolescents using the Hierarchical Personality Inventory for Children (HiPIC; Mervielde & De Fruyt, 1999) which measures traits similar to the Big Five. This study found that Benevolence (akin to Agreeableness) was related to *lower* scores on the New Ecological

Paradigm (NEP) scale for children, in contrast to findings based on adult samples, which note positive relationships between Agreeableness and measures of attitudes. Higher Benevolence may have been related to less valuing of nature because nature is pitched against human progress and people with high levels of empathy may value human progress. Alternatively, this may represent a developmental difference whereby Agreeableness is negatively related to environmentalism of adolescents, but positively related to environmentalism among adults.

In the second study looking at personality and environmental attitudes of adolescents, Wiseman and Bogner (2003) examined relationships between pro-environmental attitudes and personality in a German sample using Eysenck's personality focus on Psychoticism, Extraversion and Neuroticism. Psychoticism (capturing egocentric, cold and antisocial tendencies) was associated with preferences for environmental utilisation, whereas Neuroticism (anxiety, emotionality and low self-esteem) was associated with preferences for environmental preservation. Relationships between Neuroticism and environmental preservation preferences may arise because Neuroticism generates concern for the environment, as was noted in Hirsh (2010). In this study Extraversion was not associated with preferences for preservation or utilisation (Wiseman & Bogner, 2003). Both Wiseman and Bogner (2003) and Swami et al. (2011) investigated pro-environmental attitudes. No studies to our knowledge have looked at the relationships between personality and self-reported pro-environmental behaviour in adolescents. The current study aims to fill this gap.

6.2.2 The present study

In this paper we use survey data from a New Zealand high school to explore the utility of personality traits for predicting pro-environmental behaviour in a sample of adolescents. Survey items provided self-report measures of four pro-environmental behaviours; littering, waste sorting at school (composting, plastic and bottle recycling and paper recycling), water

conservation and power conservation. We also collect information about friendship ties between participants as part of a larger programme of research. This allows us to take into account the non-independence of friends' scores that will be present if friends are influencing each other's behaviour. We combine data on pro-environmental behaviour and the Big Five plus Honesty-Humility to test our hypotheses.

We expected that Openness to Experience (H1a-d), Conscientiousness (H2a-d), Agreeableness (H3a-d) and Honesty-Humility (H4a-d) will predict greater concurrent pro-environmental behaviour, on the basis that these personality traits have tended to be related to attitudes and behaviour in prior research. Some studies have found that Extraversion predicts pro-environmental behaviour and thus we make the same prediction (H5a-d), yet we suspect that during adolescence the relationship may be less straight forward due to the social context not favouring such behaviours. We do not expect to find a relationship between behaviour and Neuroticism (H6a-d), yet including this allows us to assess unique effects of the traits we are primarily focused on.

6.3 Method

6.3.1 Participants

Participants were recruited from a state high school in Auckland New Zealand. Around 15% of students attend the schools' indigenous language unit which is located on the school property but has its own area and classes taught in Te Reo Māori. The school has developed a number of campaigns focusing on recycling, including a new physical waste system for separating landfill waste, recyclables and compostable materials with the intention of reducing litter and reaching a target of a 50% reduction in the amount of waste sent to a landfill.

Data was collected from the final wave of a longitudinal study. The majority of enrolled students (66.9%², n = 885) agreed to participate and handed in the questionnaire. Eleven students' parents requested they did not take part. Slightly more males (53.0%) than females took part, consistent with the school demographics (57.6% male). The mean age was 14.6 years, and ranged from 12 to 18 years.

6.3.2 Measures

The items for this study were collected as part of a wider research programme. Only questions relevant for this study are reported below.

Waste sorting behaviour was measured by three questions (“*I put my bottles and cans into the school recycling bins*”, “*At school I put my food scraps in the compost (food scraps) bin*”, “*At school I put paper and cardboard in the recycling*”). The three items had moderate reliability ($\alpha = .78$) and were averaged to generate a ‘waste sorting’ score for each participant. Single items assessed littering (“*I litter (e.g. leave rubbish on the ground)*”), recycling¹⁶ (“*I put my bottles and cans into the school recycling bins*”), water conservation (“*I try to save water by taking shorter showers or turning off the water when I brush my teeth*”) and power conservation (“*I sometimes leave computers, stereos and tvs on when they are not being used*”). Responses to these waste and conservation items were collected on seven-point Likert scales ranging from Never to Always.

Personality was measured using a short-form measure of personality called the Mini-IPIP6. This measures the Big Five personality traits and includes Honesty-Humility. We chose this measure because, whilst short-form measures are less reliable than full questionnaires, they are useful when it is not possible to include larger question sets due to time constraints or the number of other items being assessed in the same questionnaire

¹⁶ This recycling item is also included in the waste sorting score. We investigate it separately so that we can assess change between Time 1 and Time 2 because other waste sorting items were not measured at Time 1.

(Donnellan, Oswald, Baird, & Lucas, 2006; Sibley et al., 2011). Further, existing environmental research has almost exclusively utilised the Five Factor model (for exceptions see Hilbig, Zettler, Moshagen, et al., 2013; Sibley et al., 2011) and thus we wanted a measure that retained the Big Five traits yet included Honesty-Humility. The Mini-IPIP6 (Sibley et al., 2011) does exactly this, has been validated in a New Zealand (adult) sample, and the items appeared to be relevant for an adolescent sample.

The Mini-IPIP6 extends the short form Mini-IPIP5 (Donnellan et al., 2006) by adding four questions designed to measure Honesty-Humility (Sibley et al., 2011). Responses to personality item statements about the self were collected on seven point Likert scales anchored at *Very inaccurate* and *Very accurate*. Informal piloting with adolescents suggested three items may be confusing to younger members of age group. On this basis we changed “*Seldom feel blue*” to “*Seldom feel sad*”, “*Have a vivid imagination*” to “*Have an active imagination*” and “*Have difficulty understanding abstract ideas*” to “*Have difficulty understanding complex ideas*”. Responses to one of these items (*Seldom feel sad*) turned out to be negatively related to the other Neuroticism items, therefore this item was dropped from the analysis. Alpha reliability of some of the scale scores was less than ideal ($\alpha = .567-.711$) but to be expected given the small number of items tapping each trait (Donnellan et al., 2006) and use with an adolescent sample which typically have less stable personality traits than older adults (Roberts & DelVecchio, 2000). Similar reliability values have been reported in other studies (e.g. Donnellan et al., 2006; Swami et al., 2011). For a list of the original Mini-IPIP6 questions and scoring procedure see Sibley et al. (2011).

Given that data was collected from a single school it is possible that our data violated assumptions of independence, particularly where participants may influence each other's behaviour. As part of a wider programme of research we collected information about friendships by asking participants to “*Please name [School name] students who are your*

close friends. You do not have to fill in all the spaces but we are providing space just in case anyone has this many close friends". Seven spaces were provided for friend names. For this paper friendship information allowed us to correct for non-independence of friends' scores. Age (in years), gender and home room number were also collected.

6.3.3 Procedure

School students present during questionnaire administration were invited to participate in this study. Questionnaire completion was supervised by a classroom teacher during an administration class. A university research assistant was also present in some classes. Questionnaires took between 15 and 20 minutes to complete.

A written information sheet and verbal explanation were used to inform students about the study. Participating students completed consent forms and parents were informed of the study via a school newsletter and provided with the researchers' contact details if they did not want their children to participate. A prize draw to win one of five \$20 shopping vouchers was used as an incentive for participating in the study.

6.3.4 Analysis

Data cleaning. Inspection of the personality data identified erroneous responses in twelve cases; seven participants reported neutral on every personality item¹⁷ and another five participants appeared to be responding randomly using the extreme high and low ends of the response scale. These cases were excluded from all analyses presented in this paper.

A "language unit" variable identifying whether each student attended the main school or the schools' indigenous language unit was generated from home room numbers supplied in the survey responses.

¹⁷ One of these participants reported a single non-neutral response.

Analysis overview. We assessed relationships between personality and pro-environmental behaviours using linear regressions to predict self-reported behaviour from personality traits. All six personality traits were included as covariates in every model to enable us to assess the unique relationship of each personality trait. We also controlled for age, gender and language unit because each variable was related to at least one of the outcomes (see the Supplementary material for Chapter 6) and we wanted to keep the covariates consistent across models. Where Lagrange multiplier (LM) tests indicated spatial clustering then models were refit using spatial regressions to assess whether the results may be due to potential non-independence in our data and these are included in the Supplementary material for Chapter 6. Further details on all models are presented below.

Regression analysis

Linear regression was used to assess which personality traits predicted behaviour. Four linear regressions predicting measures of; (1) littering, (2) waste sorting, (3) power conservation and (4) waste sorting from the six personality traits and age, gender and language unit ('demographic covariates').

Breusch-pagan tests (Breusch & Pagan, 1980) provided evidence of heteroskedasticity in most of the models (see the Supplementary material for Chapter 6) therefore we corrected the standard errors from the linear regressions using "HC3" versions of the robust standard errors which are similar to, but more conservative than the original White robust estimators (see Long & Ervin, 2000; J. G. MacKinnon & White, 1985). To get an indication of the amount of variance explained by the personality traits we calculated adjusted R^2 and compared this with an identical model which omitted the personality variables. R^2 may overestimate model fit as a result of non-independence in the data however by calculating change in R^2 (i.e. subtracting one R^2 from the R^2 of a model predicting the same behaviour) this should cancel out most of

any bias in the statistic. Variance inflation factors were less than 1.5, indicating that the regressions did not suffer from serious issues of multicollinearity.

Spearman's correlations between personality traits, pro-environmental behaviours and age are reported in Table 6.1 for transparency. Differences in pro-environmental behaviour related to gender and language unit are presented in the Supplementary material for Chapter 6. Tests of the a priori hypotheses were conducted using Bonferroni adjusted alpha levels of 0.0018 per test ($.05/28$), adjusting for 28 predictions (six personality traits predicting four outcomes plus 4 model fitting tests). We present unadjusted p values in the tables and text but our interpretations of significance tests of the regression coefficients is based on the Bonferroni corrections of $p < 0.0018$. Thus we refer to relationships which fall between $p < .05$ and $p < .0018$ as weak or "tentative" relationships.

Fitting spatial versions of the linear regressions

The regressions were all assessed for spatial clustering and, where detected, a spatial variant of the model was fitted and included in the Supplementary material for Chapter 6. The information used to assess spatial clustering and dependence is based on a binary undirected friendship matrix constructed from friendship nominations, as described in Chapter 2. Hence the term "spatial" is used here to refer to social rather than physical space.

The motivation for running this second set of models is to ascertain that our linear regression model results were not the result of spatial non-independence. Failure to model spatial dependence may lead to overestimation of the role of other predictors, including underestimation of the standard errors of model coefficients (Franzese & Hays, 2007). Correcting for these effects requires ascertaining if spatial properties (i.e. similarities between friends) exist in the dependent variable or in the error term and then applying the relevant spatial model.

We assessed model fits for evidence of spatial non-independence using the Lagrange multiplier (LM) tests implemented in the R function `lm.LMtests` in the R package `spdep`. These tests revealed that littering, water conservation and to a lesser extent waste sorting had significant SARMA (spatial auto-regressive moving average) LM scores which suggests that both a lag and error spatial component are present (Anselin, Bera, Florax, & Yoon, 1996). See the Supplementary material for Chapter 6 for an explanation and the results of the LM tests. The basic linear regression also suffered from heteroskedasticity, as mentioned earlier, which may impact on the LM tests and spatial regression outputs. Thus, because the LM tests indicated that both error and (robust) lag spatial clustering were present in at least two of the models and heteroskedasticity was present we selected a generalised spatial two stage least squares regression model (GS2LSL; Kelejian & Prucha, 1998; Kelejian & Prucha, 2010). The GS2LSL models include both spatial processes and would also account for heteroskedasticity in the model. These models were fitted in an alternating two stage process drawing on both instrumental variable regression and generalised moments to estimate the model (see Piras, 2010, p.14-16). Fitting was implemented using the `gstslshet` function in the R package `sphet` (Piras, 2010). The full regression outputs of the GS2LSL models are presented in the Supplementary material for Chapter 6 and differences between these results and the main analyses are commented on at the end of the results section.

6.4 Results

6.4.1 Correlations between personality and environmental measures

First we examine pairwise correlations between pro-environmental behaviour and personality scores. As shown in Table 6.1, correlations between the different pro-environmental behaviours were low to moderate. Even water and power conservation were not strongly related to one another. In most cases, Agreeableness, Openness to Experience,

Conscientiousness and Honesty-Humility were significantly positively correlated with waste sorting, littering, water conservation and power conservation.

Traits were occasionally negatively related to pro-environmental behaviours; Extraversion was negatively correlated with waste sorting, Neuroticism was positively correlated with littering and negatively correlated with power conservation. In a few cases no significant correlates were noted; power conservation was not significantly correlated with Agreeableness, Openness to Experience and Extraversion. Extraversion was also not correlated with littering or water conservation and Honesty-Humility was not correlated with waste sorting.

As is common for studies measuring personality (e.g. Hilbig, Zettler, Moshagen, et al., 2013; Milfont & Sibley, 2012), significant correlations existed between many of the personality measures, in particular between Agreeableness and Openness to Experience, confirming the importance of statistically adjusting for each personality facet in ascertaining the unique contribution of all six personality traits.

Table 6.1. Spearman's correlations between personality and environmental measures (n = 818)

	1	2	3	4	5	6	7	8	9	10	11
1 Waste sorting	-										
2 Littering	0.35***	-									
3 Power conservation	0.10**	0.13***	-								
4 Water conservation	0.25***	0.23***	0.25***	-							
5 Openness to Experience	0.22***	0.29***	-0.01	0.09*	-						
6 Conscientiousness	0.15***	0.22***	0.20***	0.22***	0.08*	-					
7 Agreeableness	0.33***	0.25***	-0.01	0.12***	0.47***	0.12***	-				
8 Honesty-Humility	0.07	0.20***	0.09*	0.16***	0.14***	0.10**	0.15***	-			
9 Extraversion	0.18***	0.04	-0.04	-0.05	0.32***	-0.07*	0.36***	0.16***	-		
10 Neuroticism	-0.09**	0.12***	0.12***	-0.04	0.12***	0.13***	-0.04	-0.10**	-0.09*	-	
11 Age (years)	0.01	0.06	-0.05	0.02	0.05	0.01	0.05	-0.08*	0.00	0.03	-

Note. Bonferonni corrections were not applied to this table as we do not interpret the zero order correlations but include this table for the sake of transparency. Spearman's correlations were calculated on cases with complete data on all variables so that the same n value applied to all correlations. * $p < .05$; ** $p < .01$; *** $p < .001$

6.4.2 Predicting pro-environmental behaviours from personality traits

Next we explored the independent effects of each personality trait on pro-environmental behaviour. For each pro-environmental behaviour (littering, waste sorting, power and water conservation) we first entered the demographic variables gender, age and school language unit (i.e. demographic variables). We then ran a second model including the six personality traits in addition to the demographic variables to allow us to assess improvement in overall fit offered by the personality variables. The results of the models are presented in Tables 2 and 3. Personality provided a moderate improvement (i.e. over and above demographic variables) in the prediction of littering (Δ adjusted $R^2 = 0.16$), waste sorting (Δ adjusted $R^2 = 0.10$) and small improvements to models predicting power conservation (Δ adjusted $R^2 = 0.05$) and water conservation (Δ adjusted $R^2 = 0.07$), over and above what is explained by gender, age and school unit. Log likelihood ratio tests and F tests comparing models with and without the personality variables indicated that the inclusion of the set of personality traits significantly improved the fit of all models.

Results of the regressions in Tables 2 and 3 show varying support for the predicted relationships between personality and pro-environmental behaviours. Openness to Experience predicted less frequent littering ($B = -0.28$, $SE = 0.04$, $p < .0001$, H1a) but did not significantly predict waste sorting, water or power conservation (see Table 6.2 and Table 6.3, H1b-d). Conscientiousness also predicted pro-environmental behaviour, specifically more frequent power conservation ($B = 0.33$, $SE = 0.07$, $p < .0001$, H2c), water conservation ($B = 0.31$, $SE = 0.07$, $p < .0001$, H2d) and (weakly) more frequent waste sorting ($B = 0.11$, $SE = 0.04$, $p = 0.006$, H2b). Conscientiousness did not significantly predict self-reported littering when the Bonferroni correction was applied ($B = -0.10$, $SE = 0.04$, $p = 0.010$).

Agreeableness predicted less frequent littering ($B = -0.21$, $SE = 0.05$, $p < .0001$, H3a), and more frequent waste sorting ($B = 0.28$, $SE = 0.05$, $p < .0001$, H3b) but did not

significantly predict water or power conservation. Honesty-Humility was a predictor of greater water conservation ($B = 0.22$, $SE = 0.06$, $p < .0001$, H3d) and (weakly) more frequent power conservation ($B = 0.14$, $SE = 0.05$, $p = 0.007$, H3c), consistent with H4c-d. However contrary to H4a-b, Honesty-Humility did not significantly predict littering or waste sorting. Unexpectedly, Extraversion predicted more frequent littering ($B = 0.16$, $SE = 0.04$, $p < .0001$). Extraversion did not significantly predict waste sorting, power conservation, water conservation, in contrast to H5b-d. Consistent with H6a-d, Neuroticism did not predict any of the self-reported pro-environmental behaviours.

Whilst not the focus of this paper it may be of interest to some readers that, after controlling for personality and other demographics, age continued to weakly predict littering ($B = 0.07$, $SE = 0.020$, $p = .002$) and school language unit weakly predicted waste sorting behaviour ($B = 0.30$, $SE = 0.10$, $p = 0.003$). T-tests and correlations between the demographic variables and the personality measures are presented in the Supplementary material for Chapter 6.

Table 6.2. Linear regression predicting self-reported littering and waste sorting from personality traits and gender

	Litter (n=835)			Waste sorting (n=834)		
	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>
(Intercept)	3.18	0.47	<.0001	2.81	0.56	<.0001
Openness to Experience	-0.28	0.04	<.0001	0.09	0.05	0.075
Conscientiousness	-0.10	0.04	0.010	0.11	0.04	0.006
Agreeableness	-0.21	0.05	<.0001	0.28	0.05	<.0001
Honesty-Humility	-0.06	0.03	0.051	0.02	0.04	0.617
Extraversion	0.16	0.04	<.0001	0.07	0.04	0.116
Neuroticism	0.09	0.04	0.013	-0.06	0.04	0.153
Gender (male)	0.13	0.08	0.100	-0.14	0.09	0.099
Language unit	0.10	0.10	0.329	0.30	0.10	0.003
Age (years)	0.07	0.02	0.002	0.02	0.03	0.436
AIC	2407.5			2607.1		
<i>LL</i>	-1193***			-1293***		
<i>F</i> test	27 ***			17 ***		
adj <i>R</i> ²	0.18			0.12		
Δ adj <i>R</i> ²	0.16			0.10		

Note. Likelihood ratio, F tests and Δadj R² compared each model with an equivalent model that did not include the personality variables. Standard errors and p values are calculated based on a heteroskedasticity corrected covariance matrix. * *p* < .05; ** *p* < .01; *** *p* < .001

Table 6.3. Linear regression predicting self-reported power and water conservation from personality traits and gender (n = 824, 824)

	Power			Water		
	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>
(Intercept)	2.47	0.83	0.003	1.48	0.86	0.086
Openness to Experience	-0.05	0.07	0.439	0.03	0.07	0.677
Conscientiousness	0.33	0.07	<.0001	0.31	0.07	<.0001
Agreeableness	0.00	0.07	0.990	0.09	0.08	0.247
Honesty-Humility	0.14	0.05	0.007	0.22	0.06	<.0001
Extraversion	0.03	0.06	0.638	-0.07	0.06	0.297
Neuroticism	-0.12	0.06	0.038	-0.05	0.06	0.381
Gender (male)	0.06	0.12	0.632	-0.30	0.12	0.016
Language unit	0.25	0.15	0.099	-0.09	0.16	0.588
Age (years)	-0.04	0.04	0.342	0.03	0.04	0.456
AIC			3170.2			3168.6
LL			-1574 ***			-1573 ***
<i>F</i> test			8.9***			11 ***
adj <i>R</i> ²			0.055			0.084
Δadj <i>R</i> ²			0.054			0.069

Note. Likelihood ratio, *F* tests and Δadj *R*² compared each model with an equivalent model that did not include the personality variables. Standard errors and *p* values are calculated based on a heteroskedasticity corrected covariance matrix. * *p* < .05; ** *p* < .01; *** *p* < .001

6.4.3 Summary of findings

A summary of the main findings is presented in Figure 6.1. The supplementary GS2LSL models, accounting for any non-independence across the school social network are presented in the Supplementary material for Chapter 6. These produced essentially the same results as the linear regression models indicating that the results are robust to spatial non-independence in our data. The two exceptions were weak negative relationships of littering with Conscientiousness and Neuroticism which were not identified in the heteroskedasticity adjusted linear regressions that formed the main analysis.

	Litter	Waste sorting	Power	Water
Openness to Experience	--			
Conscientiousness	~	+	++	++
Agreeableness	--	++		
Honesty-Humility			+	++
Extraversion	++			
Neuroticism	~			

Figure 6.1. Summary of which personality trait predicted each pro-environmental behaviour,

Note. ++ denotes a strong positive relationship, + a weak relationship, -- a strong negative, - a weak relationship and ~ a negative relationship in the spatial model only. All models included the other personality traits, gender, age and language unit.

6.5 Discussion

6.5.1 Results interpretation

This study sought to assess whether personality traits predicted adolescents' self-reported, everyday pro-environmental behaviour. The results show that this was the case.

The trait most consistently related to the pro-environmental behaviours measured in this study was Conscientiousness. This predicted three of the four pro-environmental behaviours measured. Participants high in Conscientiousness reported more frequent waste sorting (the average of recycling and composting behaviour), power conservation and water conservation, consistent with predictions. However, Conscientiousness was only weakly (negatively) related to littering. The pattern of behaviours predicted by Conscientiousness (waste sorting, power and water conservation but not littering) is consistent with the role of this trait in self-

discipline and the valuing of long-term outcomes. Not littering has immediate benefits and is easy to perform (i.e. by placing waste in their schoolbags or surrounding bins) therefore the value of self-discipline and placing importance on long-term outcomes should offer few advantages for reducing littering behaviour. The dominant positive relationships with behaviours in this study is consistent with research noting that Conscientiousness predicted electricity conservation (Milfont & Sibley, 2012) and recycling (Swami et al., 2011) in adult samples. However, studies which measured more unconventional behaviours, such as buying local produce, did not obtain significant relationships between pro-environmental behaviour and Conscientiousness (Hilbig, Zettler, Moshagen, et al., 2013; Markowitz et al., 2012). One likely explanation for these non-significant relationships is that Conscientiousness also captures dutifulness and preferences for order and thus should not predict novel pro-environmental behaviours which challenge the status-quo (Markowitz et al., 2012).

Agreeableness captures individual differences in motivation to maintain positive relationships with others and support collective interests (Ashton & Lee, 2007). This means that people high in Agreeableness should be more likely to perform behaviours which directly benefit others or are both visible and approved of by other people. Our results are relatively consistent with these predictions: Agreeableness predicted behaviours visible to peers (waste sorting and littering). In contrast, Agreeableness did not predict power conservation or water conservation, behaviours which commonly occur at home (e.g. showers, turning off appliances not being used) and therefore will typically not be observed by peers. Similarly, the school in which the study took place emphasises the cooperative nature of both waste sorting and not littering but does not emphasise power or water conservation. These latter behaviours may also only be framed as cooperative in some families. Our Agreeableness findings contrast with a study of Flemish adolescents (Boeve-de Pauw et al., 2011) which found that pro-environmental worldviews were negatively

related to Benevolence (a trait similar to Agreeableness). However the negative relationship obtained in that study may arise because pro-environmental worldviews have real or imagined conflicts with other people's interests. These conflicts may be disliked by people who have empathy for and want to support other people's interests. Our results suggest that Boeve-de Pauw (2001)'s findings are not indicative of a more general negative relationship between pro-environmentalism and Agreeableness during adolescence.

The two pro-environmental behaviours not predicted by Agreeableness were predicted by Honesty-Humility. Specifically, Honesty-Humility predicted more frequent water conservation and (weakly) more frequent power conservation but did not predict littering or waste sorting behaviours. The pattern is also consistent with the theory that Agreeableness should predict cooperation when one could retaliate, and Honesty-Humility should predict cooperation when a person could take advantage of others (Ashton & Lee, 2007; Hilbig, Zettler, Leist, et al., 2013). Littering and recycling are visible to others and other's non-cooperation is directly visible whereas this is not the case for Honesty-Humility. The specific relationship with water and power conservation is also consistent with findings that frugality (a subfacet of Honesty-Humility) is related to engagement in pro-environmental behaviour (Hurst et al., 2013; Kasser, 2005). The German study of HEXACO traits (Hilbig, Zettler, Moshagen, et al., 2013) noted that Honesty-Humility was associated with an average of multiple pro-environmental behaviours indicating that Honesty-Humility may also promote a broader range of behaviours than those measured in this study.

In contrast, our study found limited support for the assertion that Openness to Experience is a key predictor of pro-environmental behaviour. Participants high in Openness to Experience tended to litter less frequently and this is consistent with evidence suggesting that Openness to Experience motivates pro-environmental behaviour for aesthetic reasons (Markowitz et al., 2012) as litter can be considered "ugly". However Openness to Experience

was not related to the other pro-environmental behaviours measured in this study, possibly because these have little aesthetic value. They are also less novel than behaviours measured in studies which found that Openness to Experience was a key predictor of pro-environmental behaviour, with those who are open to experience also being attracted to novelty (Hilbig, Zettler, Moshagen, et al., 2013; Markowitz et al., 2012). The non-significance of Openness to Experience could also reflect developmental differences between adolescents and adults. For example, curiosity sub-traits captured in Openness to Experience should be less important for acquiring information about environmental degradation during adolescence when this information is presented to all students through the education system. However the aesthetic account described above is more consistent with the pattern of results obtained which demonstrate that Openness to Experience was related to littering but not to the other less aesthetically-relevant behaviours.

Unexpectedly, participants high in Extraversion reported more frequent littering (i.e. less frequently disposing of waste in a tidy manner). This contrasts with prior research noting that Extraversion predicts more pro-environmental behaviour in adult samples (e.g. Hilbig, Zettler, Moshagen, et al., 2013; Markowitz et al., 2012; Milfont & Sibley, 2012).

Extraversion is argued to relate to pro-environmental behaviour because Extraversion motivates action more generally (Markowitz et al., 2012). However our Extraversion results are not easily explained by an action-motivation account. Littering requires less action than waste sorting, yet littering was predicted by Extraversion in our study and waste sorting was not. More likely, the positive relationship between littering and Extraversion in our study reflects features of this behaviour in this social context; adolescents high in Extraversion should be more assertive, gregarious and social (Goldberg, 1999) and thus may be more willing to draw attention to themselves. Littering draws attention to oneself because it risks the individual or group being reprimanded by a teacher or possibly other students.

Finally, Neuroticism was not predictive of any of the pro-environmental behaviours measured in this study, consistent with our hypotheses and the lack of relationships noted in other studies (e.g. Markowitz et al., 2012; Milfont & Sibley, 2012).

6.5.2 Implications

The pattern of relationships noted in this study is consistent with a number of explanations offered by other authors. Conscientiousness predicted the more difficult and long-term focused behaviours measured in this study (waste sorting, power conservation and water conservation but not littering), consistent with assertions that Conscientiousness may facilitate pro-environmental behaviour by promoting self-discipline and a focus on long-term outcomes (Markowitz et al., 2012). Honesty-Humility predicted behaviours that involve frugality (power and water conservation) suggesting that frugality may be key to Honesty-Humility's relationship with pro-environmental behaviours (Hilbig, Zettler, Leist, et al., 2013). Further, Openness to Experience only predicted littering, consistent with arguments that aesthetic-interests associated with Openness to Experience explain why this trait predicts pro-environmental behaviour (Markowitz et al., 2012).

Given that personality traits are relatively stable and moderately genetically determined (Jang, Livesley, & Vernon, 1996; McCrae & Costa Jr, 2008), interventions that attempt to modify personality traits are unlikely to be successful. However, relevant contextual factors may be manipulated to draw on motivations associated with each personality trait. For example, emphasising the aesthetic rationale for pro-environmental behaviours may motivate engagement in these behaviours among people high in Openness to Experience. For people *low* in Openness to Experience, it may be important to emphasise how pro-environmental values help to maintain existing things that these individuals value, such as access to food products threatened by environmental degradation. In many schools, including this one, students may be presented with messages arguing for both aesthetics and for conservation of

important resources. The former message likely appealing to people high in Openness to Experience and the latter to people low in Openness to Experience. The likelihood that within school students high in Openness to Experience and students low in Openness to Experience receive messages promoting pro-environmental behaviour in ways that relate to their predispositions adds a further explanation for why students' degree of Openness to Experience was not predictive of most pro-environmental behaviours in this study.

Building on diffusion of innovation theory (Rogers, 1983), adolescents high in Conscientiousness and Agreeableness are likely to be “low threshold adopters” of interventions introducing new opportunities to engage in simple pro-environmental behaviours in, such as new eco-friendly printing or eco-friendly packaging options. These students are likely to be low threshold adopters based on our results demonstrating that the higher people are in these traits the more frequently they tend to perform relatively simple pro-environmental behaviours. Diffusion of innovation theory argues that engagement by low threshold adopters is important for building a critical mass and this will in turn encourage others who may initially be less enthusiastic about new environmental initiatives. Therefore our results indicate that adolescents high in Agreeableness and Conscientiousness may be useful to target in the initial stages of interventions promoting simple visible pro-environmental behaviours such as recycling.

6.5.3 Limitations

The key limitation of this study was low reliability of the (short) personality scales and unknown reliability and validity of the behaviour measures. The short length of the Mini-IPIP6 made it practical to implement but the reliability and discriminant validity of these scales was lower than desirable, although the reliability was higher than that noted in some other studies (e.g. Swami et al., 2011). In addition, littering, power conservation and water conservation were measured by single items and we did not test the reliability of these items.

It is also possible that limited reliability of the trait measures arises because personality is not fully crystallised in adolescence (Caspi & Roberts, 2001; Roberts et al., 2001; Roberts & DelVecchio, 2000).

The self-report nature of these measures may have generated some of the observed relationships. For example, people who want to manage their self-presentation are likely to rate themselves as Agreeable, Conscientious and Open to Experience as well as pro-environmental. However a self-presentation self-report bias explanation does not explain why these traits predicted some behaviours and not others.

The low reliability of the personality scale scores limited the power of our analysis, as did the large Bonferonni correction arising from the large number of tests required to predict separate pro-environmental behaviour in a single study. We may have detected a greater number of relationships if we had studied a single behavioural measure and used a lengthier and more reliable personality measure. On the other hand, the fact that we still found a number of significant relationships suggests that the link between some personality dimensions and pro-environmental behaviour may be relatively strong.

Participants were drawn from a single school and this has implications for data analysis and the generalizability of our results. First, from a statistical perspective, the regression models may be biased by non-independence in our data arising from the potential influence of some students' behaviour on the behaviour of others. Yet regression models presented in the Supplementary material for Chapter 6 which specifically accounted for spatial dependence produced similar results to those reported in the main paper. Second, predictions of waste sorting may not generalise to other schools with less emphasis on recycling and composting. However the collection of data from a single school allows us to make more informed inferences about the context surrounding these behaviours, particularly the social context surrounding littering and waste sorting behaviours performed at school. This is

important because the social context may influence which behaviours are activated by different personality traits. For example, Agreeableness traits are likely to be particularly useful for predicting behaviours that are easily viewed by others and benefit others. Thus interpreting whether this theorisation is supported will benefit from knowledge about the visibility of different pro-environmental behaviours in a given context and the degree to which the benefits or costs to others are emphasised in that context.

6.5.4 Further research

Whilst our findings are in line with prior research with adults, replication of our findings is important given the low power of our study and the focus on a single school. In particular there is a need to tease apart why Openness to Experience was not predictive of most of the pro-environmental behaviours in our study. As mentioned this may relate to the type of behaviours we measured, the context of these behaviours for this sample or development differences between adults and adolescents.

Another important direction for future research is to test the multiple and sometimes conflicting theories about why each personality trait promotes specific pro-environmental behaviours. As mentioned, whilst the pattern of our results is consistent with theoretical accounts of personality, we did not explicitly test the mechanisms linking these traits with pro-environmental behaviour. For example, Conscientiousness may promote pro-environmental behaviour because it is associated with valuing long-term rewards or because it captures self-discipline. Two papers to our knowledge directly investigated theoretical accounts (Hilbig, Zettler, Moshagen, et al., 2013; Markowitz et al., 2012). The former indicated that relationships between pro-environmental behaviour and Honesty-Humility are partially mediated by cooperation tendencies and the latter indicated that relationships with Openness to Experience are fully mediated by connectedness to nature and ecological worldviews, as measured by the NEP. More research of this kind is important for developing

theory and interventions which draw on personality differences to promote pro-environmental behaviour.

6.5.5 Conclusion

Variation in everyday pro-environmental behaviour of adolescents is partially explained by personality. Importantly, in this study each personality trait was only predictive of a limited selection of the behaviours, likely related to the particular motivations and barriers associated with each behaviour. The results suggest that Agreeableness and Conscientiousness may predict relatively simple and common pro-environmental behaviours whereas Honesty-Humility may be more relevant for behaviours performed in private or that involve conservation of resources. Tentatively, Openness to Experience was relevant for predicting the most aesthetically-oriented pro-environmental behaviour measured in this paper (littering). Overall our results show that, as for adults, personality can help us predict which adolescents are likely to engage in various pro-environmental behaviours.

***Chapter 7: ‘You can’t dedicate your whole life to such a thing’:
Stereotypes, justifications and the discursive marginalisation
of pro-environmental behaviour***

7.1 Abstract

Discourse plays a key role in constructing and negotiating whether and how we should reduce our environmental impact (Dryzek, 2005; Harré et al., 1999). In this paper I examine how 50 students from a New Zealand high school constructed pro-environmental behaviour during focus group discussions about what it means to care for the environment. Through justifications focusing on the scale of the problem, (in)convenience and downward comparisons and stereotyping of strong pro-environmental behaviour, a number of students framed minimal action as reasonable and logical. Similarly, some students used stereotypes to signal that strong engagement in pro-environmental behaviour was not appropriate by framing it as irrational, unrealistic and potentially immoral. Interestingly, other students drew on stereotypes of strong engagement to construct their and their families’ environmental engagement. I argue that justifications and stereotypes may be “system serving” by defending current behavioural norms around pro-environmental behaviour. The findings have implications for interventions and how role models may help to foster environmental engagement.

7.2 *Introduction*

Scientists have been forecasting environmental decline for at least thirty years (e.g. Manabe & Stouffer, 1980) however non-sustainable consumption and pollution continue on a trajectory towards higher temperatures, accelerated species extinction, destruction of natural habitats, threats to coastal areas, increased environmental disasters and increased stress on water and food supplies (IPCC, 2014). Despite many people professing that the environment is important (Gifford, 2011), few have adopted ‘environmentally significant behaviours’ (c.f. Thøgersen & Crompton, 2009) such as air travel, energy consumption, and meat consumption (Whitmarsh & O'Neill, 2010). Instead, many people adopt small pro-environmental behaviours (Whitmarsh & O'Neill, 2010) meaning that minimal individual engagement is the behavioural norm.

Discourse represents and negotiates environmental norms, identities and environmental solutions (Dryzek, 2005; Harré et al., 1999). Certain actions can be promoted by constructing these as reasonable and logical or discouraged if they are constructed as confused and counterintuitive (Hogg & Reid, 2006). Language can also be used to construct and negotiate personal and extra-personal responsibility (Antaki & Widdicombe, 1998) which has implications for who is expected to take action to limit environmental degradation (Butler, 2010). Due to the potential for discourse to construct environmental action, Kurz, Donaghue, Rapley, and Walker (2005, p.616) argue that “researchers interested in promoting practices deemed environmentally sustainable should also be interested in the ways in which discourses help to create social spaces in which potentially environmentally damaging practices remain unchallenged, or at least successfully defensible”.

In particular, justifications may play a key role in defending both environmental degradation and an absence of engagement in actions which mitigate environmental degradation (i.e. ‘pro-environmental behaviour’). Adults use a range of justifications for not

performing pro-environmental behaviours. These include emphasising competing time and financial responsibilities (Phillips, 2000) and claiming that they already perform other pro-environmental behaviour (Skill & Gyberg, 2010). These justifications not only defend that speaker's behaviour but also give others a guide as to what are appropriate levels of environmental action.

The construction of identities in talk may also work to defend minimal environmental action. Stereotypical categorisation of extreme environmentalism has been used by adults to define and justify not engaging in environmental action through suggesting this way of acting is unrealistic or inappropriate (Skill & Gyberg, 2010). Notably, even adults and young people involved in environmental groups have directly distanced themselves from some aspects of environmental stereotypes (Perera, 2014; Stuart, Thomas, Donaghue, & Russell, 2013). For example, Perera (2014) noted that one adolescent used the term "hippie" to construct a positive identity as a young person who was passionate about the environment. This same adolescent also constructed a negative stereotype of environmentalists that she directly distanced herself from. Whether people identify with or distance themselves from these stereotypes also appears to be influenced by motivations to avoid the negative stigma that is sometimes constructed around these stereotypes. Other studies suggest aligning oneself with stereotypes of strong action may serve to justify instances of inaction by implying that they are otherwise an environmentally engaged person (Kurz, Donaghue, Rapley, & Walker, 2005). Thus stereotypes appear to operate in multiple ways to define both individuals and pro-environmental behaviours.

Explaining adolescents' accounts of how much pro-environmental behaviour is acceptable or justifiable is important as this generation are key actors in current and future change efforts (United Nations, 2010). Peer appraisals are highly salient during adolescence (Brechtwald & Prinstein, 2011) and thus adolescents may be especially sensitive to how the

discourses of their friends position environmentally relevant behaviours. Qualitative work with adolescents (e.g. Connell et al., 1999; Hillcoat et al., 1995; Prestin & Pearce, 2010) has described young people's *attitudes* towards pro-environmental behaviour but has not considered how adolescents co-construct environmental actions and identities (for exceptions see Perera, 2014; Zeyer & Roth, 2009).

A discursive psychology approach (e.g. Edwards & Potter, 1992) is useful for examining how levels of environmental engagement are negotiated and justified in talk. This approach focuses on specific techniques which are used in conversation to manage the stake and interests of the speaker, such as the use of justifications and disclaimers (Edwards & Potter, 1992). In discursive psychology, "psychological activities such as justification, rationalisation, categorisation, attribution, naming and blaming are understood as ways in which people manage their interests" (Willig, 2001, p.91). Discursive psychologists typically adopt a relativist ontology and epistemology (for an exception see Sims-Schouten, Riley, & Willig, 2007). A relativist epistemology proposes that our knowledge of the world is constructed through social interaction and does not reflect an objective reality (Burr, 1998). Likewise a relativist ontology proposes that the world itself is constructed through social interaction and does not constitute an objective reality (Burr, 1998). However following a strong relativist approach challenges the possibility that "real" changes are occurring in a "real" environment (Burningham & Cooper, 1999). It also limits researchers' ability to argue that some behaviours (and the discourses that help maintain them) may be better than others (Burr, 1998). In examining accounts of pro-environmental behaviours I therefore adopt a critical realist epistemology which assumes that our knowledge about the world is socially constructed but posits that a real world beyond language exists (Maxwell, 2012). In other words, critical realism posits that our understanding of "reality" (i.e. concepts) is socially

constructed without denying that these concepts may reference things that exist in a physical world.

In this paper I explore how young people construct their own and others pro-environmental behaviour, focusing on how these constructions may support or challenge current behavioural norms which typically consist of minimal pro-environmental behaviour.

7.3 Method

7.3.1 Participants

Participants were recruited from a single mixed-gender government funded high school in Auckland, New Zealand. Senior staff, each responsible for the pastoral care of around 200 students, were asked to nominate students with reasonable verbal skills and to include students with and without an interest in pro-environmental behaviour.¹⁸ Prior to the focus groups, I met with these students and invited them to participate. Parents provided consent for students under 16 and all students gave their own written consent prior to the beginning of the focus group. A total of 50 students consented and attended a focus group. Participants ranged in age from 13 to 18 years.

7.3.2 Procedure

I studied discussions generated in focus groups, which allowed me, the interviewer to take a peripheral role in students' conversations (Wilkinson, 1998). Self-presentation goals are likely to be activated by the presence of a moderator and other students however, rather than being a limitation, this should provide a more realistic picture of how people use language to manage their interests in the presence of others (Wilkinson, 1998).

¹⁸ We assume that assessments of the potential environmental interest of students were determined largely by knowledge of their involvement in school-based environmental activities.

The focus groups were conducted as part of a wider research programme focusing on pro-environmental behaviour in the high school. The school where the research was conducted has become increasingly involved in environmental initiatives over the last five years, most notably through a reconfiguration of their waste system and opportunities for students to run and attend activities designed to promote positive waste disposal and active transport. Most school-wide discussions of pro-environmental behaviour focus on waste disposal and this is likely to inform students' conceptualisations of environmental issues.

In total nine focus groups were held. After seven focus groups new patterns of talk were still appearing thus two further focus groups were added. Focus groups were held separately for junior girls (Years 9 – 10 approximately 13 - 15 years old; two groups), senior girls (Years 11 - 13 approximately 15 -18 years old; two groups), junior boys (one group), senior boys (three groups) and one group of environmental leaders of mixed gender and age. These groupings were chosen so that students were more likely to interact as equals.

The number of students who attended each focus group varied between three and nine students ($M = 5.6$). Lower numbers were a result of other concurrent events, differences in how many were invited to participate in each group and no-shows on the day.

Focus groups were conducted in a quiet room on the school property during lunch time and lasted between 35 and 50 minutes. Participants were advised that the conversations were confidential and that there were no right or wrong answers. They were asked to respect what everyone had to say but were informed that it was "OK" to disagree with others.

The semi-structured interview schedule included questions about what caring about the environment meant, if and how students identified with this and asked them to reflect on their own behaviour and the behaviour of other students at this school. Drawing on insights from prior discussions, I also asked participants in the last two groups why it might be important to care about the environment and what their views were on individual responsibility for the

environment. The phrase “cares about the environment” was chosen as one that would align closely with participants’ language. Motivations for transport behaviour and the potential influence of friends on waste and transport behaviour were included in the final stage of each focus group but did not elicit responses relevant to this study.

I (JL) transcribed the data verbatim, making note of emphasis (*italics and underlined*), short pauses (“,”) and stating in parentheses where longer pauses, speech that trailed off, laughter and overlapping speech occurred. Participant names were replaced with pseudonyms in the transcript extracts and the moderators’ talk is labelled with her initials (“JL”).

Data analysis followed the focus and processes outlined in Willig (2001, pp. 94-96). Multiple iterations of revision and recoding were undertaken. Open-coding of any features that related to talk about pro-environmental behaviours was performed as a first step. A second round of coding focused on linguistic features of the conversations which are used to manage the speakers’ interests (e.g. downplaying any negative implications of their actions). Many of these features involved justifications and stereotypes and the focus groups were reanalysed focusing on these key features.

I am a PhD student in my late 20s who had been involved in research and community activities at the target school for 1.5 years when the focus groups were conducted. To consider and mitigate the impact of my own assumptions on focus group moderation, coding and analysis I actively reflected on and attended to alternative explanations, my rationale for each interpretation, how my own perspectives impacted on my analysis and my relationships with participants impacted on their responses. The analysis below offers one possible interpretation of the data as it is not possible to complete free the analysis from a researchers’ ideas (Willig, 2001).

7.4 *Results and analysis*

In this paper I present key justifications and stereotypes used in participants' discursive construction of their own and others' pro-environmental behaviour. Four extracts were chosen that provided useful examples of interesting discursive techniques which occurred across a number of focus groups. All of the extracts transpired relatively early on in the focus groups in response to questions about what caring for the environment meant, whether the participants cared, and what actions were associated with caring about the environment.

Extracts One and Two (presented first) include examples of the techniques used to emphasise the social acceptability of minimal or no pro-environmental behaviour. The extracts transpired during separate focus groups with senior boys. Extracts Three and Four (presented halfway through the results section of this chapter) provide examples of stereotypes adopted by people who presented themselves as committed environmentalists. These extracts occurred during separate focus groups with senior girls. All names have been changed (with gender preserved) and the moderator is identified by "JL".

Extract One

- 1 Tai Oh yeah, I turn the light off when, and if I don't turn the light off
2 my Mum will turn the light off, like, ummm but like at the end of
3 the day there's like picking up one piece of rubbish ain't gonna
4 make much of a difference, like yeah
- 5 JL : Yeah, do you guys want to talk about that for a minute? Like you
6 mentioned that picking up a piece of rubbish won't make a
7 difference, and planting a tree won't make a difference, so why do
8 people do these things?

9 Harry: Obviously planting a hundred trees might make a difference I'm
10 just saying that one extra might not be that much but it actually is,
11 I, I wouldn't be like (pause) I wouldn't be that kind of person that,
12 "oh doesn't matter, I'm not going to be able to help much
13 compared to, since there are another 8 billion people in the world"
14 (JL: mmhmm) "I'm one person" but then if other people start
15 thinking about that it becomes a huge group of people that doesn't
16 want to do anything (JL: mmhmmm). And that's why I think I
17 need to change, and a lot of people do also need to change

18 JL : Mmhmm. What do you guys think?

19 Grant: There's a certain kinda logic like, as a whole thing, yeah it's like
20 "oh, you know they don't need my help" or something but really
21 (pause) like it's kind of like votes, like one vote doesn't make a
22 difference but if no one votes, or if everyone decided their vote
23 didn't make a difference then there'd be no votes kind of thing

24 JL : Yip

25 John: It's mostly, it pretty much is ease and money, like if it's easy
26 (Grant: yeah) you'd do it, and if it saves you money then it's like
27 very important in the short term to you so you would do it as well
28 (JL: right)

29 Grant: Like recycling, most people recycle cause it's really easy (JL:
30 mmhm) like it's environmentally friendly and it's easy, you just
31 put it in the bin. Yeah I think if they make it convenient, it's just, a
32 lot more people would do it

Extract Two

- 1 JL: Yip. So does that make you, do you care about, do you think you're
2 someone who cares about the environment?
- 3 Ben: I think it's important to do what you can (JL: mmhmmm) right (Tama:
4 yeah) like not necessarily go to, like, to the city street and spend
5 the *whole* day picking up rubbish and doing, like that. It's doing things
6 that you can whilst doing things that you need to do (JL: yip) Like, for
7 instance going to the park with your family, that kind of thing. (JL: yip)
8 You can't dedicate your whole life to such a thing
- 9 JL : So what are the things you guys can do?
- 10 David: I think it's the small things like making sure you put your rubbish in the
11 right bin... trying to cut down...
- 12 Tama: ... (overlapping) yeah the simple things, putting things in the right bins,
13 actually being bothered to put it in the bin like a normal person would
14 (laughs)
- 15 JL : Mmmhm
- 16 Ben: It's like if you get a million people to donate 50 cents, that's a whole lot
17 of money
- 18 Tama: Yeah
- 19 Ben: But that's only 50 cents for each person

7.4.1 Justifications of limited pro-environmental behaviour

Focus group participants used “the scale of the problem”, “(in)convenience” and “downward comparison” justifications to account for their limited engagement in pro-environmental behaviour. I discuss these three justifications before moving into an analysis of stereotypes and how these position strong engagement in pro-environmental behaviour.

A number of students justified not performing pro-environmental behaviour directly or indirectly using references to the scale of the problem and the utility of their actions in relation to this scale. For example, Tai claimed that *“at the end of the day there’s like picking up one piece of rubbish ain’t gonna make much of a difference, like yeah”* (Extract One, lines 2-4). Whilst Tai initially talked more generally about his engagement in pro-environmental behaviour he then drew on the example of picking up litter to imply that pro-environmental behaviours are somewhat irrational and illogical given the limited impact he associated with this action.

Harry and Grant also drew on references to the scale of environmental degradation and explicitly noted that the utility of actions depended on the number of people also taking this action (Extract One, lines 19-23 and Extract Two lines 16-17). For example, in Extract One Harry implied that inaction cannot be justified by the scale of the problem: *“I wouldn’t be that kind of person that, “oh doesn’t matter, I’m not going to be able to help much compared to, since there are another 8 billion people in the world”* (lines 11 to 13). He then subtly undermined this claim by implying that his own inaction could only be judged in the context of other people not acting: *“And that’s why I think I need to change, and a lot of people do also need to change”* (Extract One lines 16-17). Therefore Harry presented himself as both concerned about the environment and as not someone who is discouraged by the scale of the problem, whilst also justifying his own lack of behaviour through the scale of the problem he claimed to be unaffected by.

Students also justified inaction by emphasising that pro-environmental behaviour was inconvenient. For example, some students claimed that if pro-environmental behaviours were convenient or beneficial for the individuals involved they would be performed. Further, they implied that it was someone else’s responsibility to make them so. In Extract One John explicitly described convenience and money-saving as the necessary conditions for people to

perform pro-environmental behaviour: *“It’s mostly, it pretty much is ease and money, like if it’s easy you’d do it, and if it saves you money then it’s like very important in the short term to you so you would do it as well”* (Extract 1 lines 25-28). In this way, John constructed behaviour as primarily being motivated by financial self-interest and convenience. By inferring that people would only perform these behaviours if they were convenient and cost-effective, John essentially denied responsibility for performing pro-environmental behaviours which are inconvenient or do not save money. This construction went unchallenged by other focus group members thus communicating that this was a socially acceptable reason for not performing pro-environmental behaviour. The convenience criterion was corroborated by Grant through two references to “easy” and an emphasis on the simplicity of the behaviour (*“just put it in the bin”*, Extract One, lines 30-31). Grant explicitly deflected individual responsibility for pro-environmental action by suggesting that someone else has the responsibility to make recycling easy: *“Yeah I think if they make it convenient, it’s just, a lot more people would do it”* (Extract One, lines 31-32). These statements not only excused Grant and John’s behaviour, but signalled to other students that their inaction would be excusable also. Thus, like the scale of the problem justification, inconvenience justifications helped to reinforce behavioural norms around small action by framing actions which are inconvenient or not personally beneficial as beyond what is, or should be, expected.

Another common way that students justified inaction or minimal action was through “downward comparisons” that contrasted their own actions (or attitudes) against the actions of people who did less. For example, Harry claimed his engagement in small actions was good, relative to the actions of others (Extract One, lines 9-17). Through the statement *“I wouldn’t be that kind of person”* Harry emphasised a negative conceptualisation of people who do not perform pro-environmental behaviour and explicitly distanced himself from them. Likewise in Extract Two (lines 21-25), David and Tama referred to other people who do even

less for the environment than they do in order to imply that their action is comparatively acceptable, or even good. Tama's use of the phrase "*actually being bothered to put it in the bin*" emphasised a distinction between doing nothing and performing minimal action. He created the former as socially unacceptable and lazy and positioned his own behaviour as reasonable because he does more than what some other people do. Tama does not explicitly state that he does more but implies this through his disapproval of people who do little. Similarly, in Extract 3 presented on the next page, Charmaine emphasised the morality of her own recycling and composting behaviour by contrasting her behaviour with other people's inaction in these domains. Charmaine described: "...*like at home like we have our whole recycling, like we have our bin and our recycling bin. If I go to someone else's house and I'm like 'where's your recycling!' and then they're like 'oh, just chuck it in the same bin'*" (Extract 3, lines 1-4). Charmaine's comparison implied that taking no action is unacceptable and that her fairly minimal actions were good in comparison. Downward comparisons may function problematically in two ways. First, they absolve the speaker of undertaking anything more than minimal action as long as there are examples of others who do less. Second, by stating that others are doing little, downward comparisons reinforce a sense that no-one else is contributing thus feeding into the "scale of the problem" justification for not undertaking more than minimal pro-environmental behaviour.

7.4.2 *Stereotypes of environmentalism*

A number of students constructed stereotypes of pro-environmental behaviour as a way to justify their own minimal action. Students positioned small contributions as normative, realistic and rational compared to a construction of all-consuming environmentalism. For example, in Extract Two Ben justified and reinforced his argument for minimal action by constructing an environmental alternative ("*whole day picking up rubbish*") that could easily be framed as unrealistic and irrational ("*you can't dedicate your whole life to such a thing*").

These stereotypes positioned people who take strong pro-environmental behaviour as radical or obsessive environmentalists. Many other students stated that they would not take action “*obsessively*”, “*wholeheartedly*” or “*excessively*”. In doing so they contrast their behaviour with constructions of pro-environmental behaviour as negative or extreme, which implies that a more moderate approach is reasonable. The constructions used by Ben and others marginalised the alternative to their current levels of behaviour as unrealistic and outside the boundaries of “*doing what you can*”. In doing so, they positioned their relative lack of pro-environmental behaviour as a good thing.

Despite the general negative portrayal of extreme environmentalism, some students constructed a positive position using these stereotypes as part of their description of their own and their family’s pro-environmental behaviour. Extract Three and Four provide three key examples, which are discussed following these extracts. These extracts suggests that whilst stereotypes are part of the social reality for these students, that the stereotypes can be co-opted to present environmental action as superior to not acting.

Extract Three

- 1 Charmaine It’s the same at school as it is like, at home, like at home like we have our
- 2 whole recycling, like we have our bin and our recycling bin. If I go to
- 3 someone else’s house and I’m like “where’s your recycling!” and then
- 4 they’re like “oh, just chuck it in the same bin”
- 5 Kirsten And you’re like “what are you doing”
- 6 Briana And it always kills you a little bit inside (laughs)
- 7 Kirsten But I just want to create a new recycling bin! (laughs)
- 8 Briana Like restart it yeah but anyway, (laughs) umm I dunno, why do I care
- 9 about the environment? Honestly it all just comes from my parents
- 10 they’ve just always been like, they’re real, we’re real about self being,

11 like self-sufficient and we all have like the vege garden and the compost
and

12 Charmaine (laughs)

13 Briana It's kinda like we could start a cult maybe, I dunno (laughs)
(later in the discussion)

14 Briana But my dad's all for cycling (laughs) but maybe that's why mum is all
15 for the car, I'll be like "mum, pick me up", and she'll come

Extract Four

1 Shelley: Yeah it kinda seems like there's this whole like (pause) if you like, if I like
2 talk about the environment to my group of friends they're like 'nup, just
3 shut up', they'll completely like shut out of the conversation, like they don't
4 care but my *family* and especially my mum is very environmental, we do
5 like own like chickens and do everything, like collect rain water, pretty
6 much do everything ourselves. And my friends come round to the house and
7 it's like they're in this new world they're like 'oooo, ooo, what's that tank
8 for?', 'it just collects rainwater', 'oooo, *weeeird!*' (general laughter) it's
9 kinda like, it's kinda like this sense of 'that's a bit odd, that's a bit different'

10 Alison Yeah

11 Marie: Yeah and umm, I was talking to this girl the other day and she was like
12 asking me about my life, pretty much and she was saying "so do you guys
13 only wear cotton clothes" and like (laughter) and like clothes that come
14 from natural fibres and I was like that's a stereotype attached but I dunno,
15 that's kindof *odd* (pause) (Alison: Wow) You kinda like associate

16

17 people that (pause) are into environmental stuff only wearing natural clothing, I wear some natural clothes so I guess in some sense it's true...

Identification with these stereotypes helped to construct and signal that one's behaviour was in fact environmentally substantial. Whilst these stereotypes potentially had negative connotations, negative connotations were deflected using humour or by emphasising the ignorance behind negative stereotypes of strong pro-environmental behaviour and the people who hold these stereotypes. For example in Extract 3 Briana used exaggeration to generate humour in the presentation of her and her family's behaviour as environmental: "*It's kinda like we could start a cult maybe, I dunno (laughs)*" (Extract Three, line 13). This use of humour may have mitigated some of the awkwardness associated with her family's "extreme" behaviour whilst still allowing her to emphasise that her family are superior environmentally.

Shelley constructed her friends' reactions to her family's environmental initiatives as somewhat ignorant because they did not know what a water tank looks like: "*...my friends come round to the house and it's like they're in this new world they're like 'oooo, ooo, what's that tank for?', 'it just collects rainwater', 'oooo, weeird!'....*" (Extract Four, lines 6-8). Similarly, Marie referenced a conversation with another student to present stereotypes of environmentalists as ignorant: "*I was talking to this girl the other day and she was like asking me about my life, pretty much and she was saying "so do you guys only wear cotton clothes"*" (Extract Four, lines 11-17). Through references to these stereotypes these participants positioned themselves as "radical environmentalists" who performed abnormally high levels of pro-environmental behaviour. They also constructed environmentalists as superior to those who were not environmentalists and were ignorant of the practices involved.

7.5 *Conclusion*

These focus group discussions provided a number of examples of how talk functioned to defend the status quo of minimal pro-environmental behaviour. The analysis identified that adolescents use justifications to defend their personal engagement in small pro-environmental behaviours. Justifications presented pro-environmental behaviour as inconvenient and ineffective due to the scale of the problem which functioned to construct minimal action as logical and rational. Downward comparisons with an absence of behaviour made minimal contributions seem significant. Other focus group members were largely supportive or complicit in these accounts, indicating that they were well accepted discursive strategies. Many of these justifications left non-engagement or very minimal engagement in environmentally significant behaviours unchallenged. Many of these justifications have been noted previously in research with adults (Butler, 2010; Kurz et al., 2005; Skill & Gyberg, 2010), however they have not been discussed in relation to adolescence, nor has their role in shaping and negotiating social norms around what is acceptable typically been discussed.

Stereotypical accounts served different functions depending on who proposed them and how they were espoused. Firstly, stereotypes appeared to marginalise strong engagement in pro-environmental behaviour by presenting strong engagement as unrealistic and potentially immoral because they took time away from other obligations. This builds on work showing how stereotypes may be used to justify actions towards certain groups (e.g. Potter & Wetherell, 1987) by suggesting that they can be used to justify inaction in relation to pro-environmental behaviours. The use of stereotypical presentations of pro-environmental behaviour may be particularly powerful in adolescence when peers' appraisals of oneself are highly salient (Brechtwald & Prinstein, 2011).

However some students who performed substantial pro-environmental behaviours aligned themselves with stereotypes of strong environmentalists. For these students the stereotypes

seemed to function differently, not as an aid to justifying inaction but as a key “badge” that set them apart from others. Regardless of the individual’s motivations for self-stereotyping, these may have potential to challenge the more prevalent discourse that “extreme” environmentalism is inappropriate. Students who identified with these stereotypes appeared to be well respected by their peers in the focus groups and they were a living example of how pro-environmental behaviours are not in fact inherently incompatible with other life responsibilities.

Attempts to modify common discourses about appropriate pro-environmental behaviour should pay attention to how these discourses are maintained through justifications of existing behaviour and stereotypical constructions of radical pro-environmental behaviour. The present analysis suggests that instead of motivating students, informal talk about pro-environmental behaviour could elicit justifications that serve to discourage rather than encourage pro-environmental behaviours. Given that talk about environmental action is also important for fostering knowledge sharing it seems to be important to foster alternative narratives of environmental action.

In a discursive psychology tradition “transforming the status quo becomes understood as a matter of challenging and changing discourses, encouraging people to tell different stories about themselves and others” (Edley, 2001, p.193). Alternative constructions may be facilitated by role-models who challenge discursive constructions of strong pro-environmental behaviour as incompatible with other life responsibilities. Future-focused rather than current-focused conversations may also help to generate new stories around what people want to be doing rather than what they are currently doing. Other studies have also shown that a future-focused orientation is related to individual differences in pro-environmental behaviours (Milfont et al., 2012), albeit possibly for different reasons. A future time perspective is believed to foster mental representations of future events and assist with

the planning and achievement of future goals (Milfont et al., 2012). Young people may also need help in constructing these stories through exposure to realistic alternatives they can identify with and a greater sense of self-efficacy in their own ability to perform environmentally-significant behaviours.

Overall the desire to display oneself in a positive light and the collaborative nature of these justifications appeared to reinforce a norm that small and even inconsistent action is the appropriate response to environmental degradation. The justifications and stereotypes noted here were “system-serving” in that they help defend and vindicate the status quo of environmental inaction. Yet changes to people’s ecological footprint are urgently needed (IPCC, 2014).

Chapter 8: Thesis summary and conclusion

This thesis draws on psychological, discursive and social network perspectives to study the role of friends and the broader social context of pro-environmental behaviour at a high school in Auckland, New Zealand. The findings summarised in Chapters 3 to 7 help to address important gaps in knowledge about if, when, and how friends influence each other's pro-environmental behaviour. The detailed findings, limitations and implications related to each study are presented in the individual chapters.

In this chapter I focus on the overarching findings and implications in relation to social clustering, local norms, individual differences in behaviour and contagion. I then propose some important foci for further research, reiterate the main limitations of this research and close with key conclusions. I begin the chapter with a brief discussion of my experience with social network methods, as this has implications for what follows.

8.1 Social network analysis opportunities and pitfalls

This thesis set out to explore the role of friends in pro-environmental behaviour using social network concepts and analytical techniques. As mentioned in Chapter 1, the interconnected nature of individuals in social networks could, in theory, facilitate the widespread diffusion of behaviour. Widespread diffusion is possible if each person who adopts a behaviour in turn increases the likelihood of that behaviour among their alters (people they are connected to) and those alters in turn influence their alters. Whilst clearly not the whole solution, this type of diffusion could be an important strategy for bringing about much needed reductions in our environmental impact.

Social network analysis also offers a number of possibilities for expanding on common research traditions in psychology. It enables researchers to study the structure of relationships in keeping with theories that acknowledge the interconnectedness of the social world

(Robins, 2013; Robins & Kashima, 2008). It also facilitates an exploration of homophily (friend selection) and contagion (processes by which behaviour is influenced by the performance of that behaviour among social network ties) processes. It avoids “false consensus” (assumed similarity) effects in the examination of similarities in friends’ behaviour. Thus social network analysis offers unique ways of considering, measuring and theorising about social influence on pro-environmental behaviour among students in this high school network.

However my experience using social network data within a study focused on social influence was far from smooth sailing. The time, cost and complications involved in collecting and amalgamating social network data across multiple school populations meant that this research focused on a single school. This in turn generated its own set of limitations. Second, acquiring sufficient participation over three waves¹⁹ was a substantial problem. Despite collaboration with school staff, I was unable to achieve participation rates suitable for the intended stochastic actor oriented models (SAOM; Snijders et al., 2007).. Short of not being fully transparent about the voluntary nature of participation, I felt that little more could be done to encourage enough students to participate to make this possible.

Navigating my way around alternative statistical models proved particularly difficult given that I did not possess a strong grounding in mathematics, statistics or programming. Social network methods and spatial econometric models which are suitable for testing influence processes are at the cutting edge of statistical developments. They also involve complex mathematical formulas and fitting these models require the ability to programme in the R language for statistical computing (R Development Core Team, 2007). Researchers in the future should face fewer challenges with these models as there are a number of ongoing

¹⁹ Huisman and Steglich (2008); Kossinets (2006) recommend participation rates exceeding 60% of individuals in the social network. Due to the fact that a different set of individual chose not to participate at each wave I would likely have needed to obtain an 85% participation rate in each wave to have achieved this.

attempts to make advanced social network methods more accessible. In addition, many of the more accessible social network analysis techniques focus on questions of social structure rather than influence meaning that they cannot answer questions relating to if, how and why social influence occurs. Due to a combination of participation rates, the accessibility of newer techniques, and the limited relevance of many social network techniques, I adopted spatial econometric and related statistical approaches. Other researchers interested in social network techniques have also taken a similar approach (e.g. Ali et al., 2011; Fujimoto & Valente, 2012b; Macdonald-Wallis et al., 2011)

Despite these challenges, the research reported in this thesis made a number of important contributions to the literature.

8.2 Social clustering and local norms

The analysis presented in this thesis demonstrated that pro-environmental behaviour was not distributed randomly in this school social network. All transport modes, littering and recycling tended to socially cluster in this friend-based school social network. This extends existing research which demonstrates social clustering in a range of other behaviours such as physical activity and eating (de la Haye et al., 2010), demographics (Goodreau et al., 2009) and anti-social behaviour (Dishion & Tipsord, 2011).

Social clustering is an important part of the social context because it influences what behaviours, attitudes or ideas people are commonly exposed to through people they interact with. Influence is proposed to be related to how common the behaviour is in a setting (Cialdini et al., 1990) or how common and important the behaviour is to a relevant social group (Turner et al., 1987). As such, the presence of social clustering indicates that areas of the school social network may act as local sites of pro-environmental behaviour, or local sites for non-environmental behaviour. This may in turn have implications for who, and how, to target a high school student population. For example interventions may get the most impact

out of targeting sections of the network where there is a high concentration of people who do not already perform the behaviour. Further, interventions should anticipate that within sections of the network where a behaviour is uncommon, friends may role model or encourage the absence of this behaviour and a relatively intensive intervention may be required. Similarly, if, as argued in Chapter 7, people construct environmental behaviour in ways that justify their own levels of action or inaction, then conversations within clusters of people who do not perform environmental action are likely to construct environmental action as unimportant. Conversely, although not explicitly tested in this thesis, conversations may communicate a more positive construction of environmental action in sections of the network where people were more environmentally friendly .

A number of individual characteristics appeared to contribute to some of the clustering in pro-environmental behaviours. Apparent drivers of social clustering²⁰ in transport behaviour included parent encouragement and distance to school. Likewise gender appeared to contribute to clustering in littering and recycling. However these factors did not completely account for clustering in these behaviours; as discussed later, contagion in behaviour also appeared to be a contributing factor.

8.3 Individual differences in behaviour

Whilst not the primary focus of this thesis, the results also contribute to a body of knowledge about individual differences in pro-environmental behaviour (Gifford & Nilsson, 2014).

Personality traits were found to predict individual differences in easy-to-perform pro-environmental behaviours (littering, recycling, water and power conservation). The pattern of

²⁰ It is also possible that these variables correlate with unmeasured variables that actually drive secondary homophily processes, for example people may select friends based on similar socio-economic status and this status affects which transport modes are available and thus which transport modes parents' encourage.

findings identified each of the four personality traits commonly related to pro-environmental behaviour or attitudes in adults; Openness to Experience, Agreeableness, Conscientiousness and Honesty-Humility, predicted at least one of the behaviours. At a high level, Chapter 6 extended previous research (e.g. Hilbig, Zettler, Moshagen, et al., 2013; Markowitz et al., 2012; Milfont & Sibley, 2012) to show that personality traits also predict pro-environmental behaviour in an adolescent cohort. However, perhaps more interestingly, a different pattern of personality traits predicted each behaviour.

The pattern of behaviours predicted by each trait was relatively consistent with theoretical models of personality (Ashton & Lee, 2007). For example, Agreeableness predicted behaviours which were viewed by others and whose outcomes depended on others behaviour (e.g. littering and recycling). On the other hand, Honesty Humility predicted cooperation related behaviours that were not typically observed by others (water conservation and to a lesser extent power conservation). This pattern is consistent with the link between Agreeableness and reactive cooperation and Honesty Humility and proactive cooperation noted in Ashton and Lee (2007). The Honesty-Humility findings could also be explained by a frugality account of Honesty Humility, however previous research by Hilbig, Zettler, Moshagen, et al. (2013) also pointed to a cooperation explanation for the role of Honesty-Humility in pro-environmental behaviours. Overall the fact that each behaviour was predicted by a unique set of personality traits is consistent with prior research which noted only moderate relationships between performance of different pro-environmental behaviours. These findings may explain why prior research with adults has been somewhat inconsistent regarding which personality traits are useful predictors of pro-environmental behaviour. It is also possible that some of the variation from previous research is due to the fact that personality is not fully crystallised in adolescence (Caspi & Roberts, 2001; Roberts et al., 2001; Roberts & DelVecchio, 2000). The finding that Agreeableness and Honesty Humility

predicted pro-environmental behaviours is also consistent with arguments that pro-environmental behaviours are partly performed for altruistic reasons (Kaiser & Byrka, 2011). Altruistic motivations are also indicated by the fact that adolescents who littered more and recycled less were more likely to drop out of this research.

Other individual differences also predicted pro-environmental behaviour. Walking to school was more likely among those living close to school²¹ and among those whose parents encouraged active transport. Cycling was more common among males and those whose parents encouraged active transport. Recycling was more common among young students, and female students were less likely to litter and more likely to recycle. Individuals not described by these characteristics may require greater encouragement or incentives to facilitate their engagement in pro-environmental behaviour. For example, transport interventions could focus on students who live a long way from school and encourage them to use active transport for part of the journey.

Individual differences in the likelihood of adopting a behaviour could also have implications for macro-level diffusion and contagion processes. Diffusion of innovations theory (Rogers, 1983) points to the role of “low threshold adopters” in initiating new norms. Low threshold adopters are individuals who require little incentive to adopt the behaviour. In contrast people who are not low-threshold adopters may require incentives or additional time before they adopt a behaviour. Understanding, in advance, who is unlikely to be a low threshold adopter based on personality traits, or other characteristics, may facilitate the development of strategies to target these individuals.

Relationships between personality traits and behaviour may also help to identify barriers to intervention adoption that can be targeted in interventions. For example, because

²¹ Cross-sectional relationships between distance to school and behaviour were identified in Chapter 3. Distance to school was not a unique predictor in Chapter 4, likely because it was a time-invariant factor that would have had the same impact on Time 1 and Time 2 behaviour and thus have been cancelled out in the analysis.

Conscientiousness (which is associated with planning and attention to detail) predicts low levels of power and water conservation, this indicates that failing to think about power and water conservation at appropriate times may be important barriers to these behaviours. For behaviours which are not predicted by Conscientiousness, the need for attention to detail would likely be a less important barrier to address. Each personality trait describes a range of attributes and further research is needed to isolate what aspects of each trait are actually important for facilitating or limiting each pro-environmental behaviour.

8.4 *Pro-environmental behaviour may be “contagious”*

Perhaps of greatest interest, the results presented in chapter four or chapter five of this thesis are consistent with the possibility of contagion in some of the measured pro-environmental behaviours. The analysis reported in Chapter 4 was consistent with the idea that friends' cycling impacts on change in ego's cycling one year later, for male students at this school. The results were tentative regarding the impact of friends' walking for male students and I found no evidence of contagion in other modes for either gender. Thus social clustering in car and bus travel reported in Chapter 3 appears to be the product of latent homophily (friend selection on unmeasured factors that influence the target behaviour) or manifest homophily (friend selection on the behaviour of interest), rather than contagion processes.

Similarly, the analysis presented in Chapter 5 is consistent with contagion of friends' behaviour for littering and recycling. Friends' behaviour predicted change in littering and recycling behaviour seven months later. The analyses also suggested that whilst a new recycling system at the school led to improved littering and recycling across the whole school, on average, this was not determined by a whole school norm: some individuals changed their behaviour more than others and friends' prior behaviour appeared to be an important determining factor in who changed their behaviour after the intervention. The

cycling results are consistent with cross-sectional studies and qualitative reports of friend influence on transport behaviour (e.g. Emond & Handy, 2012; Panter et al., 2010; Simons et al., 2013) The littering and recycling results extend previous research which demonstrated that site-wide norms generate short-term social influence on littering behaviour (Cialdini et al., 1990) to indicate that friends' behaviour may also be influential. However given this was not an experimental study, it is not possible to completely rule out alternative explanations for these results.

Understanding how contagion occurs is important for intervention development because it is unlikely that an individual simply "catches" a behaviour, as the analogy with disease contagion implies. Social network analysis has tended not to theorise about why contagion occurs and social psychological studies have often overlooked the complexity of real world social interactions (Robins & Kashima, 2008).

However attempts to identify mechanisms of contagion were relatively unsuccessful. Cross-sectional relationships were noted between descriptive friend norms (perceptions of the common behaviour of friends), co-travel requests (invitations to travel together, only explored for transport behaviour) and active transport behaviour. Further, focus group participants reported that norms and encouragement influenced waste behaviour.

Nonetheless, participants assessment of influence mechanisms should be interpreted with some caution given that prior research indicates that people are not very good at assessing the relative impact of different strategies on their pro-environmental behaviour (Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008). In addition, previous research which indicated these mechanisms might be important (Arnold et al., 2009; Cialdini et al., 1990; Panter et al., 2010) were also based on cross-sectional or qualitative analyses. Critically, in this research presented in this thesis, neither friends' descriptive norms (perceptions of the frequency of friends' behaviour), encouragement, or co-transport requests predicted change in behaviour

over time. It is unclear whether this was because these mechanisms were not important for contagion processes or because the quantitative analysis used a conditional change model which was only able to capture lagged influence rather than influence that happened simultaneously.

The finding that the average of friends' behaviour predicted change in ego's littering, recycling and cycling (males only) is indicative of complex contagion, which is the subtype of contagion considered at the outset of this thesis. Complex contagion describes processes whereby influence occurs if the behaviour of interest is performed by a number of connected individuals, rather than just by a single connected individual (Centola & Macy, 2007). Thus, for complex contagion to operate, a number of a person's friends must be performing the behaviour. This means that complex contagion is unlikely to occur when a behaviour is uncommon in that part of the social network, but they could be useful for spreading behaviours that are relatively common in parts or the majority, or in the network.

The statistical models may have also picked up instances of simple contagion or spread of the behaviour along single ties. Simple contagion is more consistent with the type of diffusion processes theorised in diffusion of innovations theory (Rogers, 1983) which are proposed to travel along single ties. In simple contagion a single person performing a behaviour can cause another person to adopt this behaviour. This is particularly likely for cycling behaviour. The relative infrequency of cycling meant that it may only take one friend to cycling in order to generate a relatively average friend behaviour score. However, simple contagion is unlikely to be underpinning the prediction of littering and recycling from friends' behaviour because a single friends' average behaviour is unlikely to generate much of the variation in friends' average behaviour given that both behaviours were relatively common.

The type of contagion (simple vs complex) has implications for the type of social network intervention that is likely to be effective. Segmentation-based social network interventions target behaviour change in a section of the network at the time (Valente, 2012). Often it is hoped that within-group dynamics will then work to maintain this behaviour within that section of the network. These interventions may be the most useful when complex contagion or majority influence processes rather than single individuals are unlikely to be effective.

Previous research indicates that classical peer leader and individual social network intervention (i.e. training a set of well-connected individuals in behaviour change techniques) are useful for shaping pro-environmental behaviour (Abrahamse & Steg, 2013; Arnold et al., 2009; Bloodhart et al., 2013). In Arnold et al. (2009) participants reported that individual friends supported their engagement in pro-environmental behaviour, indicative of simple contagion processes. In Bloodhart et al. (2013) between two and seven peer leaders were trained from each hall of residence, suggesting that their influence could not be due to a numerical majority, except in very small subsets of the network, and thus influence was likely to be simple contagion. These studies indicate that simple contagion processes may be influential on pro-environmental behaviour and are an important topic for future research given they offer greater opportunities for spread across a network.

8.5 Wider social contextual factors that may impact on social influence in pro-environmental behaviour

Whilst the findings of Chapter 4 and 5 are indicative of contagion, and other research has indicates that social network based interventions can be effective (Abrahamse & Steg, 2013; Bloodhart et al., 2013), the research outlined in this thesis also pointed to a number of barriers to the uptake of pro-environmental behaviours that may limit the impact of interventions, social or otherwise.

My analysis of focus group data in Chapter 7 argued that justifications and stereotypes of others' actions constructed strong environmental actions as irrational and small actions as the appropriate way to care for the environment. Justifications which referred to the scale of the problem, downward comparisons, inconvenience and stereotypes, as well as the fact that many of these went unchallenged also signalled to other students that they thought that inaction was socially acceptable. In other words justifications and stereotypes reinforced an injunctive norm that people considered minimal environmental action appropriate. This indicates that, rather than always being a positive thing, discussions with peers about the environment could help to maintain the status quo of minimal environmental engagement and limit attempts to encourage engagement in environmentally significant behaviour (i.e. behaviours which generate a relatively large reduction in environmental degradation).

To avoid this interventions should think about ways to discuss possibilities for action without requiring participants to justify their current action. Focus group participants who self-identified with the stereotypes helped to challenge constructions of strong action as unrealistic. It may also be useful for interventions to simultaneously develop young people's self-efficacy to perform actions which do count as environmental action so that people are able to identify themselves as someone who performs environmental action under a more stringent definition of this. Being able to identify as someone who cares about the environment is argued to have a causal impact on motivations to perform a range of pro-environmental behaviours (Clayton, 2012; Kempton & Holland, 2003).

In addition, the focus group extracts reported in Chapter 5 offer a couple of caveats on how much influence peer leaders will have on pro-environmental behaviour within a school setting. Focus group participants suggested that, within the peer culture at their school, it was inappropriate to chastise the anti-environmental behaviour of peers outside their immediate friendship group. Young people in other studies similarly report that talking about climate

change may be uncool and put the person at risk of being stigmatised by others (Corner, Roberts, & Pellister, 2014). Thus further work should be done to test the efficacy of individual peer leader interventions on pro-environmental behaviour rather than generalising from contexts such as smoking where peer culture around the behaviour is likely to be different (e.g. Campbell et al., 2008).

Social clustering may also be a barrier to intervention effectiveness for both social and non-social intervention. It may prevent the spread of behaviour in the overall network where parts of the network include people who are unlikely to perform the behaviour and this area of the network is central to the connectivity of the network. For example, in the case of transport behaviour, distance was socially clustered. This could limit the contagion of walking through areas of the network which most students live far from school, as long distances prevent students from walking to school. Likewise, female students seldom engaged in cycling behaviour. Due to the clustering by gender in the network it may be difficult for cycling behaviour to spread through friendships (male or female) in areas of the school social network where almost all students are female (e.g. these areas are identified by the lack of blue dots in Figure 8.1). Similarly behaviours such as recycling, water conservation and power conservation which appear to be facilitated, or at least linked to a personality may be difficult to introduce into sections of the network where most individuals are low on this personality trait.

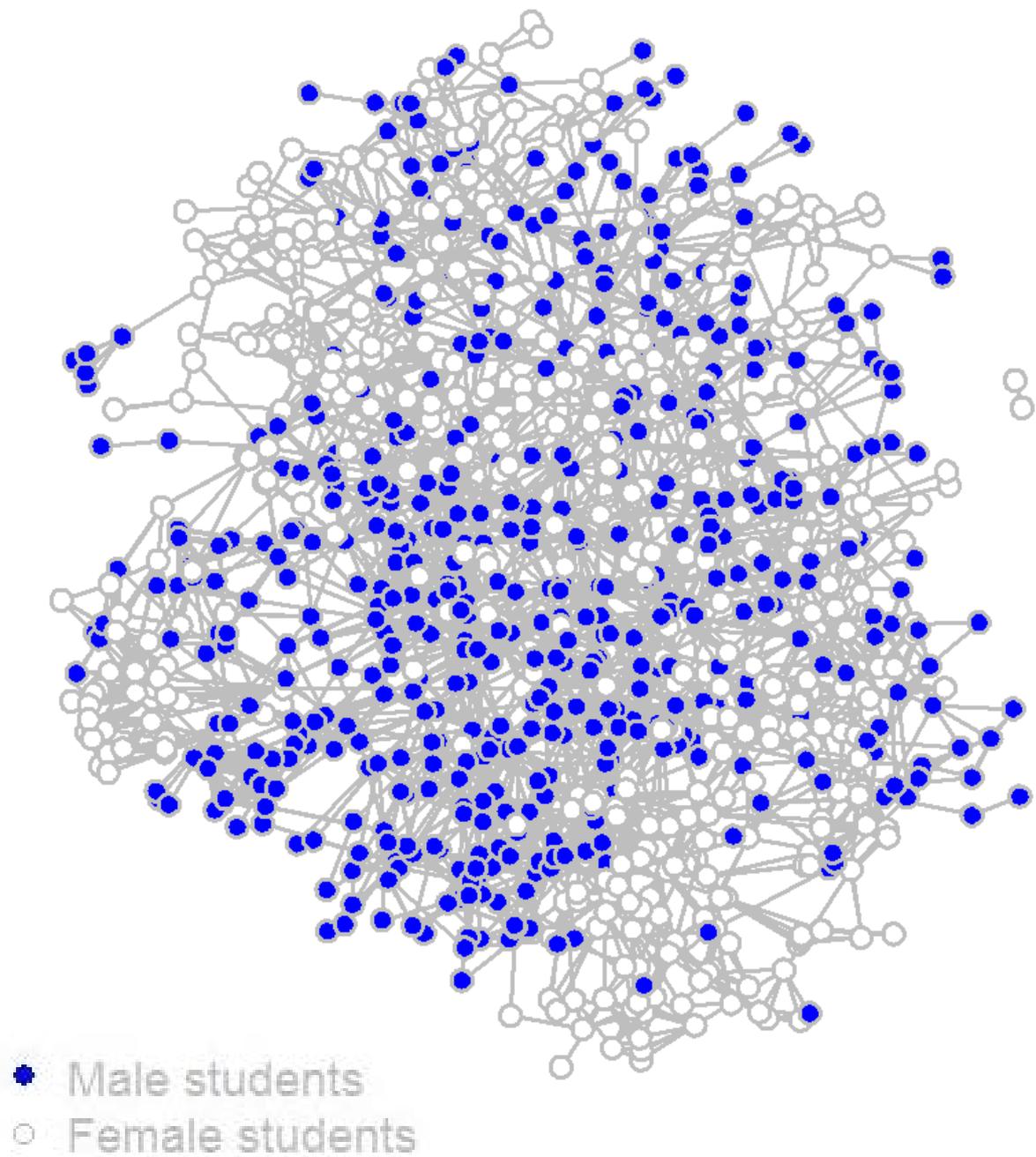


Figure 8.1. Graph of the school social network at Wave 1 which displays male students as blue dots and female students as white dots.

8.6 *Limitations, generalisability and future research*

The results and implications of the present thesis need to be interpreted in light of a number of limitations. Many of these limitations arose due to the focus on a single school, the need to minimise questionnaire length to maximise response rate, and the challenges associated with analysing social network data. In this section I reiterate some of the key limitations that are relevant to the interpretation of contagion effects and discuss the generalizability of the findings.

The residualised change models included Time 1 ego behaviour as a predictor in order to control for shared variance with measured and unmeasured variables which may confound estimates of contagion. However Shalizi and Thomas (2011) argue that it is impossible to completely rule out latent homophily (i.e. homophily on an unobserved characteristic) without very strong parametric assumptions. For example, spurious relationships may have been generated between friend's behaviour and residualised change in ego behaviour if an unmeasured variable influences change in behaviour more than it influences Time 1 behaviour and the unmeasured variable is also correlated with friends' Time 1 behaviour. It is also possible that the non-independence of friends' behaviour may have created additional modelling complexities that were not accounted for through the adjustment of standard errors.

In addition the prediction of ego Time 2 behaviour by friends' behaviour over and above ego Time 1 behaviour may be capturing error in the estimation of Time 1 behaviour. The measures relied on self-report and recall of previous behaviour and both of these features will generate some error in how well they capture actual behaviour. The measure of transport behaviour should contain less error as it did not rely on a single report of behaviour but instead asked about 10 individual trips. In addition many of the measures had low or unknown reliability and all relied on self-report data. Therefore it is possible that friends'

behaviour influenced reports of participant's own behaviour. This could generate error in the reporting of behaviour but should make influence less likely to be detected by over-inflating the degree of similarity in friend's behaviour at Time 1 and thus reducing the ability to detect increases in similarity.

The analysis did not account for social network structure given that the amount of missing data in these studies was greater than is recommended for studies assessing social network structure. It is possible that social network structure may act as a third unmeasured variable generating relationships between friends' behaviour and ego behaviour. This could be the case if social network structure is related to friends' behaviour and to Time 2 behaviour, above and beyond its relationship with Time 1 behaviour. I was unable to examine this in the present study due to the potential bias in these measures created by missing data.

In addition, the choice of the repeated measures analysis may have limited the power to detect relationships between key variables. The residualised change model was unable to capture contagion that occurred simultaneously, rather than with a delayed impact. This may explain why perceptions of friends' behaviour were not predictive of change in littering and recycling behaviour even though focus group participants reported that perceptions of friends' behaviour motivated their own littering behaviour. It is also possible that perceptions of behaviour across the whole school site or wider community are more important than perceptions of what immediate friends are doing. Friends' behaviour, perceived friends' behaviour and co-travel requests were all related to concurrent transport behaviour therefore it is possible that these had a causal effect on concurrent behaviour. Likewise, friend encouragement, perceived friends' behaviour and friends' behaviour were all correlated with concurrent littering and recycling at a single time point (see the Supplementary material for Chapter 8). Unfortunately I could not directly test for a simultaneous causal effect given that causal processes cannot be isolated with cross-sectional observational data. The inability to

isolate simultaneous causal effects was an unfortunate limitation however the residualised change specification was necessary to account for many of the potential confounds in the estimation of contagion in behaviour. Finally, the analysis reported in Chapter 7 attempted to draw implications about language in use but relied on simulated focus group conversations. These conversations will not be identical to the dynamics of informal conversations between friends because I, the moderator, was present. However mitigating this, the focus groups featured a number of sections of conversations between participants that were relatively uninterrupted by the moderator.

This study was also limited in its generalizability. The school where the research was undertaken was a relatively affluent school located in Auckland, New Zealand. Students were exposed to sustainability issues through assemblies, events and the school curriculum but anecdotally most students were relatively disengaged from environmental activities. The weather and local road infrastructure meant that active transport was a feasible method of travel for many students.

The relationship with friends' prior behaviour and cycling behaviour may be particularly unlikely to generalise to locations where weather or road safety prohibits cycling to school or where the social culture around cycling is prohibitive. Likewise friend influence on littering and recycling behaviour may not generalise to other schools or samples of adolescents where recycling and (non) littering are uncommon, or where there are other strong forces that motivate or demotivate littering and recycling. Similarly, what counts as appropriate environmental behaviour may be constructed in different ways by students in other schools or localities. However the justifications are unlikely to be unique to this school because similar justifications and subject positions are noted in studies with adults (e.g. Skill & Gyberg, 2010). Researching these phenomena in a handful of schools would still not have identified whether these phenomena were ubiquitous in adolescent school social networks. The focus

on a single school made a longitudinal analysis of the social network and an in-depth study supported by a strong understanding of the school dynamics feasible.

Caution needs to be taken in generalising these findings to other pro-environmental behaviours. As I've argued in the thesis, behaviours are distinct, as are the factors that contribute to them. For example in Chapter 6 a different pattern of personality traits predicted each pro-environmental behaviour included in that chapter. Waste sorting behaviour may offer close to a "best case" scenario for social influence on pro-environmental behaviour because it is relatively easy to perform and often visible to others. The visibility will increase the opportunity to observe others' behaviour and for others to praise or reward these behaviours. On the other hand transport behaviours are constrained by practical factors, making the evidence consistent with contagion in cycling, and possibly walking, among males particularly noteworthy. Nonetheless friends may not be influential in other behaviours. In particular, consumer purchasing behaviour in young people is largely driven by parental decisions (Grønhøj, 2006) and thus is unlikely to be altered by interventions focusing solely on adolescents.

Investigating simple contagion processes is an important point for further research given that the environmentally significant behaviours are commonly only being undertaken by a small minority of individuals (Whitmarsh, 2009). Theoretical models of minority influence and qualitative research may also be useful for understanding how the few people who do engage in pro-environmental behaviour may encourage others to do so (Arnold et al., 2009). It will also be important to test other potential mechanisms of social influence. Social affirmation identified in Arnold et al. (2009); Nye and Hargreaves (2010) could spread along single ties and thus offer greater possibilities for diffusion than mechanisms that require multiple individuals to be performing the behaviour. This, and the possibility that information sharing could facilitate contagion (e.g. Rogers, 1983) are also important avenues for future research.

Descriptive norms of friends' behaviour, encouragement and co-travel requests should also not be ruled out on the basis of the research presented in this thesis because the conditional change models did not test the impact of these mechanisms on concurrent behaviour.

As argued in Chapter 7, justifications of one's own lack of pro-environmental behaviour may operate as a form of ("negative") contagion of pro-environmental behaviour by shifting friends' ideas about pro-environmental behaviour. Conversely, self-stereotyping may act as a mechanism of ("positive") contagion of pro-environmental behaviour. The identification with environmental stereotypes appeared to foster an alternative narrative which challenges the idea that environmentally-significant behaviours are unrealistic. If this alternative narrative causes friends to adopt more pro-environmental behaviour this would be an example of indirect contagion. A useful next step would be to experimentally test the theory that justifications alter perceptions of what is considered appropriate and alter engagement in pro-environmental behaviour.

In addition, self-categorisation theory (Abrams et al., 1990; Turner et al., 1987) theorises processes which could underpin contagion of pro-environmental behaviour and were not explicitly tested in this thesis. Self-categorisation theory focuses on perceptual categorisation of oneself and others into reference groups (broad social groups that people identify with such as "academics") and the links between in-group identification and personal self-esteem. These processes have implications for the types of behaviours a person may be motivated to adopt. According to self-categorisation theory, influence (including contagion) may occur when the following conditions are present: the person identifies with the reference group, the reference group is salient, and the behaviour of interest is relevant to group identification.

As argued in Chapter 1, relational groups (groups formed through friendship connections) may overlap with reference groups which are central to self-categorisation theory's conceptualisation of influence. For example, individuals in a person's relational group could

act as prototypical examples of the reference group which they share (i.e. prototypical male adolescents) and membership within a relational group could become linked to the individual's identity in ways that promote in-group conformity. Thus relational groups may also be a source of self-categorisation related conformity effects. Future studies looking at influence in social networks could investigate if self-categorisation based conformity processes may be an important mechanism of contagion. To do this, it is important to assess if contagion depends on whether an actor identifies with their relational group, whether this group is salient and whether they consider the influencing actor/s to be prototypical of that group.

Finally, experimental research may offer greater scope to study contagion processes in pro-environmental behaviour. The data presented in my thesis assesses “naturally occurring” influence processes but does not assess what might be possible if students were trained to encourage others. It is also impossible to rule out alternative explanations without an experimental design. Studying successful cases of youth-based environmental organisations may also be another fruitful method for building theory and knowledge in this area.

8.7 Closing remarks

The research presented in this thesis demonstrated that pro-environmental behaviour is not distributed randomly across the social landscape of this high school social network. Population-based interventions which treat a group as homogenous and ignore the social context or individual differences in people's motivations for pro-environmental behaviour may be missing key opportunities to increase the number of people engaging in these behaviours.

Many authors (e.g. Ogilvie, Egan, Hamilton, & Petticrew, 2004; L. Yang, Sahlqvist, McMinn, Griffin, & Ogilvie, 2010) have lamented the difficulty of changing transport behaviours. Changing transport behaviours is difficult because these behaviours are relatively

habitual (Klößner & Matthies, 2004) or are partly constrained by the physical context (McMillan, 2007; Titze, Stronegger, Janschitz, & Oja, 2008; Van Acker et al., 2010). Thus it is noteworthy that these results were consistent with contagion in cycling among male students. The research presented in this thesis also shows that pro-environmental behaviours are held in place by the individual's primary reference group. Evidence of contagion in littering and recycling builds on prior studies demonstrating influence (e.g. Cialdini et al., 1990), yet provides an important contribution through its focus on adolescents, social networks, the relevance of immediate friends and examination of change seven months later.

Identifying how to encourage pro-environmental behaviours is one of the great challenges of the 21st century. Thus there is an urgent need to advance our understanding of factors that contribute to engagement in activities that mitigate our impact on the planet. The research presented in this thesis contributes in a small way to this challenging but important task. It uses social network data to explore how adolescent transport and littering behaviour is socially clustered, and whether and how social contagion operates on these behaviours.

Appendix A: Supplementary material

Supplementary material for Chapter 2

In this appendix I explore correlations between pro-environmental behaviour variables and social network metrics.

One of the advantages of the social network techniques that I did not employ (e.g. AALAM and SAOM) is that they are able to account for aspects of the network structure such as actor indegree. However, estimates of network structure are heavily influenced by missing data (Huisman & Steglich, 2008) and thus there appeared to be minimal value in utilising models that incorporated indices of social structure. Whilst I cannot ascertain the degree of bias in the social network measures based on the data collected, I can tentatively explore how the potentially biased indices were related to the other variables measured in this thesis.

Before presenting the correlations between measures of network structure and other variables it is useful to briefly introduce the measures of network structure. In-degree captures the number of people who nominated the ego and provides a measure of local popularity. Local transitivity is the number of sets of three connected actors which include the target actor as a proportion of the possible sets of three actors including the target actor.

Centrality estimates the importance of an actor based on its connections to other actors in the network. There are a number of subtypes of centrality. Here I focus on eigenvector centrality which provides a relatively global measure of how well each actor is connected to the rest of the network. The calculation takes into account the indegree of the actor as well as in degree of the actor's friends, friends of friends and so on. Betweenness centrality is a measure of how much an actor bridges parts of the network that would otherwise be

relatively unconnected. This is calculated as the number of most direct paths between individuals in the network that cross through that person.

Correlations between social network metrics (degree, eigenvector centrality, local transitivity and betweenness), key behaviours (littering, recycling, walking, cycling and active transport²²) are presented in Table A1. Eigenvector centrality was significantly correlated with all behaviours; positively with both littering and recycling and negatively with all three transport behaviours. Cycling was also negatively correlated with degree. These analyses suggest that more popular students tended to be more likely to both litter and to recycle, which seems somewhat counter-intuitive and indicates that our social network measures may be biased by missing data. Given the missing data in our social network data it is beyond the scope of the present work to investigate how this may impact on social dynamics in this context.

As shown in Figure A 1 eigenvector centrality has the potential to overlap with friends' scores because it is calculated in part based on friends' popularity. Figure A1 displays the social network the size of the nodes representing those highest in eigenvector centrality²³. Eigenvector centrality was particularly high among nodes who attended the school language unit (top right of this graph).

²² Active transport scores combine walking, cycling, skateboarding and scootering trips.

²³ Eigenvector centrality was normalised by transforming it to the power of 0.1.

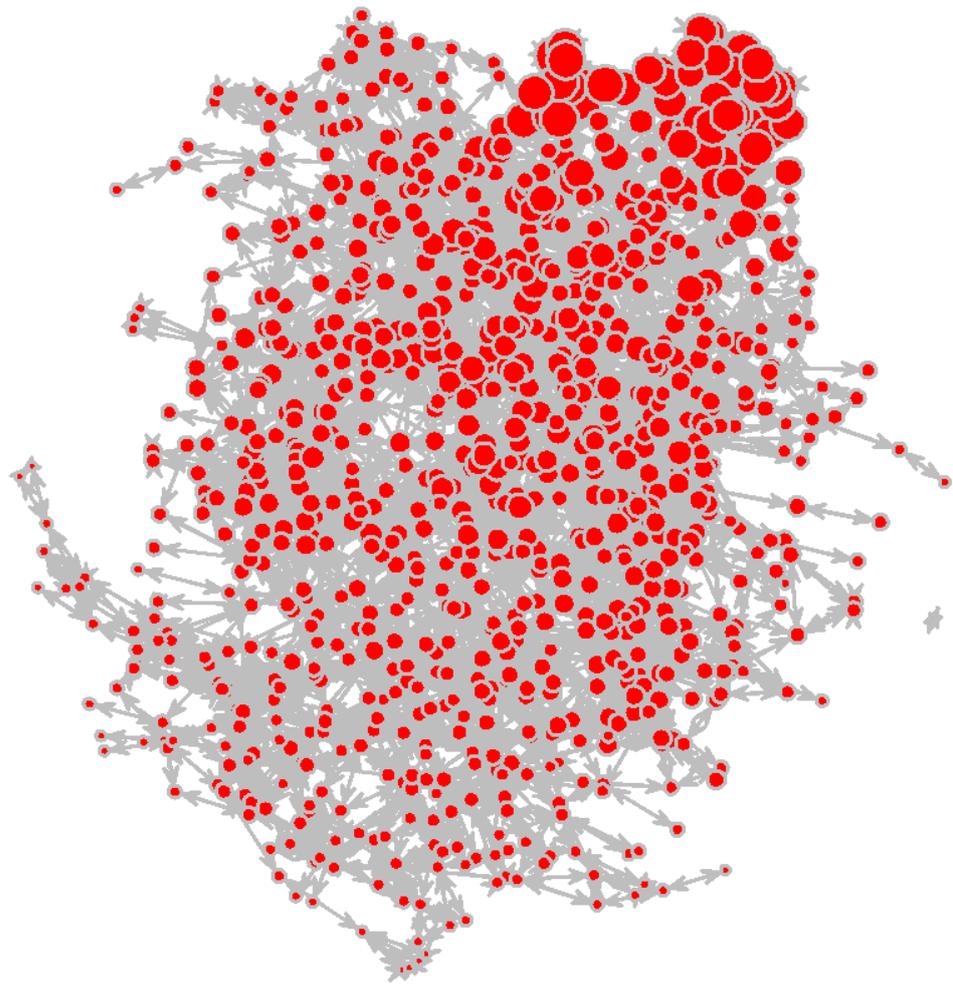


Figure A1. Eigenvector centrality plotted on the school social network. Node size is proportional to the (normalised) eigenvector centrality of the node.

Table A 1. Correlation matrix of key variables and social network indices at Time 1

	1	2	3	4	5	6	7	8	9
1 Active transport									
2 Walking	0.86***								
3 Cycling	0.29***	-0.20***							
4 Littering	-0.11**	-0.07	-0.07*						
5 Recycling	0.04	0.05	0.02	-0.34***					
6 Degree	-0.01	0.03	-0.07*	0.04	0.09*				
7 Local transitivity	0.01	0.02	-0.01	0	-0.03	-0.11**			
8 Eigenvector centrality	-0.14***	-0.09**	-0.10**	0.12***	0.07*	0.56***	-0.12***		
9 Betweenness	-0.04	-0.02	-0.03	0.01	0.05	0.63***	-0.62***	0.37***	-

Note. Significant correlations between key variables and the social network matrices are displayed in bold * $p < .05$; ** $p < .01$; *** $p < .001$

Supplementary material for Chapter 3

Table A 2. Join count tests assessing social clustering in walking, cycling and gender (n = 934)

Variable	<i>JC</i>	<i>p</i>
Gender (Female)	1141	0.0001
Gender (Male)	1074	0.0001
Language unit student	317	0.0001
Main school student	2252	0.0001

Table A 3. Moran's I tests assessing social clustering in continuous covariates and social variables (n = 934)

Variable	<i>n</i>	<i>I</i>	<i>p</i>
Distance (logged)	892	0.32	0.0001
Age (years)	934	0.81	0.0001
Parent AT encouragement	852	0.11	0.0001
Ride availability	911	0.02	0.147

Table A 4. Percentage of students using each transport mode accompanied by any friend, their ‘best friend’ and with a sibling

	n	% of students	Percentage of individuals accompanied by		
			Any friend	‘Best’ friend	Any sibling ^a
Often walk	437	46.8%	59.3%	43.1%	17.6%
Often cycle	72	7.7%	37.5%	35.1%	2.8%
Often skate or scooter	13	1.4%	0.0%	0.0%	0.0%
Often actively transport ^b	500	53.5%	57.4%	41.9%	16.2%
Often travel by bus	273	29.2%	53.5%	39.5%	12.5%
Often travel by car	181	19.4%	34.8%	26.4%	23.8%
Other or mixed	97	10.4%	46.4%	29.1%	16.5%
Missing data	13	1.4%	38.5%	100.0%	7.7%
Total	934	100.0%	54.6%	30.6%	17.2%

Note. The % will not add up to 100 because anyone who walked was also included in the AT scores and individuals could use two modes for five of their ten trips per week. The percentage of friends and siblings is calculated from the people who specified a friend, best friend or sibling rather than as a percentage of the total people using this form of transport. Only travel with nominated siblings who went to this school was included.

^a Siblings were not included in the social network matrix or friend mean calculations for the main analyses.

^b Active transport scores combine walking, cycling, skateboarding and scootering trips.

Supplementary material for Chapter 4

Relationships between transport scores and survey dropout

T-tests and non-parametric group comparisons were not appropriate for testing group differences given the non-independence of our data. Instead we use regressions corrected for non-independence among friends to identify differences between those who participated only at Time 1 and those who participated at both time points. Students in their final year of school were removed from this comparison to avoid confounding age and dropout effects.

The regression predicted each transport mode at Time 1 from a dummy variable with two levels; 1) only participating at Time 1 or 2) participating at both Time 1 and Time 2. As shown in Table A5, students who participated at both time points walked significantly more often and used bus travel significantly less often compared to participants who only completed the survey at Time 1. There was no difference in the cycling and car travel behaviour of the two groups.

Table A 5. Gaussian regression predicting the frequency of each transport mode at Time 1 from a dummy variable identifying whether the person took part at Time 1 or at both Time 1 and Time 2

	Walk		Cycle		Car		Bus	
	OR	OR CI	OR	OR CI	OR	OR CI	OR	OR CI
(Intercept)	3.66***	(3.12, 4.2)	0.45***	(0.22, 0.67)	2.00***	(1.61, 2.4)	3.06***	(2.56, 3.56)
Participated at Time 1&2	1.07**	(0.4, 1.74)	0.25	(-0.02, 0.51)	-0.33	(-0.75, 0.09)	-0.73*	(-1.29, -0.17)

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

Testing relationships between demographic, contextual covariates and change in transport

Table A6 presents the full set of odds ratios and confidence intervals for models reported in Table 1 of the manuscript. The column headers represent the dependent variable for each regression.

Table A 6. Logistic regression predicting Time 2 often use walking, cycling, car travel and bus travel from Time 1 behaviours friends' behaviour potential demographic and contextual covariates statistically adjusting for Time 1 ego behaviour (n = 440)²⁴

	Walking		Cycling		Car travel		Bus travel	
	OR	OR CI	OR	OR CI	OR	OR CI	OR	OR CI
(Intercept)	0.07***	(0.04, 0.12)	0.02***	(0.01, 0.03)	0.06***	(0.04, 0.09)	0.05***	(0.03, 0.09)
Time 1 ego behaviour	1.50***	(1.39, 1.61)	1.63***	(1.44, 1.84)	1.48***	(1.35, 1.62)	1.59***	(1.43, 1.75)
Friends' behaviour ^a	1.18**	(1.07, 1.30)	1.24	(0.95, 1.62)	1.04	(0.86, 1.25)	1.16	(0.96, 1.39)
(Intercept)	0.03***	(0.01, 0.10)	0.01**	(0.00, 0.16)	0.11***	(0.04, 0.28)	0.19**	(0.07, 0.57)
Time 1 ego behaviour	1.48***	(1.37, 1.59)	1.67***	(1.47, 1.90)	1.46***	(1.34, 1.60)	1.56***	(1.41, 1.73)
Time 1 parent encouragement	1.35**	(1.11, 1.65)	1.08	(0.67, 1.71)	0.90	(0.75, 1.09)	0.82*	(0.67, 1.00)
(Intercept)	0.27**	(0.13, 0.54)	0.03***	(0.01, 0.08)	0.05***	(0.03, 0.09)	0.03***	(0.02, 0.06)
Time 1 ego behaviour	1.45***	(1.34, 1.58)	1.67***	(1.48, 1.88)	1.46***	(1.32, 1.60)	1.52***	(1.38, 1.68)
Distance (logged)	0.69*	(0.50, 0.94)	0.64	(0.32, 1.26)	1.17	(0.85, 1.60)	1.68***	(1.26, 2.24)
(Intercept)	0.15***	(0.09, 0.27)	0.01***	(0.00, 0.01)	0.08***	(0.05, 0.12)	0.06***	(0.04, 0.11)
Time 1 ego behaviour	1.52***	(1.41, 1.63)	1.67***	(1.47, 1.89)	1.49***	(1.36, 1.63)	1.61***	(1.45, 1.78)
Gender	0.80	(0.47, 1.36)	4.14***	(2.26, 7.57)	0.61	(0.34, 1.08)	1.18	(0.59, 2.36)
(Intercept)	0.35	(0.01, 10.47)	0.08	(0.00, 12.78)	0.03*	(0.00, 0.82)	0.03	(0.00, 5.03)
Time 1 ego behaviour	1.52***	(1.41, 1.64)	1.69***	(1.50, 1.90)	1.48***	(1.35, 1.62)	1.61***	(1.45, 1.78)
Age (years)	0.93	(0.74, 1.18)	0.90	(0.64, 1.28)	1.06	(0.84, 1.34)	1.06	(0.74, 1.53)
(Intercept)	0.17***	(0.11, 0.26)	0.02***	(0.01, 0.04)	0.06***	(0.04, 0.09)	0.06***	(0.04, 0.09)
Time 1 ego behaviour	1.49***	(1.39, 1.61)	1.69***	(1.50, 1.90)	1.46***	(1.33, 1.6)	1.60***	(1.45, 1.77)
School language unit	0.11***	(0.04, 0.30)	1.05	(0.43, 2.54)	2.08	(0.93, 4.63)	3.75**	(1.48, 9.54)

Note. * $p < .05$; ** $p < .01$; *** $p < .001$. ^a Friends' behaviour on the dependent variable listed in the column heading (i.e. walking, cycling, car travel and bus travel)

²⁴ For these analyses the data were subset to cases with full data on variables in this table.

Table A 7. Logistic regression predicting Time 2 cycling from Time 1 friends' behaviour statistically adjusting for Time 1 ego behaviour, parent encouragement, school language unit and distance, excluding gender (n = 442)

	Cycling		
	OR	OR CI	<i>p</i>
Intercept	0.03	(0.00, 0.50)	0.014
Friends' cycling behaviour	1.25	(0.95, 1.64)	0.118
Time 1 ego behaviour	1.62	(1.41, 1.85)	<.0001
Parent encouragement	0.97	(0.60, 1.57)	0.895
Distance (logged)	0.60	(0.30, 1.21)	0.154
School language unit	1.85	(0.62, 5.48)	0.270
Model <i>LL</i>			-54.6

Note. Log likelihood tests compared the log likelihood of a model with and without friends' cycling behaviour was not significant. (*LL covariates with friends' cycling* = -54.6, *LL covariates only* = -55.7, χ^2 (1, N = 442) = 2.26, *p* = .132)

Supplementary material for Chapter 6

Gender and school unit differences in self-reported pro-environmental behaviours

Inspection of the data revealed gender differences in scores on the environmental measures. Female students, on average, had greater self-reported waste sorting ($F M = 5.7$, $SD = 1.1$, $M M = 5.4$, $SD = 1.2$, $t(841.3) = 3.53$, $p = 0.0004$), perceptions that peers sorted waste ($F M = 5.1$, $SD = 0.92$, $M M = 4.8$, $SD = 1.2$, $t(841.9) = 5.23$, $p < .0001$) and water conservation ($F M = 4.2$, $SD = 1.6$, $M M = 3.8$, $SD = 1.2$, $t(826.9) = 3.63$, $p = 0.0003$), relative to male students. Female students were lower in self-reported littering ($F M = 2.1$, $SD = 1.1$, $M M = 2.3$, $SD = 1.2$, $t(845.8) = -3.09$, $p = 0.002$) and were no different from male students in their self-reported power conservation ($F M = 4.7$, $SD = 1.6$, $M M = 4.6$, $SD = 1.2$, $t(825.7) = -0.0119$, $p = 0.991$).

Students enrolled in the language unit were slightly higher self-reported waste sorting (Main school $M = 5.5$, $SD = 1.2$, Language unit $M = 5.8$, $SD = 1.1$, $t(187.1) = -2.4$, $p = 0.017$), perceptions that peers sorted their waste (Main school $M = 4.9$, $SD = 0.98$, Language unit $M = 5.1$, $SD = 1.1$, $t(191) = -2.41$, $p = 0.017$). They were also slightly lower on their self-reported littering (Main school $M = 2.1$, $SD = 1.1$, Language unit $M = 2.4$, $SD = 1.3$, $t(193.8) = -2.13$, $p = 0.034$) and perceptions of whether peers littered (Main school $M = 3.4$, $SD = 1$, Language unit $M = 3.6$, $SD = 1.2$, $t(60.38) = -2.46$, $p = 0.015$), relative to students enrolled in the main school. Students enrolled in the language unit were no different in their power conservation (Main school $M = 4.7$, $SD = 1.7$, Language unit $M = 4.5$, $SD = 1.7$, $t(197.6) = 1.37$, $p = 0.173$) or water conservation (Main school $M = 4.0$, $SD = 1.7$, Language unit $M = 3.9$, $SD = 1.7$, $t(197.6) = 1.17$, $p = 0.244$), relative to students enrolled in the main school.

Tests for heteroskedasticity and spatial dependence

Anselin (2005) describes interpretation of the Lagrange (LM) tests as follows; if only the LM lag or LM error term is significant, use a spatial or spatial error, whichever is significant. If neither are significant then the linear regression is appropriate. If both are significant refer to the robust LM tests and use whichever is significant.²⁵ If the SARMA term is significant this indicates that the error and robust lag spatial component are significant, and thus a model with both, such as a model combining both spatial lag and spatial error terms may be more appropriate.

The Breusch-pagan tests (Breusch & Pagan, 1980) suggest that the models contain substantial heteroskedasticity which would bias the fit of a spatial lag or spatial error model, the LM test and linear regression models. As a result, we use heteroskedasticity corrected “HC3” versions of robust standard errors for the linear regressions reported in the main paper.

To test for the robustness of these main analyses to spatial biases we consider a generalised spatial two stage least squares regressions (GSTSLS: Kelejian & Prucha, 1998; Kelejian & Prucha, 2010) most appropriate for this data. The GSTSLS models account for heteroskedasticity and model both an error and a (robust) lag spatial component.

²⁵ Anselin, L. (2005), *Exploring Spatial Data with GeoDa: A Workbook*, <http://geodacenter.asu.edu/system/files/geodaworkbook.pdf>

Table A 8. Summary of the Lag range and Breusch-pagan tests

Hypothesis tested	DV	LM lag test	LM error test	LM robust lag test	LM robust error test	SARMA	Breusch-pagan test ^a
H1a-H6a	Littering	26.08***	13.83***	21.4***	9.16**	35.23***	60.88***
H1b-H6b	Waste sorting	3.64	6.82**	1.36	4.54*	8.18*	22**
H1c-H6c	Power	4.15*	3.74	0.49	0.07	4.22	21.08*
H1d-H6d	Water	7.49**	7.95**	0	0.46	7.95*	17.24*

Note. Breusch-pagan tests were calculated on the original linear regression model.

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

Tables A11 and A12 present the analysis predicting littering, waste sorting, power and water conservation. The analysis predicting change in littering and recycling was not assessed with a spatial model as there was no evidence of outstanding spatial dependence in these models.

Table A 9. Generalised spatial two stage least squares regression predicting self-reported littering and waste sorting from personality traits and gender (n =816, 815)

	Littering			Waste sorting		
	B	SE	p	B	SE	p
(Intercept)	2.88	0.53	<.0001	3.11	0.62	<.0001
Openness to Experience	-0.25	0.04	<.0001	0.08	0.05	0.127
Conscientiousness	-0.10	0.04	0.005	0.11	0.04	0.004
Agreeableness	-0.19	0.05	0.000	0.26	0.05	<.0001
Honesty-Humility	-0.05	0.03	0.144	0.01	0.04	0.862
Extraversion	0.14	0.04	0.0001	0.08	0.04	0.057
Neuroticism	0.09	0.04	0.010	-0.08	0.04	0.048
Gender (male)	0.11	0.09	0.204	-0.14	0.09	0.138
Language unit	0.12	0.13	0.373	0.30	0.13	0.015
Age (years)	0.07	0.03	0.006	0.01	0.03	0.642
lambda	0.00	0.01	0.851	0.00	0.00	0.902
rho	0.05	0.01	0.0003	0.03	0.01	0.003

Note. Lamda captures the spatial component in the error term of the model (i.e. similarity in error term between friends) and rho captures the spatial dependence between neighbouring friends' scores.

Table A 10. Generalised spatial two stage least squares predicting self-reported power and water conservation from personality traits and gender (n = 807, 807)

	Power			Water		
	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>
(Intercept)	2.21	0.84	0.009	1.69	0.92	0.068
Openness to Experience	-0.05	0.07	0.425	0.01	0.07	0.893
Conscientiousness	0.34	0.06	<.0001	0.32	0.07	<.0001
Agreeableness	0.00	0.07	0.979	0.09	0.08	0.216
Honesty-Humility	0.14	0.05	0.008	0.20	0.06	0.0003
Extraversion	0.04	0.06	0.563	-0.08	0.06	0.216
Neuroticism	-0.12	0.06	0.033	-0.07	0.06	0.237
Gender (male)	0.08	0.13	0.522	-0.30	0.13	0.024
Language unit	0.22	0.16	0.182	-0.14	0.18	0.462
Age (years)	-0.03	0.04	0.428	0.03	0.04	0.555
lambda	0.01	0.01	0.426	0.004	0.01	0.500
rho	0.002	0.01	0.855	0.02	0.01	0.038

Note. Lamda captures the spatial component in the error term of the model (i.e. similarity in error term between friends) and rho captures the spatial dependence between neighbouring friends' scores.

Supplementary material for Chapter 8

Social clustering in personality variables

Moran's I analysis followed the same general procedure outlined in Chapter 3 and 4. The arrangement of Time 2 (wave 3) measures of personality traits on the social network were assessed using the Moran's I analysis, with permutation tests ($n = 1000$) were used to assess the significance of the resulting Moran's I value.

Moran's I scores shown in Table A14 indicate that Openness to Experience, Agreeableness, Honesty-Humility, Extraversion, and to a lesser extent Conscientiousness were all clustered in the school social network.

Table A 11. Moran's I tests assessing social clustering in personality variables ($N = 819$)

	<i>I</i>	<i>p</i>
Openness to Experience	0.13	0.0001
Conscientiousness	0.04	0.018
Agreeableness	0.20	0.0001
Honesty-Humility	0.10	0.0001
Extraversion	0.12	0.0001
Neuroticism	0.01	0.284

Concurrent relationships between waste-related variables

Chapter 5 did not explicitly explore concurrent relationships between friends' behaviour, norms, encouragement and ego behaviour. Correlations between Wave 1 measures of these variables are presented in Table A14. All variables were significantly related to one another. Littering and recycling measures were negatively correlated with one another.

Table A 12. Spearman's' correlations between littering and recycling, perceived friends' behaviour (norms), friends encouragement²⁶, independently reported friends' behaviour and ego behaviour at Wave 1

	1	2	3	4	5	6	7
1 Ego recycling	-						
2 Recycling norms	0.69***	-					
3 Recycling encouragement	0.34***	0.45***	-				
4 Friends' recycling behaviour	0.10**	0.16***	0.11***	-			
5 Ego littering	-0.33***	-0.24***	-0.18***	-0.12***	-		
6 Littering norms	-0.17***	-0.35***	-0.27***	-0.20***	0.50***	-	
7 Friends' littering behaviour	-0.09**	-0.17***	-0.15***	-0.36***	0.32***	0.33**	*

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

²⁶ Friend encouragement was measured for recycling only.

Appendix B: Selected data collection materials

Survey information sheet for the school principal

Social Networks in Schools

Researchers: Dr Niki Harre, Dr Quentin Atkinson, Jenny Long (Masters thesis student) and Louise Walker (Honours dissertation student)

This information sheet is an official request for the Department of Psychology at the University of Auckland to undertake a new research project “Social networks in schools”. This research would be supervised by Associate Professor Niki Harre, the principal investigator for the action research project “Creating a sustainable school” which has been running in Western Springs College since 2008. Senior Lecturer Dr Quentin Atkinson and two students Jenny Long (masters thesis student) and Louise Walker (an honours dissertation student) will be working with Niki on the social networks project. Funding for this project is being sought through the University of Auckland. Through this project we hope to better understand how young people’s attitudes and behaviours relate to the attitudes and behaviours of their friends and family members; in particular we will focus on healthy eating, physical activity, use of active transport and academic grades. It is intended that the project will run from 2011 until the end of 2013.

To investigate social influence we would first like to conduct a survey that asks students to record the names of their close friends and their siblings so that we can create a “map” which identifies how students are connected with one another. The survey will also ask students about their own, their friends and their family’s attitudes and behaviours related to healthy eating, physical activity, and sustainability of themselves, their friends and their family. The questionnaire will also ask about their height, weight, siblings, who they are friends with and ask them to mark their home on a map of the school catchment area. We would then be able to look at how similar students are to students they are closely connected to within the school social network.

We would also like to request the grades awarded to students on their achievement reports in terms 2 and 4, as well as their NCEA results. The grades we extract from the school will be listed by student ID numbers but will not include any student names. We ask that you provide that information within one month of the reports being released and within two months of the school receiving the NCEA results. We will discuss with you an appropriate pay rate for a staff member to undertake the necessary information retrieval processes involved, this money will be distributed to the school to redistribute to the staff member/s involved.

After obtaining your approval, the first stage of the research would be to pilot the questionnaire in four Year 10 maths classes during May 2011. In about September 2011 we would run a revised version of this questionnaire with students from Years 9-12. We would like to re-run this survey twice every school year so that we can investigate how students may be influencing changes in their friends’ behaviour over time. We estimate that each questionnaire will take about 20 minutes to complete, and it will take an additional 10 minutes to explain the questionnaire to the students. We would also like to spend time introducing the students to the study during school assemblies so that they fully understand what is involved in participation in this project, and later present the results of the study to provide students with information about how research can be used to understand real-world problems.

In 2012, we would also like to conduct interviews with a smaller number of students. We plan to invite students who appear to have changed their eating, physical activity and/or transport behaviour to better understand why this might be. We will require some assistance from the

school to locate the students from the list of student ID numbers that we will generate from the results of our surveys. Each interview is expected to take between 15 and 45 minutes, and will take place during lunchtime. We will hold these interviews in a quiet place on the school grounds, preferably in an office or classroom that is not being used. Participating students will be provided with lunch as compensation for their time.

At all times, we will be sensitive to the school's reputation and to our participation as invited guests at the school. Niki Harré or Quentin Atkinson will read all material produced by the University of Auckland students prior to it being shown to anyone else. Three types of reports may arise from this study: theses or dissertations produced by the students (student work), articles for academic journals (articles) and media releases, magazine articles, material for the school website or other similar material (public reports).

In all of the above, the name of the school will only be used with your permission. We will ask you to sign your agreement to this on the consent form, but you may change your mind as long as you give us reasonable notice. In the case of our students' work, this will need to be by October 1, 2011. We will not use individual's names in any material we produce, only summary data from the questionnaire and anonymous interview quotations will be used.

If you sign the attached consent form, you will not be able to withdraw the survey data, the academic performance data or material from individual interviews once it is collected. However, we will show you all articles and public reports, as described earlier, before they are released. We will discuss and where possible address any concerns you may have with the content of these reports, however we maintain the final decision about the content and whether or not we submit academic articles or release any public information about the study.

The following additional measures will be taken to ensure everyone is fully informed about this project, gives voluntary consent to participation, and feels able to withdraw anything they have contributed within a reasonable time.

1. We will ask for written consent from form teachers for their classes to participate in the questionnaire. We will also work with them to ensure that any students who do not wish to take part, or whose parents do not wish them to take part (if the student is under 16 years) are treated sensitively. For example, we will make arrangements for that student to do something different while the questionnaire is taking place or suggest the student; either take a questionnaire and not complete it, or do other silent work during the questionnaire period.
2. We will ask teachers to identify any students who may have difficulty giving informed consent due to language or cognitive difficulties. For these students to participate we will require written parental consent. If this is not obtained, or if we agree that the student does not have the capacity to understand the written questionnaire, we will work with the teacher on alternative arrangements for that student when the questionnaire is being delivered.
3. All staff and students will receive an information sheet (attached) informing them that the project is taking place and requesting their participation in the questionnaire. They will be informed that participation is voluntary and be told how to withdraw their participation. Information sheets will also be provided for parents, to be distributed in a way negotiated with you, ideally with a school newsletter posted home directly. Parents of students under 16 years will be informed as to how they can withdraw their child's participation from the questionnaire. All students will be asked to sign consent to participate.
4. A member of your school staff will be recruited to replace names collected on the questionnaire forms with student ID codes before the information is entered into our dataset. Student ID codes will be replaced with 5 digit numbers in any information that is

published from this research project. The academic grade information we collect will be linked to student ID numbers but will not include a list of student names.

5. In every case, when we interview an individual, we will provide a second information sheet to students selected to participate and the parents of students under 16 years of age who are invited to participate. We will require written consent from parents prior to the participation of students under 16 in this section of the study. These interviews will be audio-taped and later transcribed. Any individuals not mentioned on this form that are involved in transcribing will be required to sign confidentiality agreements that state that they will not talk about any of the comments from the interviews with other persons.
 6. We would also like to ask for your assurance that the participation or non-participation of students and staff at the school in this research will in no way affect their relationship with the school or jeopardise their participation in the sustainability activities.
 7. All data will be stored indefinitely. Data will be kept on the researcher's computers at the university or at home. We wish to keep the data indefinitely in case it is useful for further studies. The questionnaires themselves will be destroyed after 7 years and the recordings will be deleted at the end of the year that they are recorded.
 8. You have the right to withdraw the school's participation from further data collection at any stage in the process. You will receive a summary report of our findings by March 2012.
- It is possible that in future we may discuss with you an intervention based on the findings of our study. This may be designed to increase sustainable transport modes, healthy eating, physical activity engagement or academic performance. We may then use the social network data gathered in this study as a baseline to measure the effectiveness of that intervention. Prior to conducting research on an intervention, we would provide you with another information sheet like this and obtain your written consent.

To contact Niki Harre: please phone 3737599 ext 88512 or write to n.harre@auckland.ac.nz or Dr Niki Harre, Department of Psychology, The University of Auckland, Private Bag 92019, Auckland 1142. Contact Quentin Atkinson on 373 7599 ext 84316 or write to q.atkinson@auckland.ac.nz or Quentin Atkinson, Department of Psychology, The University of Auckland, Private Bag 92019, Auckland 1142.

You may also contact the Head of the Psychology Department, Associate Professor Douglas Elliffe by writing to d.elliffe@auckland.ac.nz Department of Psychology, The University of Auckland, Private Bag 92019, Auckland 1142. Ph 3737599 extn. 85262.

Further, if you have any concerns of an ethical nature you can contact the Chair, University of Auckland Human Participants Ethics Committee, University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142. Ph 3737599 ext 83711

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS' ETHICS COMMITTEE ON 12/05/2011 FOR THREE YEARS FROM 12/05/11 TO 12/05/14. REFERENCE NUMBER 2011/167.

Focus group information sheet for the school principal

SOCIAL NETWORKS IN SCHOOLS: FOCUS GROUPS ON SUSTAINABILITY

Researchers: Dr Niki Harre, Dr Quentin Atkinson, Jenny Long (PhD student) and Erica Lawn (Honours student)

This information sheet is an official request for the Department of Psychology at the University of Auckland to add focus groups to the project “Social networks in schools”. This research would be supervised by Associate Professor Niki Harre, the principal investigator for the action research project “Creating a sustainable school” which has been running in Western Springs College since 2008. Senior Lecturer Dr Quentin Atkinson and two students Jenny Long (PhD student) and Erica Lawn (Honours student) will be working with Niki on the social networks project. Funding for this project is being sought through the University of Auckland. The overall project looks at how young people’s attitudes and behaviours relate to the attitudes and behaviours of their friends and family members; in particular in regards to transport use, recycling and eating. The new part of the project looks involves asking students more about how the interpersonal peer context of transport and recycling behaviours. It is anticipated that this new part of the project will run from mid 2011 up until mid 2014.

Students will be invited to participate in focus group sessions held over lunch time in a quiet place on the school grounds. Students under 16 years of age will need to have consent from their parents to take part. This will involve interested students taking letters home for their parents to sign. Questions will focus on how they notice environmentally friendly behaviours of their peers, how students encourage each other to be more environmentally sustainable and what they and their impressions of the Wisers sustainability leaders work. Approximately five students will participate in each focus group and these will be audio-recorded and later transcribed. Participating students will be provided with lunch as compensation for their time.

At all times, we will be sensitive to the school’s reputation and to our participation as invited guests at the school. Niki Harré or Quentin Atkinson will read all material produced by the University of Auckland students prior to it being shown to anyone else. Three types of reports may arise from this study: theses or dissertations produced by the students (student work), articles for academic journals (articles) and media releases, magazine articles, material for the school website or other similar material (public reports).

In all of the above, the name of the school will only be used with your permission. We will ask you to sign your agreement to this on the consent form, but you may change your mind as long as you give us reasonable notice. In the case of our students’ work, this will need to be by October 1, 2012. We will not use individual’s names in any material we produce, only summary data from the questionnaire and anonymous interview quotations will be used.

If you sign the attached consent form, you will not be able to withdraw the focus group data once it is collected. However, we will show you all articles and public reports, as described earlier, before they are released. We will discuss and where possible address any concerns you may have with the content of these reports, however we maintain the final decision about the content and whether or not we submit academic articles or release any public information about the study.

The following additional measures will be taken to ensure everyone is fully informed about this project, gives voluntary consent to participation, and feels able to withdraw anything they have contributed within a reasonable time.

We will provide an information sheet to students selected to participate and the parents of students under 16 years of age who are invited to participate. We will require written consent from parents prior to the participation of students under 16 in this section of the study.

These focus groups will be audio-taped and later transcribed. Any individuals not mentioned on this form that are involved in transcribing will be required to sign confidentiality agreements that state that they will not talk about any of the comments from the focus groups with other persons.

We would also like to ask for your assurance that the participation or non-participation of students and staff at the school in this research will in no way affect their relationship with the school or jeopardise their participation in the sustainability activities.

All data will be stored indefinitely. Data will be kept on the researcher's computers at the university or at home. We wish to keep the data indefinitely in case it is useful for further studies. The audio recordings will be deleted at the end of the project (mid 2014) or before.

You have the right to withdraw the school's participation from further data collection at any stage in the process. As part of the larger Social network in schools project you will receive an annual report of our findings in March each year.

To contact Niki Harre: please phone 3737599 ext 88512 or write to n.harre@auckland.ac.nz or Dr Niki Harre, Department of Psychology, The University of Auckland, Private Bag 92019, Auckland 1142.

Contact Quentin Atkinson on 373 7599 ext 84316 or write to q.atkinson@auckland.ac.nz or Quentin Atkinson, Department of Psychology, The University of Auckland, Private Bag 92019, Auckland 1142.

You may also contact the Head of the Psychology Department, Associate Professor Douglas Elliffe by writing to d.elliffe@auckland.ac.nz Department of Psychology, The University of Auckland, Private Bag 92019, Auckland 1142. Ph 3737599 extn. 85262.

Further, if you have any concerns of an ethical nature you can contact the Chair, University of Auckland Human Participants Ethics Committee, University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142. Ph 3737599 ext 83711

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS' ETHICS COMMITTEE ON 12/05/2011 FOR THREE YEARS FROM 12/05/11 TO 12/05/14. REFERENCE NUMBER 8259.

Wave 3 questionnaire

[All questions included in the thesis are included in this questionnaire, however previous questionnaires included additional questions not included here or used in this thesis. The page breaks on this version of the questionnaire differ from the original due to the formatting of this thesis].

IMPORTANT INFORMATION

1. Please complete this survey, especially if you have filled one in before
2. All your answers are confidential – we won't collect your name. It is important that you write your ID number from your ID card, but don't write your name. If you don't know your ID number put your hand up and your teacher will look it up for you.
3. Most questions involve circling numbers to tell us about your attitudes and what your friends and family do.
4. Some questions ask about your mum or dad (or a person like them who lives with you). If you don't live with one of your parents, you may have someone who acts like a mum or dad you can answer about, or you can just put a line through questions that ask about mum or dad and go to the next question.
5. We will ask you to name friends and brothers and sisters who go to Western Springs College however we won't get to see their names. This page will be given to a person at school who will replace names with ID codes but this person won't get to see the rest of the questionnaire.
6. If you are uncomfortable answering a question then you don't have to answer it.
7. Please write neatly; if we can't read an answer then we have to record it as blank.
8. The questionnaire should take you about 15 minutes.



Do you have any questions? If you come across a question you don't understand please put up your hand.

START HERE 😊

1. **WSC Student ID number**.....
(this is the number of your ID card, it is something like "912345")
2. Age years
3. What form class are you in? (e.g. WOA)
4. Are you: Male Female
5. School Year: Year 9 Year 10 Year 11 Year 12 Year 13

6. What ethnicity are you? (you can choose more than one)

- | | |
|--|--|
| <input type="checkbox"/> NZ Maori | <input type="checkbox"/> Other European |
| <input type="checkbox"/> NZ European/Pakeha | <input type="checkbox"/> Tongan |
| <input type="checkbox"/> Cook Islands Maori | <input type="checkbox"/> Samoan |
| <input type="checkbox"/> Other Pacific Island | <input type="checkbox"/> Indian |
| <input type="checkbox"/> Chinese | <input type="checkbox"/> Other Asian (e.g. Japanese, Korean) |
| <input type="checkbox"/> I do not want to answer this | |
| <input type="checkbox"/> Other (e.g. African, South American), please specify your ethnicity _____ | |

A. SOCIAL NETWORK QUESTIONS



The names on this sheet will be replaced with ID codes, so the researchers won't see your name or the names of your friends.

1. Please name WSC students who are your close friends. You do not have to fill in all the spaces but we are providing space just in case anyone has this many close friends. **Please write each friend's first AND last name.**

1a. We often hang out at lunch or interval
1b. We often hang out after school and weekends
1c. We often come to or from school together

First name _____	Last name _____	Year ____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
First name _____	Last name _____	Year ____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
First name _____	Last name _____	Year ____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
First name _____	Last name _____	Year ____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
First name _____	Last name _____	Year ____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
First name _____	Last name _____	Year ____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
First name _____	Last name _____	Year ____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. Please tick ✓ in the columns on the right hand side to show whether you hang out at lunchtime/interval, hang out after school/weekends or travel to school with each friend

3. Using the friend list you recorded under #1, please circle the name of your 'best friend' at school

4. Do you have any brothers and sisters who currently go to WSC? If so, what are their names?

4a. We often eat food together e.g. meals
4b. We often hang out after school and on weekends
4c. We often come to or from school together

First name _____	Last name _____	Year ____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
First name _____	Last name _____	Year ____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
First name _____	Last name _____	Year ____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. Please tick ✓ in the columns on the right hand side if you often eat together, hang out together and travel to school with each sibling.

B. ENVIRONMENTAL QUESTIONS

1. Yesterday did the food or drink you had at school have any packaging or food scraps?
2. Yes No, I didn't have any packaging or food waste yesterday

3. If yes, which places did you put rubbish, packaging, bottles etc? (tick as many boxes as you need to)

- Food scraps (compost) bins
- Recycle bins
- Landfill (rubbish)bins
- I took my rubbish/recycling home
- I left my rubbish on the ground



4. Do you have a compost bin or something to compost food scraps at home?
 - Yes No

Please circle the number that best indicates how much you agree with the following statements.

5. I litter (e.g. leave rubbish on the ground)

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

6. My friends litter

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

7. Western Springs College students litter

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

8. I put my bottles and cans into the school recycling bins

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

9. My friends put their bottles and cans into the school recycling bins

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

10. Western Springs College students put their bottles and cans into the school recycling bins

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

For the next questions if you don't live with a mum or a dad or if mum or dad doesn't travel to work then just cross the relevant question out and go to the next one.

11. My Mum (or a caregiver like my mum) puts bottles and cans in the recycling

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

12. My Dad (or a caregiver like my Dad) puts bottles and cans in the recycling

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

13. My teachers put their bottles and cans in the recycling

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

14. My friends encourage me to put my bottles and cans in the recycling

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

15. My teachers encourage me to put my bottles and cans in the recycling

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

16. My mum encourages me to put my bottles and cans in the recycling

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

17. My dad encourages me to put my bottles and cans in the recycling

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

18. I often talk with my school friends about recycling

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

19. I don't listen to people who talk about environmental issues

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

20. I often talk about environmental issues with my school friends

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

21. I think that all students should recycle their bottles and cans

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

22. Recycling bottles and cans is inconvenient

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

23. Recycling bottles and cans is beneficial

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

24. Bottles and cans put in the school recycle bins are recycled

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

25. At school I put my food scraps in the compost (food scraps) bin

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always



26. At school I put paper and cardboard in the recycling

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

27. My friends put their food scraps in the compost (food scraps) bin

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

28. My friends think I should put my food scraps in the compost (food scraps) bin

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

29. My friends encourage me to put my food scraps in the compost (food scraps) bin

1	2	3	4	5	6	7
Never	Almost never	Occasionally	Half the time	Mostly	Almost always	Always

30. Western Springs College students put their food scraps in the compost (food scraps) bin
- | | | | | | | |
|-------|-----------------|--------------|------------------|--------|------------------|--------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Never | Almost
never | Occasionally | Half the
time | Mostly | Almost
always | Always |
31. I think that all students should put their food scraps in the compost (food scraps) bin
- | | | | | | | |
|----------------------|----------|--------------------|---------|-----------------|-------|-------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Strongly
disagree | Disagree | Mildly
disagree | Neutral | Mildly
agree | Agree | Strongly
agree |
32. My friends see me as someone who cares a lot about the environment
- | | | | | | | |
|----------------------|----------|--------------------|---------|-----------------|-------|-------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Strongly
disagree | Disagree | Mildly
disagree | Neutral | Mildly
agree | Agree | Strongly
Agree |
33. I am someone who cares a lot about the environment
- | | | | | | | |
|----------------------|----------|--------------------|---------|-----------------|-------|-------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Strongly
disagree | Disagree | Mildly
disagree | Neutral | Mildly
agree | Agree | Strongly
Agree |
34. I often do things to help protect the environment
- | | | | | | | |
|----------------------|----------|--------------------|---------|-----------------|-------|-------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Strongly
disagree | Disagree | Mildly
disagree | Neutral | Mildly
agree | Agree | Strongly
Agree |
35. I try to save water by taking shorter showers or turning off the water when I brush my teeth
- | | | | | | | |
|----------------------|----------|--------------------|---------|-----------------|-------|-------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Strongly
disagree | Disagree | Mildly
disagree | Neutral | Mildly
agree | Agree | Strongly
agree |
36. I sometimes leave computers, stereos and tvs on when they are not being used
- | | | | | | | |
|----------------------|----------|--------------------|---------|-----------------|-------|-------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Strongly
disagree | Disagree | Mildly
disagree | Neutral | Mildly
agree | Agree | Strongly
agree |

C. TRUST AND VOLUNTEERING

Please rate how well you agree with each statement.

1. How often do you volunteer at school events?
- | | | | | | | |
|-------|-----------------|--------------|------------------|--------|------------------|--------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Never | Almost
never | Occasionally | Half the
time | Mostly | Almost
always | Always |
2. How often do you volunteer for non-school events? (e.g. other clubs and events)
- | | | | | | | |
|-------|-----------------|--------------|------------------|--------|------------------|--------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Never | Almost
never | Occasionally | Half the
time | Mostly | Almost
always | Always |

3. You can't trust strangers anymore

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

4. When dealing with strangers, one is better off using caution rather than trusting them

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

D. PERSONALITY QUESTIONS

Instructions: This part of the questionnaire asks about personality. Please circle the number that best represents how accurately each statement describes you.

1. Am the life of the party.

1	2	3	4	5	6	7
Very inaccurate	Inaccurate	Mildly inaccurate	Neutral	Mildly accurate	Accurate	Very accurate

2. Sympathize with others' feelings.

1	2	3	4	5	6	7
Very inaccurate	Inaccurate	Mildly inaccurate	Neutral	Mildly accurate	Accurate	Very accurate

3. Get chores done right away.

1	2	3	4	5	6	7
Very inaccurate	Inaccurate	Mildly inaccurate	Neutral	Mildly accurate	Accurate	Very accurate

4. Have frequent mood swings.

1	2	3	4	5	6	7
Very inaccurate	Inaccurate	Mildly inaccurate	Neutral	Mildly accurate	Accurate	Very accurate

5. Have an active imagination.

1	2	3	4	5	6	7
Very inaccurate	Inaccurate	Mildly inaccurate	Neutral	Mildly accurate	Accurate	Very accurate

6. Feel entitled to more of everything.

1	2	3	4	5	6	7
Very inaccurate	Inaccurate	Mildly inaccurate	Neutral	Mildly accurate	Accurate	Very accurate

7. Don't talk a lot.

1	2	3	4	5	6	7
Very inaccurate	Inaccurate	Mildly inaccurate	Neutral	Mildly accurate	Accurate	Very accurate

8. Am not interested in other people's problems.
- | | | | | | | |
|-----------------|------------|-------------------|---------|-----------------|----------|---------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very inaccurate | Inaccurate | Mildly inaccurate | Neutral | Mildly accurate | Accurate | Very accurate |
9. Have difficulty understanding complex ideas.
- | | | | | | | |
|-----------------|------------|-------------------|---------|-----------------|----------|---------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very inaccurate | Inaccurate | Mildly inaccurate | Neutral | Mildly accurate | Accurate | Very accurate |
10. Like order.
- | | | | | | | |
|-----------------|------------|-------------------|---------|-----------------|----------|---------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very inaccurate | Inaccurate | Mildly inaccurate | Neutral | Mildly accurate | Accurate | Very accurate |
11. Make a mess of things.
- | | | | | | | |
|-----------------|------------|-------------------|---------|-----------------|----------|---------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very inaccurate | Inaccurate | Mildly inaccurate | Neutral | Mildly accurate | Accurate | Very accurate |
12. Deserve more things in life.
- | | | | | | | |
|-----------------|------------|-------------------|---------|-----------------|----------|---------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very inaccurate | Inaccurate | Mildly inaccurate | Neutral | Mildly accurate | Accurate | Very accurate |
13. Do not have a good imagination.
- | | | | | | | |
|-----------------|------------|-------------------|---------|-----------------|----------|---------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very inaccurate | Inaccurate | Mildly inaccurate | Neutral | Mildly accurate | Accurate | Very accurate |
14. Feel others' emotions.
- | | | | | | | |
|-----------------|------------|-------------------|---------|-----------------|----------|---------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very inaccurate | Inaccurate | Mildly inaccurate | Neutral | Mildly accurate | Accurate | Very accurate |
15. Am relaxed most of the time.
- | | | | | | | |
|-----------------|------------|-------------------|---------|-----------------|----------|---------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very inaccurate | Inaccurate | Mildly inaccurate | Neutral | Mildly accurate | Accurate | Very accurate |
-
16. Get upset easily.
- | | | | | | | |
|-----------------|------------|-------------------|---------|-----------------|----------|---------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very inaccurate | Inaccurate | Mildly inaccurate | Neutral | Mildly accurate | Accurate | Very accurate |
17. Seldom feel sad.
- | | | | | | | |
|-----------------|------------|-------------------|---------|-----------------|----------|---------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very inaccurate | Inaccurate | Mildly inaccurate | Neutral | Mildly accurate | Accurate | Very accurate |
18. Would like to be seen driving around in a very expensive car.
- | | | | | | | |
|-----------------|------------|-------------------|---------|-----------------|----------|---------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very inaccurate | Inaccurate | Mildly inaccurate | Neutral | Mildly accurate | Accurate | Very accurate |

19. Keep in the background.

1 2 3 4 5 6 7
 Very Inaccurate Mildly Neutral Mildly Accurate Very accurate
 inaccurate inaccurate accurate accurate

20. Am not really interested in others.

1 2 3 4 5 6 7
 Very Inaccurate Mildly Neutral Mildly Accurate Very accurate
 inaccurate inaccurate accurate accurate

21. Am not curious about complex ideas.

1 2 3 4 5 6 7
 Very Inaccurate Mildly Neutral Mildly Accurate Very accurate
 inaccurate inaccurate accurate accurate

22. Often forget to put things back in their proper place.

1 2 3 4 5 6 7
 Very Inaccurate Mildly Neutral Mildly Accurate Very accurate
 inaccurate inaccurate accurate accurate

23. Talk to a lot of different people at parties.

1 2 3 4 5 6 7
 Very Inaccurate Mildly Neutral Mildly Accurate Very accurate
 inaccurate inaccurate accurate accurate

24. Would get a lot of pleasure from owning expensive luxury goods.

1 2 3 4 5 6 7
 Very Inaccurate Mildly Neutral Mildly Accurate Very accurate
 inaccurate inaccurate accurate accurate

E. TRANSPORT QUESTIONS

1. On a normal week, how do **you** get to and from school? Use what you did last week unless this was an unusual week. Tick only one option for each column that applies for the **main part** of your journey.
 e.g.

	To school		Home from school	
	Mon	Tues	Mon	Tues
Option A	✓			
Option B		✓	✓	✓

Mode of transport	To school					Home from school				
	Mon	Tues	Wed	Thurs	Fri	Mon	Tues	Wed	Thurs	Fri
Walk										
Cycle										
Motor scooter										
Skate/scooter										
Bus										

Driven to school										
I drive myself in a car										
Other (please specify) _____										

Circle the number on each 1-7 scale that is most true for you.

2. Walking to school is fun

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

3. Walking to school is dangerous

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

4. Cycling to school is dangerous

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

5. Walking to school is not enjoyable

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

6. Walking, cycling or skating to school is good for the environment

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

7. I think that all students should walk, cycle or skate to school if they can

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

8. My friends from WSC often walk, cycle or skate to and from school

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

9. Most WSC girls my age often walk, cycle or skate to and from school

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

10. Most WSC boys my age often walk, cycle or skate to and from school

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

For the next questions if you don't live with a mum or a dad or if mum or dad doesn't travel to work then just cross the relevant question out and go to the next one.

11. My Mum (or a caregiver like my mum) often walks or cycles to and from work

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

12. My Dad (or a caregiver like my Dad) often walks or cycles to and from work

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

13. My friends from WSC encourage me to walk, cycle or skate to and from school

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

14. My Mum (or a caregiver who acts like a mum) encourages me to walk, cycle or skate to and from school

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

15. My Dad (or a caregiver who acts like a dad) encourages me to walk, cycle or skate to and from school

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

16. My teachers encourage me to walk, cycle or skate to and from school

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

17. One or more of my friends sometimes asks me to walk, cycle or skate to or from school with them

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

18. One or more of my friends lives close to my house and is driven to school (or drives themselves)

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

19. A member of my family is able to drop me at school by car

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

20. A member of my family is able to pick me up from school by car

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

21. Do you have a working bike you could use to ride to school? Yes No

We now want to understand how far people travel to school, to do this we ask for a street name and suburb but we don't ask for your house number.

22. What suburb do you live in? _____

23. What is the name of your street? _____



24. a) If you live in two different houses during weekdays, what is the suburb and street name of your second house?

Suburb _____ Street name _____

b) In an average week, how many WEEKNIGHTS do you stay at the second house?

Weeknights at second house: _____ (maximum 5 week nights)

F. PHYSICAL ACTIVITY QUESTIONS

Physical activity is any activity that **increases your heart rate and makes you get out of breath some of the time**. Some examples of physical activity are running, brisk walking, rollerblading, dancing, biking, swimming, soccer, basketball, rugby and surfing.



1. I enjoy being physically active (this can include playing sports)

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

2. I think that all students should do regular sport or physical activity

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

3. Physical activity is beneficial

1	2	3	4	5	6	7
Strongly disagree	Disagree	Mildly disagree	Neutral	Mildly agree	Agree	Strongly agree

4. This week, are you taking part in any **school sports or physical activity?** (don't include PE time)

Yes No If yes, which ones?

5. This week, are you taking part in sports (or physical activity) **outside of school?** (e.g. at a local gym or with friends)

Yes No If yes, which ones?

6. What is your school Year: Year 9 Year 10 Year 11 Year 12
 Year 13

7. What intermediate school did you go to? _____

Pasadena

Ponsonby

Kowhai

Other intermediate school (please name) _____

8. What primary school did you go to? _____

Gladstone

Richmond rd

Ponsonby

Ficino

Pt Chev

Waterview

Balmoral

Avondale

Other primary school (please name) _____

Mt albert

9. Have you written your student ID number on the front page? Yes



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Focus group questions

Introduction and consent

5 minutes

Welcome everyone. Thank you for coming along today.

So today's discussion focuses on young people and the environment and friends. You were invited because you are all students of Western Springs College, you are young people. I want to understand what it's like to be a college student and hear your opinions. You guys are the experts; I don't have very much of an idea about what goes on at the school. I was your age once, but that's a while ago!

Today's discussion will be recorded but your name won't be included in anything that we write about, if you don't want to be recorded you can choose to leave now. You've all received a consent form and information sheet. I need those signed and returned before we start. Thanks for the forms.

Can you also write down your age and ethnic group on another piece of paper I'm handing around.

Everyone needs to agree that we respect everyone's comments and don't use put-downs or negative language and secondly we don't go and gossip about the discussions with our friends. If you are not ok to do this you may leave now.

Ok, now that those formalities are out of the way we can start to get a little more comfy. Today's chat isn't like school (even though we're at school); there are no wrong answers, and there's also no right answers.

We expect you to have different points of view so please share what you think, even if it disagrees with what others have said. I'm interested in hearing from all of you so if you are talking a lot I might ask you to let someone else have a go. If you haven't said much I might also ask for your opinion.

Let's spend two minutes going around the room, telling me your name and what interested you to come along today?

So I'm interested in how people interact with the environment. Think about the people you know, and the people you see at school or on the street. Can we tell which people care about the environment?....

[Collect in the demographics questions]

Focus group key question list

Note. *These were semi-structured focus groups. Some additional questions emerged as prompts to explore ideas raised by focus group participants. Additional questions were used in the focus group with student leaders but were not analysed in this thesis.*

- 1) What sort of things come to mind when you hear the phrase: “cares about the environment”?
2. Are you someone who cares about the environment? What things do you do? Would other people know that you’re someone who cares?
3. Is it important to care about the environment? Why?
4. How much responsibility do individual people have to look after the environment?
5. Can we tell who cares about the environment and who does not? How can we tell?
 - What does someone who cares about the environment look like?
 - What does someone who cares about the environment act like?
6. Do you have students at Western Spring College who care about the environment?
[Without giving me names]
 - Do you know who they are?
 - How? *[Do they look and act like the things we discussed before?]*
7. Do friendship groups at school differ in how much they care about the environment?
How? How do you know?
8. Is your waste behaviour affected by your friends? If so, how?
 - Your parents? Your teachers?
 - Do you influence your friends waste behaviour?
9. Do you think there are friendship groups who litter? How do you know? Why do they do it?
10. How do you get to school, why that mode, do you travel with anyone?
11. Do people influence how their friends get to school?

Closing question

So today we’ve talked about “environmentally friendly people” and social travel to and from school. Before we finish, does anyone have anything that they haven’t yet had a chance to say? What about [add name]? Thank you all for coming along – I really appreciate hearing about your ideas!

Example prompts used in the focus groups

- Can you say more about what you have just told me?
- You said earlier..... could you tell me more about this?
- Let’s hear from someone who hasn’t spoken yet...
- Does anyone see it differently?
- Can you give us an example?

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