Peer Influences on Children’s Street Crossing Behaviours: Are some children more susceptible to influence than other children?

by

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ABSTRACT

PEER INFLUENCES ON CHILDREN’S STREET CROSSING BEHAVIOURS: ARE SOME CHILDREN MORE SUSCEPTIBLE TO INFLUENCE THAN OTHER CHILDREN?

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The present study examined influence of peers on risk taking while crossing streets. Children were assigned to one of four peer manipulation conditions: control, peer presence, peer modeling riskier behaviour, or peer modeling safer behaviour. Participants crossed a virtual street prior to and after manipulation, and change in the mean gap size that they crossed into was measured. Individual attributes (social anxiety, fear of negative evaluation, need for approval and positive urgency) were hypothesized to predict the change in risk taking. Peer modeling significantly impacted behaviour such that children altered their behaviour to more closely match modeled behaviour, but no traits predicted change in behaviour. Peer presence did not significantly influence change in risk taking but child age and level of positive urgency predicted change in behaviour. Peers and personal attributes play an important role in risk taking when crossing streets, but modeling and presence influence child risk taking differently.
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Peer Influences on Children’s Street Crossing Behaviours:  
Are some children more susceptible to influence than others?

Unintentional Childhood Injuries

Each year in Canada unintentional injury accounts for over 3 million emergency room visits, 230,000 hospitalizations, and 15,000 deaths. It is the leading cause of death for children over the age of 1 year (Parachute, 2015). In 2010 unintentional injuries accounted for 82.5% of the cost of all injuries in Canada, for a total of $22.1 billion (Parachute, 2015). Similarly, in the United States and most other developed nations, unintentional injury remains the leading cause of death for children, and non-fatal injuries leave many more children with a disability (Center for Disease Control and prevention [CDC], 2015; World Health Organization [WHO], 2008).

Worldwide, road traffic injuries are the second leading cause of death among children age 5-14 (WHO, 2008). Additionally, road traffic injuries are significantly more likely than other unintentional injuries to leave a child with some form of disability (e.g., 62% compared to 52% for a burn injury; WHO, 2008). In Canada, pedestrian injuries alone (both adult and children) accounted for 369 deaths, 2902 hospitalizations, 17,725 emergency room visits, and $234 billion in hospital costs in 2010 (Parachute, 2015). Unfortunately, children are particularly more likely to be involved in a motor vehicle incident as a pedestrian than adults (Zeedyk, Wallance, Carcary, Jones, & Larter, 2001), and are more likely to be permanently disabled because of their small stature (Safe Kids Canada, 2008; WHO, 2008). In a pedestrian setting, children are at highest risk for a severe injury between the ages of 5 and 9 years (Morrongiello & Barton, 2009). Resulting in approximately 30 deaths and 2,412 each year, pedestrian injury is the leading cause
of injury-related death for children under age 14 in Canada, (Safe Kids Canada, 2008). US data demonstrates similar impact of child pedestrian injury; in 2013 pedestrian injury accounted for 27,468 non-fatal injuries and 122 fatalities among children age 1-14 years, and ranked among the top 5 causes of unintentional injury deaths in this age group (CDC, 2015).

Historically referred to as accidental injuries, more recent research has demonstrated that injuries are predictable and preventable and, therefore, not accidents. Hence, unintentional injury has replaced the term accident and research has shifted towards prevention (WHO, 2008). Identifying risk factors that can be targeted in prevention programs is a general goal in research on child pedestrian behaviours. Whitebread and Neilson (2000) noted that children age 5-9 are given more independence in pedestrian environments as they age, but they may not have the skills, strategies, and understanding to safely navigate traffic without supervision. In addition, the presence of peers may elevate children’s risk for injury even more. For example, increasing evidence demonstrates that injuries in school-age children occur more frequently when making independent decisions about risk taking away from parents and in the presence of peers (Morrongiello, 1997; Scheidt et al., 1995; Shannon, Bashaw, Lewis, & Feldman, 1992; Wills et al., 1997). Indeed, some researchers have argued that the presence of peers is a risk factor for injury during the school years (Morrongiello, Corbett, & Sandomierski, 2013; Wilson, Baker, Teret, Shock, & Garbarino, 1991). The present study focused on assessing the impact of peers on children’s risk behaviours during street crossing.
Peer Influences on Child Risk Behaviours

As children develop, peers play an increasingly important role and strongly impact their attitudes and behaviour (Erwin, 1993; Tinsley, 1992). Although many studies have examined peer influences during adolescence (Smith, Chein, & Stienburg, 2013; Swadi, 1999), much less is known about these processes during childhood. The few studies that have been completed with children, have found that peers influence risk behaviours through a number of aspects of the social-situational context, including by active persuasion/encouragement, modeling risk behaviours, and even just by being present and observing (Christensen & Morrongiello, 1997; Morrongiello & Bradley 1997; Morrongiello & Dawber, 2004; Morrongiello & Rennie, 1998; Morrongiello & Sedore, 2005; Miller & Byrnes, 1997; Potts, Doppler, & Hernandez, 1994).

Peers and older siblings have been shown to influence risk taking decisions by active verbal persuasion (Christensen & Morrongiello, 1997; Morrongiello & Bradley 1997; Morrongiello & Dawber, 2004). Moreover, children were more likely to go along with their requests if the persuader was someone they shared a close relationship with, such as an older sibling rather than a short term acquaintance (Christensen & Morrongiello, 1997; Morrongiello & Bradley 1997). In addition, Morrongiello and Dawber (2004) found that among best friend dyads, the more highly children 7-10 years rated the relationship quality, the more frequently they were persuaded to engage in greater risk taking.

Children are also influenced by non-verbal facial expressions and modeling of risk behaviours by their peers. Positive facial expressions (e.g., smiling) by unknown children when risk taking, resulted in observing children (age 6-11 years old) down rating the extent of possible
injury severity and increasing their intentions to imitate that risk behaviour (Morrongiello & Rennie, 1998). If instead that unknown peer displayed wary facial expressions (e.g., worried/scared expression), observers were more likely to rate the behaviour as having high injury risk and to refuse to do the behaviour. Peer modeling of physical risk on television also has been shown to influence a child’s risk taking behaviours (Potts, Doppler, & Hernandez, 1994). Thus, observing peers successfully engage in risk behaviours increases children’s likelihood of imitation, presumably because they rate the risk of injury as low (Morrongiello & Rennie, 1998).

Lastly, the mere presence of peers has been shown to increase risk taking (Morrongiello & Sedore, 2005; Miller & Byrnes, 1997). While playing a game, with no threat of physical injury, children took more risks when a peer was present (Miller & Byrnes, 1997). Similarly, in a setting that did pose some threat of physical injury, children were more likely to choose to walk across a higher balance beam (more risk) while being observed by an age and sex matched peer, than when they were not being observed by a peer (Morrongiello & Sedore, 2005). This peer was unknown to them, and did not say anything, demonstrating that while a stronger relationship between peers increases the likelihood a child would be persuaded to take risks, no prior relationship is needed for a peer to increase risk taking. Thus peers can impact risk taking by active verbal persuasion, modeling risk behaviour, expressing positive emotions during risk, and their mere presence.

While there is no direct research examining the impact of peers on children’s street crossing behaviours, at least one study noted an association between peer presence and
pedestrian injury. Wills and colleagues (1997) found that the majority (68%) of children age 5-12 who had been injured as a pedestrian were in the presence of a peer at the time of injury, suggesting that peer factors may contribute to child pedestrian injury risk behaviours. Given the high risk associated with street crossing injuries, the proposed research aimed to directly assess *if peers influence children’s street crossing behaviours, and if these influences are achieved via their presence or modeling of crossing behaviours*. In addition, the study explored if certain personality attributes make some children more susceptible to this influence than other children.

**Individual Difference Attributes and Risk Taking**

The literature has identified several types of individual attributes that influence children’s risk taking including gender, temperament traits, and injury appraisals (Morrongiello & Sedore, 2005; Parachute, 2015; Schwebel, Davis, & O’Neal, 2012; Schwebel & Gaines, 2007; WHO, 2008). For example, boys, children high in sensation seeking (a tendency to take more risks, enjoy risk taking, and seek out high risk situations, Schwebel & Gaines, 2007) and those who attribute injuries to bad luck rather than their own behaviour all engage in greater risk taking than children who do not possess these attributes (see Morrongiello, Corbett & Switzer, 2013 for a complete review). For purposes of studying peer influences, however, we limited our focus to attributes that are likely to influence a child’s beliefs about and reaction to a peer’s judgment of their own performance, specifically, social anxiety, fear of negative evaluation, need for approval, and positive urgency. These traits are the focus because they seem likely to interact with the social-situational context and impact the extent to which children react to peers.
Social anxiety refers to the experience of anxiety in, or in anticipation of, a social situation (laGreca & Stone, 1993). Research on social anxiety has revealed it is comprised of two distinguishable constructs: a) social avoidance and distress, and b) fear of negative evaluation (laGreca & Stone, 1993; Watson & Friend, 1969). Social avoidance and distress (SAD) reflects social inhibition, avoidance of social situations, and feelings of distress or discomfort associated with such situations.

Fear of negative evaluation (FNE) is an apprehension about being evaluated unfavourably by others in a social situation (Leary, 1983). In an effort to avoid negative evaluation, those who are particularly concerned with being evaluated negatively may be more susceptible to the influence of the social-situational context, and perhaps more persuadable (Leary, 1983; Sears, 1967). Watson and Friend (1969) also noted it has been implicated in social psychological phenomenon such as conformity, attitude change, and compliance. More recently, SAD and FNE have been show to predict behavioural reactions, specifically reduced approach behaviours (Reijntjes, Dekovic, & Telch, 2007). Thus we anticipated SAD and FNE would impact a child’s reaction to peers in this setting and the extent to which they engage in risk taking; those high in these traits may take more risks when with a peer to avoid a negative social interaction and negative evaluation.

Need for approval is often described as a personality trait that refers to a need to present one’s self positively, in order to appear socially acceptable to others (Crowne & Marlowe, 1960; Crowne & Marlowe, 1964). Need for approval can be measured using a social desirability scale, and those high in social desirability have been found to conform to demand characteristics and
social norms (Crowne & Marlowe, 1964). Those high in this trait may also be particularly reactive to peer influence, and may engage in more risk with the intent to gain approval of their peers.

Positive urgency is a measure of an emotion-based disposition that is distinct from impulsivity, and reflects an individual’s tendency to engage in rash or ill-advised behaviours when emotionally aroused (Cyders & Smith, 2007). Impulsivity has been found to contain distinct constructs: sensation seeking, lack of deliberation, lack of persistence, and urgency (Whiteside & Lynam, 2001). However, Cyders and colleagues (2007) suggested that this conceptualization of impulsivity lacks an understanding of rash action when in a positive mood and developed a measure to assess this tendency in particular. Factor analysis of their Positive Urgency Measure (PUM) and the UPPS Impulsive Behaviour Scale- Revised (Whiteside & Lynam, 2001) revealed that PUM is a separate from impulsivity (Cyders et al., 2007). Additionally, positive urgency uniquely predicted risky behaviour beyond that of other forms of impulsivity in adults (Cyders et al., 2007). Those high in this attribute have been shown to engage in more risk taking when in a positive mood (Morrongiello, Stewart, Pope, and Boulay, in press), and children have been found to change their injury-risk appraisals in response to emotional arousal (Morrongiello & Matheis, 2007).

Surprisingly, there are very few studies that have assessed these attributes and their relation to risk taking in social contexts. Morrongiello and Sedore (2005) investigated the relationship between children’s decisions to risk take (choosing the height at which to set a balance beam before walking across it) during peer presence and related this to their scores on a
fear of negative evaluation (FNE) scale and a need for approval (social desirability) scale. As expected, peer presence led to greater risk taking. Although neither attribute was correlated directly with risk taking in this study, the risk taking task (crossing a balance beam) is less familiar than risks children encounter in daily life, such as crossing a street. Using an unfamiliar risk task may not best represent the kind of tasks a child regularly encounters, and risk taking on such an unfamiliar task may be more influenced by their level of comfort with the task itself. It may be that attributes such as FNE and need for approval come into play more readily when children’ have experience with the risk task and some confidence they can do it. On a familiar task a child’s level of risk taking may be less dependent on their experience and confidence with the task and more on their own attributes and the social-situational context. The present study will test the hypothesis that these attributes (social avoidance and distress, fear of negative evaluation, need for approval, and positive urgency) will predict the extent to which peer influence impacts children’s risk taking when crossing streets.

We hypothesized that the various attributes would predict increased risk taking differentially across various forms of peer influence. Specifically, because children are more likely to model another’s behaviour when they seek approval, and those high in this attribute are known to conform to demand characteristics, we expected need for approval to strongly predict the effect of peer modeling, such that those high on this trait are expected to change their behaviour to match that of the behaviour modeled by the peer. Similarly, social anxiety is associated with concern regarding appropriate social behaviour and for the approval of others, thus we expected social anxiety to strongly predict the effect of peer modeling on risk taking. In contrast, peer presence is often associated with increased arousal, and thus we expected positive
urgency to strongly predict the effect of peer presence on risk taking; specifically those higher on positive urgency are hypothesized to become more risky when exposed to peer influence than children lower on this trait. Lastly, peer presence, unlike peer modeling, presents an opportunity to be evaluated by the peer during their presence, thus we expected fear of negative evaluation to significantly predict the influence of peer presence on risk taking, such that there will be a positive relationship between the change in risk taking and endorsement of the fear of negative evaluation trait.

Because other factors have been shown to impact risk taking, we also considered gender, and controlled for child age in the analyses as needed. Male sex has been found to increase extent of risk taking consistently across tasks in both injury and non-injury contexts (Parachute, 2015; WHO, 2008). Miller and Byrnes (1997) found that boys were particularly susceptible to peer influence when risk taking in a non-injury setting. However, when setting the height of a balance beam during peer presence, a context that did pose physical injury-risk, the magnitude of increase in risk taking was not different between males and females (Morrongiello & Sedore, 2005). Thus it is possible males would not demonstrate a larger increase in risk taking during peer influence while street crossing.

**Methodological Considerations in Studying Children Crossing Streets**

The high risk of disability and fatality associated with pedestrian injury makes it important to study, but also presents a challenge to do so in a safe yet ecologically valid manner. Until recently, it has been particularly challenging to do so rigorously. Historically, street crossing behaviour has been examined using natural observation (Routledge, Repetto-Write, &
Howarth, 1976) or a simulated “pretend road” method by which participants cross a pretend road that is adjacent to a real road. Children pretend the cars on the real road are also on the pretend road, and are to cross the pretend road as if they were crossing in gaps between cars on the real road (Lee, Young, McLaughlin, 1984; Young and Lee, 1987). However, in this method participants did not actually see the cars from a realistic perspective, researchers were not able to control traffic or the gap sizes between cars, and were not able to accurately assess whether the pace of a child’s ‘pretend’ crossing would have been successful.

Later the ‘shout’ and ‘two step’ method were developed. In the ‘shout’ method participants stood next to a real road and shouted “Now!” when they deemed it safe to cross the street (Demetre et al., 1992). The ‘two step’ method was similar; participants would stand a short distance from a real road and take two steps toward it to indicate when they deemed it safe to cross (Demetre et al., 1992). Although these methods correspond to other pedestrian safety measures, the shout method lacks motor initiation and the ‘two step’ method lacks perceptual accuracy as participants stand a distance from the road (Schwebel, Gaines, & Severson, 2008).

More recently virtual reality has become popular for assessing street crossing behaviour. This is a particularly well-suited method because it allows children to interact with the environment without the dangers inherent in that environment, and practice many crossings in a short period of time (Schwebel, et al., 2008). Virtual reality refers to a computer-generated display that provides the user with a feeling of immersion and an ability to interact with the environment (Reid, 2002). Most research has been done using non-immersive virtual reality. For example, Schwebel, and colleagues (2008) use a semi circle of three monitors to display the
virtual environment and ambient noise to enhance realism. Participants stand on a ‘curb’ that triggers a pressure plate when they step off, indicating they think it is safe to cross. The environment then changes from immersive to third person and participants watch an avatar cross the street when they intended to. The avatar crosses the street at a pace that represents the average speed that child walked during trials done not in the virtual environment. This method benefits from an ability to manipulate the rate of the cars, and has demonstrated construct, convergent and face validity, but does not capture the full street crossing behaviour. Because the avatar walks across the street at a constant pace that was determined from the child walking in an environment without traffic it does not consider the possibility the child could change their pace if needed to avoid injury. This limitation results in an overestimate of children being hit; using a virtual reality system that captures the full street crossing behaviour indicates children use evasive action to increase their pace and avoid hits or near misses (Morrongiello, Corbett, Milanovic, Pyne, & Vierich, 2015)

Presently, fully-immersive virtual technology using a head mounted display and movement tracking system allows us to vary the rate of traffic as well as capture full street crossing behaviour including the pace children actually cross the road, how soon they start crossing after the previous car, and how much time they have to spare after they reach the other side. Using this technology allows us to accurately manipulate the rate of traffic and the order in which gap sizes are presented, identify the average gap size in traffic the participants consider safe, as well as measure the pace at which they cross the virtual street in various gap sizes. All of this information will allow us to accurately capture the influence of peers and individual differences on risk taking during street crossing.
Present Study

The present study used virtual reality technology to examine street crossing behaviour in children age 8-10 years, as this represents a developmental stage during which children are gaining independence, are increasingly influenced by peers, and unintentional injuries are a leading cause of death and disability.

While peer presence and modeling has been demonstrated to significantly increase risk taking in previous studies, it is possible that the high risk associated with street crossing will limit the impact of peers in this particular context. Thus the first aim of the present study was to replicate the effect of peer presence and peer modeling, and determine the extent to which peers influence risk taking in the context of street crossing in the four conditions (control, peer presence condition, a safe peer modeling condition, and a risky peer modeling condition). Despite the high potential severity of injury in this context we hypothesize that peer presence and peer modeling will significantly increase risk taking during street crossing. The second aim was to examine the extent to which change in risk taking is influenced by individual attributes of SAD, FNE, need for approval and positive urgency. We hypothesized that those scoring high on SAD and need for approval will be especially reactive to peer modeling, and those scoring high on FNE and positive urgency will be especially reactive to peer presence, and show a greater increase in risk taking than those low on these attributes.

Identifying risk and protective characteristics that make a child most susceptible to peer influence in risky situations provides the foundation needed for developing effective
interventions to reduce risk taking while with peers. Given the already limited resources for health interventions, determining specifically who is at risk for unintentional injury while street crossing will ensure interventions reach susceptible populations most effectively.

**Method**

**Design**

A repeated measures pre/post design was used, such that each participant completed a set of street crossing trials once and then again after the manipulation of peer influence. Analyses assessed the change in risk taking from pre to post using difference scores. Condition was a between-participants factor, with participants randomly assigned to a control (no influence of peer), peer presence, or peer modeling condition. Participants were blind to their assigned condition.

Examining standardized differences from past research in this lab we expected to find a moderate effect size (.25) when comparing risk taking across the four conditions. Using an α of 0.05 and power of 0.80, this results in needing 45/group or a total sample size of at least 180 participants (equally distributed across groups, with half boys and half girls).

**Participants**

For this study a total of 79 normally developing children (41 male, 38 female) age 8-10 years of age (mean = 9.4, SD = .89) were recruited through the lab database and randomly assigned to each condition. This resulted in 20 participants in the control group (11 male), 19 in peer presence (10 male), 19 in risky modeling (8 male), and 21 in safe modeling (12 male), with each condition and age group containing approximately equal number of males and females. The
composition of our sample roughly represents the demographics of the population of Guelph, Ontario, thus most participants are Caucasian, middle to upper income, and English speaking. Participants were not recruited if any immediate family member had a pedestrian injury. The University Research Ethics Board approved all procedures and measures. Written informed consent was obtained from a parent or legal guardian and assent was obtained from the child participant prior to testing.

Measures

Prior to enrollment, participants were screened for increased susceptibility to simulator sickness and general health to ensure they were appropriate candidates for participation (see Appendix A). The simulator sickness questionnaire assessed history of migraines, claustrophobia, motion sickness, dizziness and nausea (Kennedy, Lane, Berbaum, & Lilienthal, 1993). The general health questionnaire assessed history of heart attack, stroke, tumors, head trauma, seizures, vertigo, diabetes, hypoglycemia, and medication. If a participant answered yes to two or more questions on the questionnaires they were excluded.

Social avoidance and distress about social situations (SAD) was measured using two subscales from the revised form of the Social Anxiety Scale for Children (laGreca & Stone, 1993). This measure consists of 10 items each with a 5-point likert scale with responses ranging from 1=Not at all to 5= all the time (see Appendix B). An example item is “I worry about doing something new in front of other kids. ”. Cronbach’s alpha was .85. Items were averaged to create composite SAD scores for each participant. Higher scores indicate more social anxiety and distress about being in a social context.
Fear of negative evaluation was measured using the Fear of Negative Evaluation subscale (FNE) from the Social Anxiety Scale for Children (LaGreca & Stone, 1993). This scale consists of 8 items each with a 5-point likert scale with responses ranging from 1=Not at all to 5=all the time (see Appendix C). An example item is “I worry about what other kids think of me”. Cronbach’s alpha was .87. Items were averaged to create composite FNE scores for each participant. Higher scores indicate more fear of negative evaluation by peers.

Need for approval was measured using the Children’s Social Desirability Short Scale (Miller et al., 2014). This scale consists of 14 yes or no questions and is adapted from the full Children’s Social Desirability Questionnaire (see Appendix D) (Crandall, Crandall, & Katkovsky, 1965). An example item is “Do you always do the right things?”. Cronbach’s alpha was .81. Items were averaged to create composite need for approval scores for each participant. Higher scores represent more social desirability and more need for approval.

Positive urgency was measured using the Positive Urgency Measure for children (PUM) developed by Morrongiello, et al., (in press) modeled after the Positive Urgency Measure for Adolescents (Cyders et al. 2007). This scale consists of 14 items, each with a 7-point likert scale with responses ranging from 1=Very strongly disagree to 7=Very strongly agree (see Appendix E). An example item is “When overjoyed, I feel like I can’t stop myself from going overboard.”. Cronbach’s alpha was .87. Items were averaged to create composite positive urgency scores for each participant. Higher scores indicate more positive urgency.
Risk taking. The primary measure of risk taking was the mean inter-vehicle gap size within which participants choose to cross. Participants had the opportunity to cross the virtual street in gap sizes (measured in time between cars) ranging from 1.5 to 8 seconds, with smaller gaps posing greater risk of injury (see Appendix F for a list of inter-vehicle gap sizes as presented to participants). Mean gap size was measured pre and post peer manipulation, and difference scores were calculated by subtracting mean gap size pre from mean gap size post scores such that positive scores represent a child crossing more safely after manipulation and negative scores represent a child crossing in a riskier fashion after manipulation.

Virtual reality system

To conduct this research we used a fully immersive virtual reality and movement tracking system constructed in an 8 x 5 meter room in a lab at the University of Guelph. Eight cameras were used to track the child’s position and orientation using PPTiH and Vizard software. Participants viewed the virtual environment through a head mounted display (HMD) and their position was tracked and presented to them in real-time, so the view changed as they moved, to make their experience as real as possible. The virtual environment included a two-lane road and cars approach only from the participant’s left. To enhance its realism, the environment included trees, houses, shadows, textures, and the participant was presented with realistic audio of traffic movement (see Figure 1 for back and white image of virtual environment). The participants had control over the direction they walk, their pace, and were able to evade risk by either changing their pace or moving back onto the curb if they made a poor crossing decision.
Procedure

Testing took place in a lab on the University of Guelph campus. Two research assistants conducted the experiment; one operating the computer that controls the VR system from the control room, while the other assisted the participant with the headset and the completion of the questionnaires.

Each child completed several phases. In phase 1 (VR demonstration) the participant was introduced to the system and a researcher demonstrated a safe street crossing while wearing the headset. She also demonstrated an unsafe crossing to show the participant what would happen if one were hit by a virtual car (i.e., cars disappear and audio of sirens plays in the headset).

In phase 2 (adjustment of HMD) the participant was fitted with the headset and it was adjusted until the child could clearly see letters presented on the screen.

In phase 3 (practice without cars) the participant practiced crossing the street with no cars present. They crossed the virtual road 10 times to ensure they were comfortable with the headset and understood where they were to start and stop. Participants started on the curb of the road, but to prevent a possible tripping hazard the floor of the testing room was flat and curbs were only presented visually. Because traffic only approached from the left, participants only crossed the first lane and were indicated to stop on a green circle presented in the virtual environment just past the yellow line that runs down the center of the road. The participant then turned around and returned to where they began (indicated by a large green cylinder); there were no cars approaching during their return to the start. These trials allowed the child to get use to walking
with the headset on and ask any questions they may have had. Participants have been shown to be fully adjusted to the VR equipment after practicing in the virtual environment (Kennedy, Stanney, & Dunlap, 2000) and previous data from our lab confirmed walking speed stabilizes by 10 practice trials.

In phase 4 (practice trials with cars) participants practiced crossing the street while cars approached for 9 trials. Within each trial, gap sizes between approaching cars increased incrementally by 0.5 seconds, and as trials progressed the initial gap size becomes smaller, thus participants became familiar with various gap sizes and learned that the longer they wait the larger the gap sizes became (see Appendix F for a list of gap sizes per trial).

In phase 5-Pre (incremental gap - baseline) participants completed 24 trials, and each trial presented the same set of incrementally increasing gap sizes.

At this point participants took a break from street crossing and completed the questionnaires noted above (in random order). After completion of the questionnaires participants were exposed to peer influence as per their condition; the procedure for manipulation of peer influence in described below. Phase 5-Post was then completed immediately after exposure to peer influence. This phase proceeded exactly the same way as phase 5-Pre.
Manipulation of peer influence

In the peer presence and peer modeling conditions, participants were exposed to peer influence during the break, immediately after completing their questionnaires. In the peer presence condition, the RA told participants that another child of the same age and gender arrived early and would be watching them from the control room nearby. To ensure the child believed that another child is watching them, an audio track of common noises (i.e., coughing, sneezing, clearing throat) was played periodically during the child’s testing to serve as a constant reminder that another age-mate was presumably watching them cross.

In the peer-modeling conditions participants were shown a video of another child of the same gender completing the same street-crossing task. Participants were randomly assigned to either a safe modeling or risk modeling condition and viewed a video in which a child modeled either safer or more risky crossings, respectively. This video was viewed in a separate room on the same computer used to answer the questionnaires. Note, that if a child was randomized to the risky modeling condition and their baseline score was already at the lowest gap size that allowed for a safe crossing (i.e., it is not possible to present a riskier crossing model) then the child’s assignment was switched to the safe modeling condition; the data from such children was not used in this project.

The videos showed a child modeling crosses in temporal gaps that were .5 and 1.0 seconds longer (safe modeling condition), or temporal gaps that were .5 and 1.0 seconds shorter (risk modeling condition) than the participant’s mean gap choice. The participant’s mean gap choice was calculated using trials from phase 5-Pre. To enhance the realism of this manipulation,
participants were told another child was completing a similar experiment down the hall, and that the participant could help the research assistant by watching this child complete their crossings and reporting a few things so the assistant could code this information into a computer. The child was told that once this task is completed then the assistant could finish the child’s session. The participant was asked to view the video and report if the child crossed without being hit and to say the colour of the car s/he crossed in front of; pilot tests confirmed that these reports ensure the participant is fully attending to the child on the video. After each crossing the researcher said out loud to the participant as they enter the information on the computer, whether the child in the video crossed in a ‘larger’ (safer) or ‘smaller’ (riskier) gap size than the participant had done. In this way, we assured the child observed the model crossing, and knew how the model performed relative to his or her own performance (i.e., model crossed in a safer or riskier way); these procedures were pilot tested to confirm effectiveness.

In the control condition, participants were not exposed to any peer influence, and after completing questionnaires went back to the testing room to repeat the street crossing trials.

**Statistical Analyses**

Prior to assessing the effect of manipulations, inter-correlations of variables were explored to assess whether age correlated with risk scores. Similarly, the effect of gender on risk scores was also assessed. Gender was controlled for in later analyses if level of risk was different between genders. Similarly, age was controlled for in later analyses if it correlated with risk scores. To determine if the peer manipulations were effective in influencing risk taking, an ANOVA was conducted comparing the change in average gap size from pre to post peer
exposure across condition (4: control, peer presence, peer modeling-safe, peer modeling-risky); an a priori simple contrast was used to assess the difference between each condition and control.

We then assessed if FNE or PUM predicted magnitude of change in risk taking post peer presence, and determined if SAD or need for approval predicted the change in risk taking post peer modeling (both risky and safe conditions). First, inter-correlations between the traits, covariates (age, gender), and risk taking change scores were explored. Hierarchical regressions were then conducted separately for each manipulation (peer presence, safe modeling, risky modeling), with covariates entered in step one and attributes of interest entered in step two. Prior to running the regressions, a preliminary screening was done to check for distribution normality and collinearity. In addition, potential outliers were assessed for their impact on multivariate analyses when Cook’s distance values exceeded 3SD above the mean.

Results

Preliminary Analyses

Individual difference measures. As shown in Tables 1-4, there were some inter-correlations between individual traits, but the level of these correlations confirm that they measured distinct and different attributes. Hence, their relations to pedestrian measures were examined separately, as planned. Means and standard deviations of these variables are listed in Table 6.

To determine if reported levels of measured traits were similar across conditions, ANCOVAs were conducted to compare each trait separately across conditions, with age as a covariate and both condition and gender as between-participant factors. These results
demonstrated no significant effect of condition on any of the traits measured when controlling for age and gender, thus level of endorsement of each trait can be considered similar across conditions (see Table 7 for all ANCOVA results). However, there was a significant effect of age on PUM and SAD, such that younger children endorsed higher levels of these traits, and a significant effect of gender on FNE and SAD, such that girls endorsed higher levels of these traits than did boys. Lastly, CSD showed no significant effects of age, gender, or condition (see Table 7).

**Pedestrian injury risk behaviours.** Inter-correlations among all variables in each condition are given in Table 1-5 and means and standard deviations of these variables are listed in Table 6.

To determine if there were any unexpected differences in crossing behaviours before the peer manipulation, an ANCOVA was conducted on the gap size pre-test data, with gender (2) and condition (4) as between-factors, and age as a covariate. All effects were non-significant, as expected, indicating that children showed similar levels of risk taking at pre-test regardless of age \([F(1,70) = 0.27, p = .60, \eta^2_p = .004]\), gender \([F(1,70) = 0.78, p = .38, \eta^2_p = .01]\), and condition \([F(3,70) = 1.12, p = .35, \eta^2_p = .05]\). Thus, it was acceptable to examine difference scores in risk taking across conditions in our primary analyses.

Mean gap size was measured pre and post peer manipulation, and difference scores were calculated by subtracting mean gap size pre from mean gap size post scores. Thus, positive scores represent that a child crossed more safely after peer exposure and negative scores
represent a child crossed in a riskier fashion after the peer manipulation. To determine if age or gender influenced the change in risk taking post peer manipulation, and to determine if either should be included in the primary analysis, an ANCOVA was conducted with age as a covariate and gender as a between subjects factor. This analysis found no significant difference between genders \( F(1, 76) = 3.68, p = .06, \eta_p^2 = .05 \). Given that change in risk taking after peer exposure was similar across genders, gender was excluded from all further analyses to increase power in our small sample size. Similarly, this analysis showed that age was not a significant covariate of change in risk taking \( F(1, 76) = 1.60, p = .21, \eta_p^2 = .02 \), thus it was not included in the comparison of change in risk taking across conditions.

**Primary Analyses: Assessing the Influence of Peer Manipulation and the Role of Individual Differences**

To determine whether change in risk taking in each condition was different from that of the control condition, an ANOVA was conducted and planned simple contrasts were done to compare each condition to control. The effect of condition on change in risk taking was significant \( F(3, 75) = 8.74, p < .001, \eta_p^2 = .26 \) indicating that peer exposure evoked changes in risk taking behaviour differentially across conditions. Planned simple contrasts comparing each condition to control are discussed below.

**Peer presence, PUM, and FNE.** The first planned simple contrast of the above ANOVA revealed that change in risk taking in the peer presence condition \( M = -.15 \) was not significantly different from change in risk taking in the control condition \( M = -.27 \), \( p = .376, 95\% CI [-.148, .388] \). Contrary to hypotheses, this indicates that the presence of peers did not significantly
increase risk taking while street crossing more so than the change observed due to repeating the task (control condition).

Next, the influence of PUM and FNE on change in risk taking in the peer presence condition was explored using correlations and a hierarchical regression. Examination of correlations indicated a strong positive correlation between age and change in risk taking during peer presence \( r = .56, p = .013 \), indicating that younger age children showed riskier crossings in reaction to peer presence. A strong negative correlation between PUM and change in risk taking indicated that children higher in positive urgency showed more risky crossing with peer presence, \( r = -.59, p = .008 \). Neither gender nor FNE correlated with change in risk taking in the peer presence condition (see Table 2). Thus, age and PUM were entered into the regression predicting change in risk taking score; age was entered in step one and PUM in the second step.

According to the hierarchical regression, age (step 1) accounted for approximately 31% of the variance in change in risk taking, \( R^2 = .31, F(1,17) = 7.68, p = .013 \). When PUM was added in step 2, it accounted for an additional 25% of variance for the change in risk taking, \( R^2 = .56, F(1,16) = 8.81, p = .009 \). The standardized coefficient for both age \( [B = .218, SE = .080, \beta = .46, t = 2.73 p = .015] \) and PUM \( [B = -.206, SE = .069, \beta = -.504, t = -2.97, p = .009] \) were significant. These results indicate that younger children and those who endorsed higher levels of PUM crossed in a riskier fashion in reaction to peer presence.

**Risky modeling, SAD and need for approval.** The second planned simple contrast of the above ANOVA indicated change in risk taking in the risky modeling condition \( (M = -.59) \)
was significantly greater than the change in risk taking in the control condition ($M = -.27$), $p = .02$, 95%CI [-.59, -.05]. No significant correlations were found between change in risk taking and age, gender, SAD, or need for approval (see Table 3). Thus, exposure to a risky peer model led to greater risky crossing behaviours and this change was not affected by any other variables; no regression analyses were warranted.

**Safe modeling, SAD and need for approval.** The third planned simple contrast from the ANOVA above showed change in risk taking in the safe modeling condition ($M = .08$) was significantly less than the change in risk taking in the control condition ($M = -.27$), $p = .009$, 95%CI[.09, .613]. After exposure to peers modeling safer crossing behaviours than the child had shown, those in the modeling condition crossed more safely than those in the control condition. No significant correlations were found between change in risk taking and age, gender, SAD, or need for approval (see Table 4), indicating none of these hypothesized variables predicted change in risk taking post modeling; no further analyses were warranted.

**Discussion**

The current study aimed to advance our understanding of why children are at such high risk for injury in pedestrian environments. Previous research demonstrated that 68% of children injured as pedestrians were with peers at the time of the incident (Wills et al., 1997), suggesting peers are an important factor in understanding child injury risk while crossing streets. Although peer influence while risk taking in a pedestrian environment has not been extensively studied, evidence indicates that peers can influence risk taking in other settings simply by being present or by modeling risky behaviour (Morrongiello & Sedore, 2005; Miller & Byrnes, 1997; Potts,
Doppler, & Hernandez, 1994). Thus, in the present study we used virtual reality to determine whether peer presence and peer modeling increase child risk taking in a pedestrian environment. In addition, we explored whether the extent to which a child is influenced by a peer can be predicted by personality attributes.

**Influence of Peer Modeling on Risk Taking**

Of the participants exposed to peer modeling, half were exposed to a peer who modeled risker street crossings (the peer crossed into gap sizes 0.5 and 1.0 seconds smaller than the participant’s average gap size), and half were exposed to a peer who modeled safer street crossing behaviour (the peer crossed into gaps 0.5 and 1.0 seconds larger than their average gap size). As hypothesized, both of these modeling conditions resulted in changes in risk taking that were significantly different from that of the control condition. Specifically, those in the risky modeling condition showed increased risk taking compared to control, while those in the safer modeling condition showed decreased risk taking compared to control. These findings support previous research that demonstrates the effect of peer social norms and the susceptibility of children to the influence of social-situational factors (Morrowiello, McArthur, Kane & Fleury, 2013). Children are strongly influenced by peers, such that they will change their behaviour to more closely match that of their peer. It seems that children conform to what they perceive to be favoured by even a single unknown peer. Despite the high level of risk associated with street crossing children changed their behaviour to imitate their peers, both towards riskier and safer behaviour. These findings have implications for injury prevention. Although older children may be more capable of crossing in smaller gaps safely, having younger children observe these crossings could lead to imitation and, therefore, greater risk of injury for these young observers.
who are less skilled pedestrians. On the positive side, however, the current findings suggest that exposing child pedestrians to those who cross in very safe ways, can effect positive changes and potentially reduce their risk of injury as pedestrians.

Contrary to our hypotheses, no individual attributes predicted change in risk taking in either modeling condition. It is possible that peer modeling was so effective in changing behaviour that the variability in risk taking contributed by personal attributes was minimal compared to the total change in risk taking. In these conditions the social norm is salient and children are able to exactly imitate their peer’s behaviour to conform to this norm. The mean change in risk taking for those in the risky condition (M = -.59) was very similar to that of the modeled behaviour (-.5 and -1.0 difference from their average), suggesting that children were motivated to closely match their behaviour to the peer norm. Additionally, children in the risky modeling condition experience a floor effect as the gap size they are able to cross into while not being hit is limited, thus they can only change their behaviour as far as they are still able to cross the street without being hit. Because the change in risk taking in the risky modeling group is limited to gap sizes that still allow for a safe crossing, there may be less variability among gap sizes children entered into after exposure to risky peer modeling. Thus, this limited variability in the gap sizes participants were able to cross into means any variability contributed by personal attributes could also be limited and the extent to which a trait is able to predict change in behaviour may be statistically limited because of this floor effect.
Influence of Peer Presence on Risk Taking

Unlike the peer modeling conditions, peer presence did not have a significant effect on change in risk taking. One of the main differences between this condition and the modeling conditions is that no social norm is made salient. Participants know a peer is watching but do not receive any information from this peer, while in the modeling conditions the peer provides useful information about how the participant can match the social norm. In the peer presence condition, the participant is still pulled to behave in a way they would expect a peer to approve of, but is not provided information about what behaviour their peer favours or how to perform that favoured behaviour.

Additionally, in this study participants may have experienced multiple competing goals: first to get across safely, and second to conform to social norms. It was made clear that the goal of the task was to get across safely; although participants’ response to being hit was not explicitly recorded, several children noted that they did not like getting hit by a virtual car, and expressed disappointment or embarrassment when hit. In contrast to our findings, previous research demonstrated that when peers are watching, children respond by behaving in a more risky fashion (Morrongiello & Sedore, 2005) possibly for the purpose of peer admiration (Miller & Byrnes, 1997). Thus, in opposition to the goal of crossing safely, participants were likely pulled to conform to what they perceived to be the social norm. It is also possible that different children interpreted the social situation differently, some may have believed peers will be more impressed with risky crossings, while others may believe that peers will be more impressed by completing the task ‘correctly’ and getting across safely. While no social norm is made explicit in this condition, children may draw on previous experiences and their memory of social norms.
from any number of situations, and draw on those various social norms to alter their behaviour when a peer is watching. These competing goals and the lack of explicit social norms may result in more variability across participants, which may prevent the identification of the effect of peer presence on change in pedestrian behaviour.

Alternatively, the presence of a peer during the participant’s street crossings could also be viewed from the perspective of social facilitation. The social facilitation literature suggests that the presence of others increases arousal which in turn increases the dominant response during a task (Zajonc, Wolosin, Wolosin, & Loh, 1970). The literature on the effect of social facilitation on risk behaviour is mixed, some studies find that social facilitation leads to riskier behaviour (Chou & Nordgren, 2016; Yechiam, Druyan, & Ert, 2008) while others found that social facilitation leads to more conservative (safer) behaviour (Zajonc, Wolosin, Wolosin, & Loh, 1970). The dominant response seems dependent on the task, and the participant’s initial response to the task; if they were initially cautious, social facilitation would result in more cautious behaviour while if they were initially more risky, social facilitation would result in riskier behaviour (Zajonc, Wolosin, Wolosin, & Loh, 1970). It is possible that our findings reflect this mixed literature as it seems participants response to peer presence varied widely, thus resulting in no difference in change in risk taking compared to control. Some researchers have suggested the effect of social facilitation is influenced by individual differences (Faralla, Innocenti, & Venturini, 2013) and our findings seem to support this claim as we found a relationship between individual attributes and change in behaviour.
Although no direct effect of peer presence was observed on risk taking, change in risk taking was predicted by age and the positive urgency trait when in the presence of peers, suggesting that the effect of peer presence is moderated by age and by positive urgency. Positive urgency is described as “the tendency to act rashly or maladaptively in response to positive mood states” (Cyders et al. 2007). Although this trait is thought to include impulsivity and sensation seeking, research reveals that it is a distinct construct that uniquely predicts risk taking (Cyders et al. 2007). As hypothesized, high levels of PUM was associated with a behavioural shift towards riskier crossing when in the presence of a peer. PUM can be considered a child’s ability to regulate themselves when excited or aroused. Thus, it appears that children who have more difficulty regulating themselves when aroused are those most likely to show more risky behaviour. The relationship between PUM and change in risk taking can also be considered in the context of the Self-Regulation Model (SRM) described by Miller and Byrnes (1997). This model posits that inappropriate risk taking is related to the effect of dysregulating influences such as peers. Authors suggest there are several self-regulatory tendencies that can increase the likelihood a child would meet their goal in a risk situation, including the ability to coordinate multiple goals and the ability to overcome dysregulation. It also suggests that in the presence of peers, a more self-regulated child is better able to manage multiple goals than a less self-regulated child, and thus engages in less risk (Miller & Byrnes, 1997). A less well-regulated child may only be able to manage one goal at a time and thereby switch from the goal of crossing safely when alone, to focus entirely the goal of ‘showing off’ when in the presence of a peer. When focused solely on the goal of impressing others, children are more likely to take risks. Children who endorse higher levels of PUM may be similar to those children Miller and Byrnes
describe as less well-regulated, and may be focusing more on impressing the observing peer than crossing the street safely.

**The Effect of Age and Gender on Risk Taking**

In contrast to some previous research (Byrnes, Miller, & Schafer, 1999; Parachute, 2015; WHO, 2008), gender did not have an effect on initial level of risk taking before the peer manipulation. It is possible that a gender effect was not seen because the ages included in the present study were limited to 8 to 10 years. In some previous studies where gender differences were demonstrated, participants included children up to age 12 or 13 (Miller & Byrnes, 1997; Morrongiello, McArthur, Kane, & Fleury, 2013). Some of the previous literature that demonstrate gender differences examine risk taking in non-injury settings (e.g., Miller & Byrnes, 1997), while other studies have found that in a setting that poses physical injury risk, this effect is no longer present (Morrongiello & Sedore, 2005). This lack of gender differences may also be observed in the present study as we examined a situation that poses physical injury risk.

Age had no effect on risk taking prior to the peer manipulation. This finding supports that of many previous studies that have also found no effect of age on initial levels of risk taking among children (Miller & Byrnes, 1997; Morrongiello, McArthur, Kane, & Fleury, 2013; Morrongiello & Sedore, 2005). It is also possible that age may not have affected initial risk taking score because the ages included were limited to 8 to 10 years. This limited age range may not be large enough to show variability among ages.
Interestingly, although age did not correlate with initial levels of risk, or change in risk taking in the overall sample, it did correlate with change in risk taking in the peer presence condition, such that younger children were more likely to increase risk taking in reaction to peer presence. Researchers agree that emotional regulation develops with age throughout the lifespan (Cicchetti, Ackerman, Izard, 1995; Gross, 1998; Kopp, 1989; Cole, Luby & Sullivan, 2008,) and previous research has also identified emotional regulation as a factor that influences risk taking. Morrongiello, Kane, McArthur, and Bell (2012) found that children with poorer emotional regulation skills were more likely to engage in risk taking on a playground than those with better emotional regulation skills. Thus it is possible this age effect was seen in the peer presence condition because younger children are poorer in their ability to regulate the emotional arousal that occurs in response to having another peer present. Consistent with this explanation, those high in positive urgency, which is a trait also associated with poorer emotional regulation, also reacted to peer presence with greater risk taking. Thus, the pattern of these results suggest that the effect of peer presence on risky crossing behaviour may be greater among children poorer in emotion regulation, which includes younger aged children.

Limitations and Future Research Directions

Although this study adds important insight to our understanding of the ways peers and personal attributes influence child risk taking while crossing streets, it is not without limitations. First, the sample size is more limited than desired, resulting in reduced statistical power. Accordingly, the findings should be interpreted with caution until a replication with a larger sample size is completed. Second, the sample was fairly homogeneous and limited in demographic characteristics; most were Caucasian, well-educated and had upper-income status.
Similarly, all were from a suburban setting, which may influence their exposure to and experience with pedestrian environments. Thus, the findings may not generalize to children with experience in urban traffic environments. Lastly, feasibility concerns limited our focus to peers with whom the child had no actual relationship. However, a more ecologically valid test of peer influence should include actual friends and determine if peer influences are even more robust than those observed in this study. Past research, for example, has shown greater effects on risk taking by youth with whom children share a closer relationship, such as best friends (e.g., Morrongiello & Dawber, 2004).

Given the interesting findings of the effect of peer presence and influence of PUM on risk taking, it would be especially valuable to further explore the effect of peer presence in a larger sample size to determine if peer presence substantially changes risk taking or if risk taking remains similar to control. This new knowledge may also inform research on interventions for preventing pedestrian injury. It would be valuable to test the effectiveness of teaching children about the influence of social norms, and the pull to imitate peer behaviour. It is possible that directly teaching children about normative human behaviour will help them recognize when they are taking risks for the purpose of peer approval and help to change this behaviour. Related to this, although we now have a better understanding of the effects of modeling and presence of an unknown peer on child street crossing behaviour independently, it is likely that in reality children experience both of these social influences simultaneously. It would be valuable to further explore the effect of peer modeling and presence together on child pedestrian behaviour.
Conclusions

Peer modeling and peer presence influence risk taking differentially in the context of children crossing the street. Most children react relatively similarly to peer modeling and will attempt to change their behaviour to comply with the expressed social norm, regardless of whether the modeled behaviour is more or less risky than their usual behaviour without a peer. This effect appears rather powerful, such that even a single peer who is unknown to the child can influence behaviour, and the extent of reactivity to peer modeling does not seem to be influenced by individual differences. In contrast, presence of a peer does not substantially change street crossing behaviour, but does not impact all children in the same way. The presence of a peer does not include communication of a specific social norm, and the extent to which a child changes their behaviour in reaction to the peer is dependent on a child’s individual attributes, specifically their age and their endorsed levels of positive urgency trait. Younger children and those with high levels of positive urgency show more risk in reaction to peer presence compared with older children or those lower in positive urgency. Overall this study demonstrates the important role of peers and individual attributes in child pedestrian injury. This research adds to the understanding of how peers influence risk taking and further research in this area may aid in finding ways to prevent child pedestrian injury in the future.
References


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Table 1

*Intercorrelations of variables in the control condition*

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*Note.* Significant correlations are noted with a * and the significance is listed directly below the correlation. * is significant at the .05 level, and ** is significant at the .01 level. The control condition includes 20 participants, except for the CSD measure which includes 19 participants.
Table 2

*Intercorrelations of variables in the peer presence condition*

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*Note.* Significant correlations are noted with a * and the significance is listed directly below the correlation. * is significant at the .05 level, and ** is significant at the .01 level. The peer presence condition includes 19 participants, except for the CSD measure which includes 18 participants.
Table 3

*Intercorrelations of variables in the risky peer modeling condition*

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<td>-.54*</td>
<td>-.15</td>
<td>-.17</td>
<td>.17</td>
<td>.12</td>
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<tr>
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<td>-.34</td>
<td>-.63**</td>
<td>-.16</td>
<td>.23</td>
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<tr>
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<td>.006</td>
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<td>-.43</td>
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<td>.10</td>
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<tr>
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<td></td>
<td>-.04</td>
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</tr>
<tr>
<td>CSD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.25</td>
</tr>
</tbody>
</table>

*Note.* Significant correlations are noted with a * and the significance is listed directly below the correlation. * is significant at the .05 level, and ** is significant at the .01 level. The risky peer modeling condition includes 19 participants, except for the CSD measure, which includes 18 participants.
Table 4

*Intercorrelations of variables in the safer peer modeling condition*

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>PUM</th>
<th>FNE</th>
<th>SAD</th>
<th>CSD</th>
<th>Gap Size Difference</th>
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<tr>
<td>Age</td>
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<td></td>
<td>.29</td>
<td>-.39</td>
<td>-.29</td>
<td>.08</td>
<td>.25</td>
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</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-.23</td>
<td>.21</td>
<td>-.20</td>
<td>.01</td>
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<td></td>
<td>.57**</td>
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<td>-.31</td>
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<td>.007</td>
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</tr>
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<td></td>
<td>-.314</td>
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<td>.34</td>
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<td></td>
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<td>CSD</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>-.07</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

*Note.* Significant correlations are noted with a * and the significance is listed directly below the correlation. * is significant at the .05 level, and ** is significant at the .01 level. The safer peer modeling condition includes 21 participants.
Table 5

Correlations of variables with initial levels of risk taking (pre peer manipulation) for each condition

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Peer Presence</th>
<th>Risky Modeling</th>
<th>Safe Modeling</th>
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<tbody>
<tr>
<td>Age</td>
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<td>-.46*</td>
<td>-.03</td>
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</tr>
<tr>
<td>Gender</td>
<td>-.10</td>
<td>-.10</td>
<td>-.29</td>
<td>.01</td>
</tr>
<tr>
<td>PUM</td>
<td>.03</td>
<td>.61**</td>
<td>-.20</td>
<td>.06</td>
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<td></td>
<td></td>
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<td>FNE</td>
<td>.18</td>
<td>.19</td>
<td>.37</td>
<td>-.34</td>
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<td>SAD</td>
<td>.06</td>
<td>.22</td>
<td>.17</td>
<td>-.29</td>
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<tr>
<td>CSD</td>
<td>-.38</td>
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<td>.17</td>
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<td>Gap Size Difference</td>
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<td>-.31</td>
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<tr>
<td></td>
<td>.05</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Significant correlations are noted with a * and the significance is listed directly below the correlation. * is significant at the .05 level, and ** is significant at the .01 level.
Table 6

Means (M) and standard deviations (SD) of variables in each condition

<table>
<thead>
<tr>
<th>Measure</th>
<th>Control</th>
<th>Peer Presence</th>
<th>Risky Modeling</th>
<th>Safe Modeling</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Age (years)</td>
<td>9.60</td>
<td>0.92</td>
<td>9.30</td>
<td>0.90</td>
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<tr>
<td>Gap Size PRE (sec)</td>
<td>3.04</td>
<td>0.52</td>
<td>3.15</td>
<td>0.76</td>
</tr>
<tr>
<td>Gap Size Diff. (sec)</td>
<td>-0.27</td>
<td>0.27</td>
<td>-0.15</td>
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<tr>
<td>PUM</td>
<td>3.00</td>
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</tr>
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<td>FNE</td>
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<td>SAD</td>
<td>2.29</td>
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<td>1.89</td>
<td>0.50</td>
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<tr>
<td>CSD</td>
<td>0.33</td>
<td>0.24</td>
<td>0.37</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Note. Possible range for each questionnaire measure PUM (1-7), FNE (1-5), SAD (1-5), CSD (0-1).
Table 7

*Independent ANCOVA results assessing the effect of condition on each trait (PUM, FNE, SAD, and CSD) with age and gender as covariates*

<table>
<thead>
<tr>
<th>Trait</th>
<th>Effect of Condition</th>
<th>Effect of Gender</th>
<th>Effect of Age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>$F$</td>
<td>$p$</td>
</tr>
<tr>
<td>PUM</td>
<td>(3,70)</td>
<td>2.34</td>
<td>.08</td>
</tr>
<tr>
<td>FNE</td>
<td>(3,70)</td>
<td>0.79</td>
<td>.50</td>
</tr>
<tr>
<td>SAD</td>
<td>(3,70)</td>
<td>2.15</td>
<td>.10</td>
</tr>
<tr>
<td>CSD</td>
<td>(3,67)</td>
<td>0.89</td>
<td>.45</td>
</tr>
</tbody>
</table>

*Note. A * is used to denote significant effects. * is significant at the .05 level, and ** is significant at the .01 level.*
Figure 1. Black and white image of the virtual environment, the actual environment was displayed in colour.
Appendix A

Simulator Sickness Items

1. Does your child experience **migraine headaches**? 
   Yes  No

2. Does your child experience **claustrophobia** (fear of closed in spaces)? 
   Yes  No

3. Does your child have a history of motion sickness? 
   Yes  No
   If yes, please describe where and when (i.e. car for long time).

4. Does your child typically experience dizziness or nausea while watching a movie in a wide-screen (e.g. Silver City or Omnimax Theatre)? 
   Yes  No
   If yes, please describe.

5. Has your child ever experienced dizziness or nausea as the result of going on a **carnival ride**? 
   Yes  No

General Medical History Questions

1. Does your child have **heart problems** or has your child ever had a **heart attack**? 
   Yes  No

2. Does your child experience lingering effects from **stroke, tumor, or head trauma**? 
   Yes  No

3. Does your child suffer from **epileptic seizures**? 
   Yes  No
   If yes, please describe.

3. Does your child have any **inner ear problems** (vertigo)? 
   Yes  No

4. Does your child have **diabetes for which insulin is required**? 
   Yes  No

5. Does your child have problems with **low blood sugar/hypoglycemia**? 
   Yes  No

6. Is your child currently **taking medications** that make him/her feel extremely nauseated or dizzy? 
   Yes  No
Appendix B

Two Subscales from the Social Anxiety Scale for Children - Revised

Social Avoidance and Distress subscale – Specific to new Situations

1. I worry about doing something new in front of other kids.
2. I feel shy around kids I don't know.
3. I only talk to kids I know really well.
4. I get nervous when I talk to new kids.
5. I feel nervous when I'm around certain kids.
6. I get nervous when I talk to kids I don't know very well.

Generalized Social Avoidance and Distress subscale

1. I am quiet when I'm with a group of kids.
2. I feel shy even with kids I know very well.
3. It's hard for me to ask other kids to play with me.
4. I'm afraid to invite others to my house because they might say no.
Appendix C

Fear of Negative Evaluation Subscale from the Social Anxiety Scale for Children - Revised

1. I worry about being teased.
2. I worry about what other kids think of me.
3. I'm afraid that other kids will not like me.
4. I worry about what other children say about me.
5. I feel that kids are making fun of me.
6. I feel that other kids talk about me behind my back.
7. I worry that other kids don't like me.
8. If I get into an argument with another kid, I worry that he or she won't like me.
Appendix D

Children’s Social Desirability Short Scale

1. Have you ever felt like saying unkind things to a person?
2. Are you always careful about keeping your clothing neat and your room picked up?
3. Do you sometimes feel like staying home from school even if you are not sick?
4. Do you ever say anything that makes somebody else feel bad?
5. Are you always polite, even to people who are not very nice?
6. Sometimes, do you do things you’ve been told not to do?
7. Do you always listen to your parents?
8. Do you sometimes wish you could just play around instead of having to go to school?
9. Have you ever broken a rule?
10. Do you sometimes feel angry when you don’t get your way?
11. Do you sometimes feel like making fun of other people?
12. Do you always do the right things?
13. Are there some times when you don’t like to do what your parents tell you?
14. Do you sometimes get mad when people don’t do what you want them to do?
Appendix E

Positive Urgency Measure for Children

1. When I am very happy, I can’t seem to stop myself from doing things that can lead to bad outcomes.

2. When I am in a great mood, I tend to get into situations that cause me problems.

3. When I am very happy, I tend to do things that may cause problems in my life.

4. I tend to lose control when I am in a great mood.

5. When I am really crazy happy, I tend to get out of control.

6. Others would say I make bad choices when I am extremely happy about something.

7. Others are shocked or worried about the things I do when I am feeling very excited.

8. When I get really happy about something, I tend to do things that can have bad outcomes.

9. When overjoyed, I feel like I can’t stop myself from going overboard.

10. When I am really excited, I tend not to think about what the consequences of my actions might be.

11. I tend to act without thinking when I am really excited.

12. When I am really happy, I often find myself in situations that I normally wouldn’t be comfortable with.

13. When I am very happy, I feel like it is okay to give in to cravings or overindulge.

14. I am surprised at the things I do when I am feeling in a great mood.
**Appendix F**

Table F1

Presentation of Temporal Gap Sizes Between Oncoming Cars in Each Phase

<table>
<thead>
<tr>
<th>Phase</th>
<th>Gap sizes presented (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstration</td>
<td>N/A</td>
</tr>
<tr>
<td>2. Adjustment of HMD</td>
<td>N/A</td>
</tr>
<tr>
<td>3. Practice without cars</td>
<td>N/A</td>
</tr>
</tbody>
</table>
| 4. Practice with cars              | 1. 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9  
                                  | 2. 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9  
                                  | 3. 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9  
                                  | 4. 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8  
                                  | 5. 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8  
                                  | 6. 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8  
                                  | 7. 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8  
                                  | 8. 1.5, 1.75, 2, 2.25, 2.5, 2.75, 3, 3.25, 3.5, 3.75, 4, 4.25, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7, 7.25 7.5, 7.75, 8  
                                  | 9. 1.5, 1.75, 2, 2.25, 2.5, 2.75, 3, 3.25, 3.5, 3.75, 4, 4.25, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7, 7.25 7.5, 7.75, 8  |
| 5-Pre. Incremental gap baseline    | Trials 1-24:                     |
|                                    | 1.5, 1.75, 2, 2.25, 2.5, 2.75, 3, 3.25, 3.5, 3.75, 4, 4.25, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7, 7.25 7.5, 7.75, 8  |
| 5-Post. Incremental gap test       | Trials 1-24:                     |
|                                    | 1.5, 1.75, 2, 2.25, 2.5, 2.75, 3, 3.25, 3.5, 3.75, 4, 4.25, 4.5, 4.75, 5, 5.25, 5.5, 5.75, 6, 6.25, 6.5, 6.75, 7, 7.25 7.5, 7.75, 8  |