Determinants of Risky Decision-making:

What is Peer Influence?

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The studies included in this thesis were written as standalone articles to be submitted for publication. The articles are preceded by a General Introduction to the broader the research area, and followed by a General Discussion, where the findings from all of the studies are integrated. Due to the structure, there may be some repetition of the content across sections of this thesis.

Abstract

Impulsive and risky decision-making have been linked to dangerous driving, substance use, gambling, overspending, and general delinquency. The aim of the series of studies presented in this thesis was to gain an understanding into contextual factors that influence decision-making, focusing on the effects of peers, age, and gender.

Article 1 (Chapter 2) reports on a single study where participants completed a delay-discounting task either alone, or in the presence of a same-aged peer of the same gender. Those in the peer condition exhibited significantly greater rates of discounting compared to those alone when comparing the area under the curve; however, there was no significant difference between the discount rates (k) between those in the peer condition and those in the alone condition. Due to difficulty with recruitment, we had a small sample, therefore, these results should be interpreted with caution.

Article 2 (Chapter 3) presents two studies which examine the difference between peer presence, and peer influence (when peers provide an opinion) on risk-taking. In both studies, we used three hypothetical probabilistic-discounting scenarios to examine risk-taking. The first study investigated risk-taking under three conditions: peer absence, peer presence, and negative peer influence (risk-promoting peer). The second study added a fourth condition, positive peer influence (risk-averse peer), to examine whether positive peer influence was more like peer absence, or peer presence. Both studies showed that participants exhibited the greatest amount of risk-taking in the negative peer-influence condition, compared to both the peer-present and peer-absent conditions. Risk-taking was also greater in the peer-present condition compared to in the peer-absent condition. Therefore, both the presence and negative influence of peers increased risk-taking. The results of the second study in Article 2 extended our findings, showing that positive peer influence resulted in the lowest rates of risk-taking behaviour, lower than when decision-making occurred in the absence of peers.

Article 3 (Chapter 4) outlines two studies which examined whether peer influence extends to other social relationships. The first study in Article 3 investigated whether risk-taking differs under the influence of parents, partners, and friends. We found that risk-taking was higher for parents and partners, compared to friends. We hypothesised that people were more influenced by their partners and parents as they had a closer relationship with them, compared to friends. Thus, the second study in Article 3 examined whether risk-taking differed based on the closeness of the relationship. Using a combination of probability and social discounting methods, we asked participants how likely they would be to risk receiving a fine for five social contacts of varied degrees of closeness. We found that risk-taking

systematically differed based on the closeness of the relationship. Participants exhibited greater risk-taking for a closer social contact, compared to a more distant social contact.

We also examined the effects of age and gender on decision-making across the five studies presented in this thesis. Our findings provided little evidence that risk-taking was related to age, however, there was some evidence that risk-taking of younger participants may be more influenced by peers than risk-taking of older participants. Risk-taking between men and women was similar and susceptibility to the presence and influence of peers was also similar between men and women.

Collectively, these studies illustrate that both the presence and influence of peers affect decision-making, however, providing a direct influence has a greater effect. The greatest risk-taking occurs when peers provided a risk-promoting opinion, and the least when peers provided a risk-averse opinion. The influence of peers is not just limited to friends, but peer influence extended to others, such as romantic partners and parents. People were most influenced by those with whom they had a closer relationship. Thus, the social context wherein decision-making occurs is fundamental to the likelihood of risky choices.

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Chapter 1
General Introduction

Harmful risk-taking and impulsivity have been associated with gambling (Mishra et al., 2010), dangerous driving (Iversen, 2004), texting while driving (Walshe et al., 2021), and substance abuse (Feldstein & Miller, 2006). Impulsivity can be defined as acting on impulse, without forethought, planning, or considering the potential consequences of the behaviour. As an example, smoking, drinking, or choosing an unhealthy snack option are choices which are seen as impulsive, and avoiding these behaviours might be seen as having self-control. People who are said to "have self-control" are thought to be able to control their impulses, delay gratification, and consider the available information to make a well-thought-out choice. Some impulsive choices are also risky choices, but not all impulsive choices are risky. A risky choice involves weighing up the outcomes of the decision, where there is a chance of a negative outcome occurring: that is the likelihood of a negative outcome occurring relative to a positive outcome occurring (Nigg, 2017). Making a risky choice does not mean that the person has accurately assessed the likelihood of the risk occurring, or that a negative outcome will definitely occur. Risk-taking can lead to positive outcomes, for example, moving across country to take on a new job, starting a new business venture, or gambling and winning money. Therefore, risk-taking is not always seen as harmful, and in some cases, it may be encouraged. Due to the similarities within these concepts, impulsivity and risk-taking are often related; a person who behaves impulsively, will often take risks (Donohew et al., 2000). Both impulsivity and risk-taking are also related to sensation-seeking, where a person seeks out novel experiences (Donohew et al., 2000). A person seeking a new experience may impulsively try a new experience (impulsivity) or misjudge or ignore potential harmful outcomes (risk-taking). The act of making a choice, whether it be risky, impulsive, or both, is known as decision-making, therefore, it is useful to understand factors that affect the likelihood of risky choices in decision-making.

Peers and Risk-taking

Risk-taking and impulsive decisions often occur in the presence of others, are discussed with others, or are posted on social media where they are subject to approval from others. These situations allow for influence prior to the decision, and/or approval from peers leading to reinforcement and a continued pattern of risk-taking. As decision-making often occurs with input from, or in the presence of others, it is worth understanding the effect others have on the choices people make.

The presence of others can affect the decision outcome, particularly for adolescents and young adults (see Albert et al., 2013; Defoe et al., 2015). The influence of peers can lead to riskier choices or more impulsive behaviour (e.g., Bingham et al., 2016; de Boer et al., 2016; Gardner & Steinberg, 2005; Kessler et al., 2017; O'Brien et al., 2011; Simons-Morton et al., 2014; A. R. Smith et al., 2014). Although the effects of peers are well-researched, the way influence is defined across studies differs (Riedijk & Harakeh, 2017). Some researchers assume influence is based on the peers being present or observing during the decision-making process, but that the peers do not have direct input into the decision (e.g., O'Brien et al., 2011; A. R. Smith et al., 2014; Weigard et al., 2014). Using this method, comparisons are made between decisions made alone to those made in the presence of peers. As an example, O'Brien et al. (2011) asked participants to complete a delay-discounting task either alone or in the presence of two friends (of the same age and gender). Participants who were in the presence of peers preferred smaller, more-immediate outcomes, forgoing larger outcomes available after a delay. Participants who were alone, however, preferred larger-later outcomes (O'Brien et al., 2011). Peers do not even need to be physically present or known. Participants who believed they were being observed by a same-aged anonymous peer in another room via a closed-circuit computer system made more impulsive choices than those who were alone (Weigard et al., 2014). However, present peers must be, or be perceived to be, monitoring the decisions, not just present (Somerville et al., 2018). The assumption that peers influence behaviour by being present is not often clarified and is just regarded simply as "peer influence" in the literature.

Another common way to measure peer influence is more direct; peers are present, and the participant is shown or given information about what choice the peer would make (e.g., Gardner & Steinberg, 2005; Gilman et al., 2014). Being given information on what peers may do in certain situations allows researchers to examine whether the participant will imitate the choice (Knoll et al., 2015). When given information regarding how peers perceive a certain behaviour, participants were more likely to change their own perception of the behaviour to be more closely aligned with the perceived risk provided by the peer (Knoll et al., 2015). When participants were informed that peers had chosen the smaller-sooner rather than the larger-later option on a delay-discounting task, they were more likely to make the same choice, having steeper discount rates than those who were not provided information regarding peer choices (Gilman et al., 2014). Even those who report high resistance to peer influence were found to have higher rates of impulsive behaviour when influenced by peer decision-making (see Riedijk & Harakeh, 2017). Therefore, being given information about a peer's decision in a situation could affect risk-taking.

It is important to understand that not all peer influence on decision-making is negative. Peer influence may also be positive. Peers may discourage risky behaviour or increase prosocial behaviours such as volunteering (Ahmed et al., 2020; Cascio et al., 2015; Choukas-Bradley et al., 2015; Foulkes et al., 2018; Osmont et al., 2021; Simons-Morton et al., 2014; van Hoorn et al., 2014). Although the presence of peers is linked to an increase in some negative behaviours, such as running of red lights and speeding, Ross et al. (2016) found that running of amber lights was reduced by the presence of peers. Being provided with a risk-averse opinion can also lead to less risk-taking behaviour (e.g., Bingham et al., 2016; Cascio et al., 2015; Osmont et al., 2021; Simons-Morton et al., 2014; Tomova & Pessoa, 2018). When shown a peer making riskier choices, participants are more likely to make risky choices, and conversely when a peer is risk-averse, participants are more likely to make safer choices (Tomova & Pessoa, 2018). As peers can increase and decrease risk-taking, the effects of having peers simply present versus having peers provide an opinion on risk-taking are yet to be fully understood. Moreover, it would be helpful to understand factors that lead to the influence of peers being positive or negative.

There are several explanations for the effects peers may have on behaviour. One theory is that young people seek peer approval and are preoccupied with the social consequences of their actions (Reniers et al., 2017). Young people, in particular, are at a time of heightened anxiety where they value friendships more than other types of relationships (Reniers et al., 2017). Therefore, when young people are making decisions in a social environment where they may be exposed to potentially negative social consequences, they will ensure their decisions closely align with how their friends would behave (Andrews et al., 2021). Another theory is that risk attitudes, preferences, and behaviours may lead someone to choose a particular friend or friend group as they have behaviours in common (Brechwald & Prinstein, 2011; Kandel, 1978). People seek others who have similar risk appetites to themselves, and therefore display similar behaviours. Risk-averse people are likely to stick together, but likewise, so are friends who engage in risk-taking. In turn, it is likely that behaviour which aligns with that of their peers is reinforced by the peer and becomes a continued pattern of behaviour. Given that there are changes to risk-taking in the presence of peers, it is evident that the social environment of decision-making has an effect on the outcome.

Age and Risk-taking

Age is another factor that is associated with impulsivity and risk-taking. Impulsivity and risk-taking are negatively correlated with age, meaning impulsive behaviour decreases as age increases (Mamerow et al., 2016; Reimers et al., 2009). Adolescence is known as a period in which young people make impulsive, risky choices, and seek new experiences (Blakemore, 2018; Reyna & Farley, 2006; Shulman et al., 2016). The relationship between age and impulsivity is described as an inverted U-shape, as, from childhood, impulsivity increases through adolescence, and then typically decreases in adulthood (Steinberg, 2008; Steinberg et al., 2008; Steinberg et al., 2018).

A meta-analysis on age differences found that adolescents (aged 11-19) took more risks than those aged 20-and-over in laboratory-based tasks, which reflects real-world differences between the behaviour of adolescents and adults (Defoe et al., 2019). The age bracket of 11-19 years is quite broad, but an earlier meta-analysis by Defoe et al. (2015) showed that early adolescents took more risks than mid-to-late adolescents in laboratory tasks, but that this did not reflect self-reported behaviour. In mid-to-late adolescence, young people have more risk opportunity so their real-world risk-taking in behaviours such as substance use, delinquency, and risky sexual behaviours increase. Willoughby et al. (2021) found that although risk-taking was high in adolescence, when considering different types of risk-taking behaviour across multiple domains, the period of increased risk-taking was actually between the ages of 20-29 years.

The period of mid-to-late adolescence, or early adulthood as it may be called, is a period where young people may move away from parental homes and household rules and have access to a new set of choices (Duell et al., 2018). Therefore, it is unsurprising that mid-to-late adolescents have higher rates of real world risk-taking compared to that of early adolescents (Defoe et al., 2015; Defoe et al., 2019). The transition period between adolescence and adulthood, where risk opportunity changes, was initially thought to be linked to the western culture of coming of age, however, studies of young people from non-western backgrounds also found risk-taking behaviour was higher during this period (Duell et al., 2018; Mata et al., 2016). Across studies, the period of adolescence is ill-defined and ranges from early teen years to late teens, but it is still thought that teenagers and young adults (under 25 years of age) are more impulsive than adults.

Impulsivity is often stable after early adulthood; however, some studies report changes later in life (e.g., Read & Read, 2004; Richter & Mata, 2018; Seaman et al., 2016). Some researchers have found that older adults come to prefer smaller-sooner outcomes after middle-adulthood, in their later years (see Read & Read, 2004; Richter & Mata, 2018; Seaman et al., 2016). Older adults discount outcomes less than younger adults at short-to-moderate delays, showing less impulsivity; however, at longer delays older adults discounted outcomes similarly to younger adults, showing similar rates of impulsivity (Leverett et al., 2021). Older adults may perceive delay to receiving outcomes differently as they have limited time left, or a closer proximity to death (Richter & Mata, 2018). It is possible that contextual changes such as perceived remaining time and health status may affect decision-making (Seaman et al., 2016).

The relationship between age and impulsivity, or age and risk-taking, also differs depending on how behaviours associated with impulsivity and risk are measured (Olson et al., 2007; Scheres et al., 2006). Scheres et al. (2006) found differences in discounting behaviour between children (aged 6-11 years) and adolescents (aged 12-17 years) on a delay-discounting task, but not on a probability-discounting task. Furthermore, there were no differences in responses on a probability-discounting task between younger adults (20-29 years) and older adults (61-82 years) when using either real or hypothetical outcomes (Horn & Freund, 2021). It is also possible that risk-taking differs across age by domain (Bonem et al., 2015; Rolison et al., 2014; Willoughby et al., 2021). Most laboratory tasks or self-report measures of risk-taking and impulsivity tend to focus on specific outcomes or commodities (e.g., alcohol, drug-use, and delinquent behaviours) which may be less applicable to adults. Willoughby et al. (2014) discussed whether certain types of behaviour such as financial investing or marital infidelity would be more relevant in assessing risk-taking prevalence in adults. Wilson et al. (2021) found that younger adults showed greater impulsivity on a laboratory-based task compared to older adults, but there was no difference in self-reported impulsivity between the two groups suggesting laboratory-based tasks and self-reported measures may be capturing different facets of impulsivity.

Although there are many studies which examine the relationships between age and impulsivity, and age and risk-taking, there are also many inconsistencies between these studies. To summarise, it is thought that adolescents are more impulsive, and make more risky decisions than adults but the period of adolescence is poorly defined, and inconsistently applied across studies. Therefore, how age affects decision-making may depend on many factors, such as the types of measure used, the types of behaviours measured, the type of outcomes (e.g., real or hypothetical), and the commodities (such as food, money, or alcohol) on choice-based tasks.

Gender and Risk-taking

Many researchers have also examined the effect of gender on risk-taking. Young men tend to exhibit greater impulsivity, risk-taking behaviour, and seek novel experiences more often than young women (Bener, 2013; Cross et al., 2011; Cross et al., 2013; de Boer et al., 2016; Dohmen et al., 2011; Gardner & Steinberg, 2005). Perception of risk may account for some of the differences in risk-taking behaviour between men and women (Harris et al., 2006; Reniers et al., 2016). Women perceive negative outcomes as more likely or more severe, and anticipate less enjoyment from risky decisions, compared to men (Harris et al., 2006). Reniers et al. (2016) found that men are less likely to rate a particular activity as risky, compared to women. As an example, young women are less willing to ride in a driverless vehicle than young men (Rice & Winter, 2019). Women also anticipate that riding in a driverless vehicle would be less fun and of lower perceived value than men, which contributed to their willingness (Rice & Winter, 2019). It may be that men are given more opportunities to experience risk and reward than women, and are taught and encouraged to take risks (see Gustafsod, 1998, for a review). The differences in risk perception between men and women may also be accounted for by learned experiences, and therefore, exposure to consequences.

Most studies that have identified a gender difference show that men are more impulsive than women (e.g., Byrnes et al., 1999; Cross et al., 2011; de Boer et al., 2016; Gardner & Steinberg, 2005). Other studies have found no difference between men and women (e.g., Reynolds et al., 2006). However, a few studies have also shown that women have higher rates of impulsive behaviour compared men (e.g., Beck & Triplett, 2009; C. Smith & Hantula, 2008). A review of differences by gender, on a delay-discounting task, found that women discount outcomes more steeply than men, a finding which differs from results of other studies using various measures of impulsivity (Weafer & de Wit, 2014). Weafer and de Wit (2014) attributed the difference to the outcome type: women are more impulsive when it comes to hypothetical outcomes, whereas men are more impulsive when it comes to actual outcomes.

Similar to age, the differences between men and women in risk-taking also depends on the behaviour measured (Byrnes et al., 1999; Morgenroth et al., 2017; Rolison & Shenton, 2020). For example, women are more risk-averse when it comes to financial decisions and investments (Charness & Gneezy, 2012; Jianakoplos & Bernasek, 1998) but when it comes to social risks, there are very few differences between men and women (Harris et al., 2006). Many of the tools that measure risk-taking focus on behaviours that are seen as more masculine, such as betting on sports races, poker games, or riding a motorcycle without a helmet (Morgenroth et al., 2017). The domain specific risk-taking (DOSPERT) scale is a commonly used self-report measure of risk-taking that focuses on behaviours from five domains: financial, health/safety, recreational, ethical, and social (Blais & Weber, 2006; Weber et al., 2002). Morgenroth et al. (2017) argues that many of the behaviours in the DOSPERT scale are biased toward men. The behaviours on the DOSPERT are more likely to appeal to men compared to women, so results show that men make more risky choices (Morgenroth et al., 2017). With the addition of more feminine forms of risk-taking behaviour (e.g., getting plastic surgery, horseback riding without a helmet, or splurging on expensive clothing), gender differences may not exist, or are reversed, with women showing higher rates of risk-taking (Morgenroth et al., 2017). Therefore, it may be difficult to ascertain whether gender affects risk-taking behaviour, if the behaviours reflected in the measurement of risk-taking are biased toward men. Furthermore, differences between men and women's rates of risk-taking have also been attributed to the measurement type. A meta-analysis found that studies using self-report measures reported higher rates of impulsivity for men compared to women, however, for behavioural tasks, results were mixed (Cross et al., 2011). There was no difference between men and women's decision-making on a delay-discounting task but there were differences for another behavioural task known as the balloon analogue risk task (BART), where men were shown to have higher risk-taking compared women (Cross et al., 2011). Therefore, gender differences in risk-taking should be considered for the task itself, and not generalised to behaviours outside of the domain measured (Nelson, 2014).

Age and Peers

Susceptibility to the influence of peers seems to vary by age (see Gardner & Steinberg, 2005). Young people are more susceptible to peer influence (McCoy et al., 2017). Gardner and Steinberg (2005) found adolescents (13-16 years) and youths (18-22 years) took more risks and showed a higher preference for risky choices in the presence of their peers compared to adults (24 and older). The age of the influencing peers also may also contribute to the effect of peers on decision-making. Knoll et al. (2015) observed that young people were more likely to change their perception of risk, based upon the opinions of similar-aged people rather than adults, showing they gave more value to the opinion of their similar-aged peers. Decisions made by adolescents were riskier when with same-aged peers than when alone, however, when one of the peers was slightly older, risk-taking decreased and more closely resembled that when alone (Silva et al., 2016).

Adolescent's greater susceptibility to peer influence may be explained by the idea that young people have a strong desire to fit in with their peers, and worry about social rejection, meaning they are more likely to follow "social norms," or the behaviour of others (Andrews et al., 2021; Blakemore, 2018). Participants are more influenced by choices made by peers, compared to choices made by a computer (Braams et al., 2019). Peers provide social consequences which a computer cannot, supporting the theory that young people conform due to social consequences. It is thought that adults are not as susceptible to peer influence. However, research on peer influence tends to use "peers" synonymously with "friends," therefore, peer-influence research focuses on the relationship between an adolescent and their friends, usually of a similar age (e.g., O'Brien et al., 2011). Adults, however, are influenced by peers if the definition of peers is broadened. Several studies have shown that adults in relationships are influenced by their romantic partners (e.g., Homish & Leonard, 2008; Homish et al., 2007; Leonard & Mudar, 2003, 2004; Windle & Windle, 2018), similar to how people can be influenced by friends. Behaviours such as drinking, smoking, substance use, or unhealthy eating habits of one partner are adopted by the other, over time spent in their presence (Homish & Leonard, 2008; Homish et al., 2007; Leonard & Mudar, 2003, 2004; Windle & Windle, 2018).

Decision-making differs in different social environments. People are more influenced by people they know, compared to strangers (Salvy et al., 2007; Ziegler & Tunney, 2012). Young people are also known to be influenced by their parents (Carter et al., 2014; Casswell et al., 2002; Mares et al., 2011; Wood et al., 2004; Yurasek et al., 2018). But perhaps most importantly, people seem to be more influenced by those closest to them (Foreman et al., 2019; Ziegler & Tunney, 2012).

As age increases a person's susceptibility to peer influence may decrease. Although it may be seen as favourable that as someone ages, they are less likely to be influenced by their friends, it also means that people may become less receptive to peer suggestions not to take risks, or positive peer influence (Ahmed et al., 2020). Furthermore, as young people become adults, while it may seem that they are not influenced by their friends-as-peers, they may be influenced by romantic partners-as-peers instead.

Gender and Peers

There is also some evidence that shows young men are more susceptible than young women to peer influence (e.g., de Boer et al., 2016; Defoe et al., 2020). Young men and women have exhibited similar rates of risk-taking while alone, but when observed by two peers of the same gender to the participant, men showed higher risk-taking than women (Defoe et al., 2020). In a study by de Boer et al. (2016), adolescents completed the BART either alone or in the presence of two peers. The groups, made up of three participants, were boy-only, girl-only, or a mixture of boys and girls. Those in groups exhibited more risk-taking than those alone, however, the gender composition of the group affected the extent of peer influence. Boys took greater risks when they completed the task in the presence of other boys, rather than in a mixed group. While girls in the presence of others took more risks compared to when alone, they took fewer risks than boys in the presence of others, regardless of the gender of those present. de Boer et al. (2016) therefore showed that boys were more susceptible to the influence of peers compared with girls, and that boys were more influenced by same-gendered peers when in group situations.

Interestingly, approximately half of the literature reviewed by McCoy et al. (2017) reported that men were more susceptible to peer influence compared to women, while the remaining half reported no difference between men and women in risk-taking when influenced by peers. Although there is little evidence to suggest that women are more susceptible to peer influence than men, they may be more sensitive to social consequences and experience greater anxiety around conforming to peer behaviours (Reniers et al., 2016). As previously stated, many measures of risk-taking focus on masculine forms of risk-taking which may also affect the findings of susceptibility to peer influence.

Measuring Impulsivity and Risk-taking Through Discounting

There are many ways to measure impulsivity and risk-taking, such as self-report (reported behaviour), hypothetical choice (projected behaviour), and observed behaviour (actual behaviour; Bran & Vaidis, 2020; Byrnes et al., 1999). Discounting procedures are one behavioural task used in decision-making research to examine impulsivity and risk-taking through hypothetical choice (see Moreira & Barbosa, 2019; Reimers et al., 2009). There are multiple types of discounting dimensions, such as delay, probability, social, and spatial. Perhaps the most used is delay discounting, where choice is dependent on two variables: the outcome and the delay to its receipt (Odum, 2011a). Both humans and animals tend towards wanting larger outcomes over smaller, and sooner rather than later (Odum, 2011a).

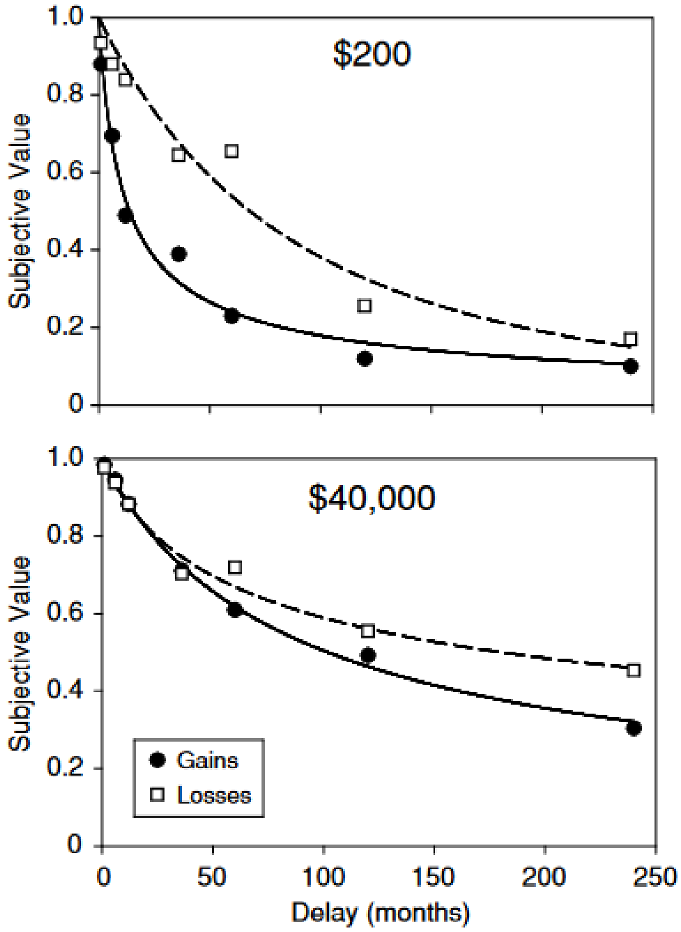
In a typical monetary delay-discounting scenario, one decision may be “would you rather $50 now or $100 in one week’s time?” The participant must evaluate both outcome amount ($50 vs. $100) and the delay to when the outcomes are available (now vs. 1 week). These decisions are a binary choice; the participant must choose between one of two presented options (C. Smith & Hantula, 2008). Over a series of decisions, both the magnitude and the delay-to-receipt change (e.g., Odum & Rainaud, 2003; Ohmura et al., 2006; Simpson & Vuchinich, 2000; C. Smith & Hantula, 2008). Evaluating choices over a series of decisions allows researchers to find the point at which the participant's preference changes from one alternative to the other (Odum & Rainaud, 2003). Choosing a smaller-sooner alternative over a larger-later one is often seen as an impulsive choice, whereas choosing to wait for the larger-later outcome is seen as exhibiting self-control (Odum, 2011a).

The way in which variables such as magnitude and immediacy of outcome are varied over the series of decisions can differ between tasks. For example, in delay discounting, common changes across the series of choices are adjusting the delay while keeping the amount constant, adjusting the immediate amount while keeping the delay constant, or adjusting the delayed amount while keeping the sooner amount constant. One of the most common procedures for how the decisions vary within a series of choices is known as the adjusting-amount procedure. Using the adjusting-amount procedure, the immediate amount is systematically changed based on the previous decision, and the delayed amount is kept constant at a delayed point across the series of decisions (Mazur, 1987). There are two common ways to terminate the task when using an adjusting-amount procedure. The trials may be terminated when the participants' preference changes from the larger-later outcome to the smaller-sooner. As the participant works through a number of trials the difference between the two options becomes less discriminable, as the smaller-sooner amount increases based on the previous trial. Alternatively, the task may continue until a set number of decisions are made (e.g., Steinberg et al., 2009), at which point it would reset to the first decision, but with a shorter or longer delay. Over a series of decisions, researchers calculate an indifference point (also known as a subjective value), where the preference for the immediate and delayed amounts are equal, which is the midpoint between the last known immediate choice, and the last immediate rejected alternative (Du et al., 2002; McKerchar & Renda, 2017; Rachlin et al., 1991). The data for each participant are, therefore, a series of indifference points with their corresponding delays (see McKerchar & Renda, 2017, for a review). Although there may be differences in how the dimensions change, participants systematically discount the value of the outcome across changes in the discounting variable (Holt et al., 2012).

Figure 1 shows an example of systematic discounting of gains and losses for two amounts of monetary outcomes (one large and one small) over seven delays (in months). Figure 1 demonstrates that the subjective value of both gains and losses decreased as the delays to the outcome increased. The discounting of gains (indicated by the solid circles) is steeper than for losses (open-squares) for both small (top graph) and large amounts (bottom graph), indicating greater impulsivity for monetary gains compared to monetary losses. Figure 1 also shows smaller magnitudes of both gains and losses also produced steeper discounting curves, showing more impulsivity compared to discounting for larger magnitudes.

Figure 1

Example of Discounting the Subjective Value of both Small and Large Monetary Gains and Losses as a Function of Delay



Note. Rachlin's 2-parameter hyperboloid fitted to the data (see Equation 3). Figure from "Differential effects of amount on temporal and probability discounting of gains and losses," by S. J. Estle, L. Green, J. Myerson, and D. D. Holt, 2006, *Memory & Cognition, 34*(4), p. 917 (https://doi.org/10.3758/BF03193437). Copyright 2006 by the Psychonomic Society, Inc.

Analysis of Discounting

The typical pattern for delay discounting is that when delays are small (e.g., 1 day or 1 week), people tend to choose larger-later outcomes, but when delays are large (e.g., 5 years or 10 years), people tend to choose smaller-sooner outcomes. Therefore, over a series of delays from short to long, indifference points typically decrease showing people get more impulsive as delays increase. A curvilinear function can be fitted to a series of indifference points to model the decrease in the of the subjective values across delay. Most functions are derived from either the exponential model or the hyperbolic model, with common models being the exponential model (e.g., Simpson & Vuchinich, 2000), the hyperbolic model (e.g., Rachlin et al., 1991; Simpson & Vuchinich, 2000), and an extended 2-parameter hyperboloid (e.g., Simpson & Vuchinich, 2000).

The exponential model is generally preferred by economists and is less common in psychology research:

$$V = Ae^{-kD} \tag{1}$$

where V is the present, discounted value, of the delayed outcome (the indifference point), A is the amount or magnitude of the outcome, D is the delay until the outcome can be received, and k is the discounting rate. The mathematical constant e is the base of the natural logarithm and is approximately equal to 2.718. A larger k value means steeper discounting and a smaller k value means that the rate of discounting of the future outcome is shallower (Green & Myerson, 1996).

There is an underlying assumption in delay discounting that as time passes to the receipt of the delayed outcome, there is an increased risk that something might happen to prevent its receipt (Green & Myerson, 1996). An assumption of the exponential function is that the degree of discounting is the same between any two delays of the same length. For example, the rate of discounting between an outcome available tomorrow and the day after, will be the same as for an outcome available in 1 year, and 1 year and 1 day from now (Oliveira & Green, 2012). The second assumption implies that, as the delay between the two time periods is the same, 1 day, the risk that something will prevent the receipt of the outcome remains the same, and thus, the preference of the participant should also remain the same (Green & Myerson, 1996; Oliveira & Green, 2012). To summarise, the exponential function relies on the assumption that the rate of discounting remains constant and does not change in relation to the discounting dimension (e.g., delay; Oliveira & Green, 2012).

A better fit for the data is provided by hyperbolic equations which are popular with psychology researchers (Myerson & Green, 1995; Oliveira & Green, 2012; Rachlin et al., 1991). Mazur (1987) gives the hyperbolic equation as:

$$V = A / (1 + kD) \tag{2}$$

where *V*, *A*, *k*, and *D* are described as they were previously for the exponential function. The main difference between the exponential and the hyperbolic function regards the assumption of discount rate over the delay (or another discounting dimension, e.g., social proximity). The hyperbolic function is based on the assumption that something will prevent the receipt of the outcome is higher initially and decreases with the additional delay to the outcome (Green & Myerson, 1996; Oliveira & Green, 2012). To describe the function more simply, the pattern of discounting will be steep initially, and become shallower with each unit of delay (Oliveira & Green, 2012). Therefore, an assumption of the exponential function is that the rate of discounting is constant, whereas the hyperbolic functions is based on assumption that the rate discounting is not constant (Oliveira & Green, 2012).

Mazur's equation underestimates an individual's subjective sensitivity to the magnitude of the outcome, so may not provide the best fit across people, thus, the equation was extended by raising the denominator to a power to account for more variance (Du et al., 2002; Myerson & Green, 1995; Simpson & Vuchinich, 2000). Rachlin (2006) describes an extended equation:

$$V = A / (1 + kD)^s \tag{3}$$

where the added parameter *s* better accounts for individual differences in discounting, compared to the hyperbola described by Equation 2, therefore providing a better fit to the indifference points (Du et al., 2002; Myerson & Green, 1995; Simpson & Vuchinich, 2000). See Figure 1 as an example of Equation 3 fitted to discounting for both gains and losses as a function of delay.

In a comparison of two different ways of administering a delay-discounting task (computer vs. paper and pencil), C. Smith and Hantula (2008) found that data were best described by hyperbolic rather than exponential functions. The best fit of the data can be found by using tools such as the Discounting Model Selector which fits multiple models to the data provided, calculating the parameters (e.g., *k*), and measures which describe how well each model fits the data (Gilroy et al., 2017).

Another alternative to analysing discounting data is to calculate the area under the curve (AUC). By plotting the indifference points for each delay, the trapezoids can be computed. The equation for AUC is:

$$X_2 - X_1 [(Y_1 + Y_2)/2] \tag{4}$$

where the ordinate is the proportion of the non-discounted absolute value, and the abscissa shows the proportion of the maximum possible delay (C. Smith & Hantula, 2008). The summed values present an area that ranges from 0.0 to 1.0. Lower discount rates have AUC values closer to 1.0 as they have a shallower curve.

Reliability and Validity of Discounting

Delay-discounting tasks have good reliability (Ohmura et al., 2006; Simpson & Vuchinich, 2000; C. Smith & Hantula, 2008). The two most common discounting procedures involve binary choice (e.g., choosing between $50 now or $100 available in 1 month) or fill-in-the-blank questions (C. Smith & Hantula, 2008). Fill-in-the-blank procedures ask participants to name the amount they would accept immediately that would be just as good as a larger amount (e.g., $1000) in the future (Chapman, 1996; C. Smith & Hantula, 2008). C. Smith and Hantula (2008) found there was a moderate correlation coefficient (*r* = .75) between the *k* values from fill-in-the-blank and binary-choice procedures, showing good alternate-forms reliability, however, the correlation between the AUC values from the two procedures was weak (*r* = .33). They also found no differences observed between administering the delay-discounting task via pen-and-paper or a computer (C. Smith & Hantula, 2008).

Simpson and Vuchinich (2000) investigated reliability using a hypothetical monetary reward task, where they asked participants to choose between a smaller-sooner amount and a larger-later amount, in two sessions, 1 week apart. The subjective values from the two delay-discounting tasks which were taken 1 week apart were strongly correlated at delays greater than 1 month (Simpson & Vuchinich, 2000). Furthermore, derived *k* values from the two tasks 1 week apart were also significantly moderately-to-strongly correlated (*r* = .91 when *k* was calculated by Equation 2, and *r* = .74 for *k*, and *r* = .79 for *s* when calculated by Equation 3), indicating delay-discounting tasks have good reliability across 1 week (Simpson & Vuchinich, 2000). Furthermore, discount rates (*k*) and AUC values for delay and probability-discounting tasks, showed good reliability across 3 months (Ohmura et al., 2006).

Delay-discounting tasks also have good validity (Du et al., 2002; C. Smith & Hantula, 2008). C. Smith and Hantula (2008) found moderate convergent validity between the derived *k* values (from the hyperbolic model) and the Eysenck Personality Questionnaire Impulsivity (EPQ-I) scale, and a lack of correlation with scores on Zuckerman's Sensation Seeking Scale - Disinhibition (SSS-D), showing good divergent validity. Questions from the EPQ-I relate to a decision where a reward is compared against an uncertain future outcome whereas the questions from the SSS-D focus on evaluating choices between immediate consequences only. As discounting performance was significantly correlated with the EPQ-I, and not correlated with the SSS-D, the findings indicate that discounting is related to impulsivity and not to disinhibition, thus showing good convergent and divergent validity (C. Smith & Hantula, 2008). Furthermore, delay-discounting tasks have been used across cultures and there are no significant differences as a function of the culture of participants, other than small differences in the steepness of the discounting function (Du et al., 2002).

Variations of Discounting

In some scenarios, the immediate consequence of making an impulsive decision might be uncertain. For example, running a red light might get a driver to their destination faster, but they might have an accident. Choosing to stop is seen as less impulsive, as the driver is more likely to get to their destination safely. Discounting tasks that involve uncertainty in the likelihood of the outcome are known as probabilistic discounting, where the delay is replaced with the probability of an outcome occurring (McKerchar & Renda, 2017; Rachlin et al., 1991). Probability-discounting tasks are used as a metric for risk-taking behaviour, as the participant chooses between a smaller-certain outcome and a larger-uncertain outcome (Rachlin et al., 1991). The subjective value of the outcome decreases as the likelihood of receiving the outcome decreases (McKerchar & Renda, 2017). Choosing larger, less certain outcomes is considered riskier than choosing smaller, more-certain outcomes (Oliveira & Green, 2012). Exhibiting self-control in probabilistic discounting means choosing the smaller more-certain outcomes over larger less-certain outcomes, which is the opposite to delay discounting, where choosing the smaller-sooner option is more impulsive (Oliveira & Green, 2012). Probabilistic discounting is more likely to involve a loss rather than a gain, meaning the participant must choose between losing a small but certain amount, or a larger amount at a varied probability (Oliveira & Green, 2012). Consider insurance as an example, the insured person chooses to pay a small but certain amount for their insurance policy to avoid a potentially larger cost to them in an event such as fire, theft, or illness. Not being insured is considered riskier, as, in the event of a house fire, the person may struggle to replace their house and contents, whereas, having insurance would mean the cost is covered by the insurer. Therefore, being insured is perceived as less risky, as although the likelihood of a fire occurring is slim, the person chooses the smaller more-certain outcome rather than the larger but less certain outcome.

Probability discounting is analysed similarly to delay discounting. Participants make a series of decisions of across varied probabilities of receiving an outcome (e.g., 95%, 90%, 50%, 30%, 10%, and 5%), and their indifference points are plotted against the likelihood of the risk occurring, calculated as an odds against ratio. Odds against is calculated as:

$$\Theta = (1 - p) / p \quad (5)$$

where Θ represents odds against and *p* is the likelihood of the outcome occurring (percentage). In calculating the discount rate, the delay in the exponential (Equation 1), hyperbolic (Equation 2), and an extended hyperboloid (Equation 3) functions is replaced by odds against. Similarly to delay discounting, hyperboloid functions tend to provide a better fit for probabilistic discounting data and can be used to describe discounting for both gains and losses (Estle et al., 2006; Oliveira & Green, 2012).

Although money is a common discounting commodity, many outcomes have been used, such as alcohol (e.g., Odum & Rainaud, 2003), food (e.g., Odum & Rainaud, 2003; Robertson & Rasmussen, 2018), health (e.g., Berry et al., 2017; Bleichrodt et al., 2016; Chapman & Elstein, 1995; Seaman et al., 2016), environmental outcomes (e.g., Kaplan et al., 2014; Sargisson et al., 2021; Sargisson & Schöner, 2020), and others (e.g., Foreman et al., 2019; Lawyer & Schoepflin, 2013; Weatherly & Ruthig, 2013; Weatherly et al., 2010). Commodities are often valued differently (Weatherly et al., 2010), for example, money has been found to be less steeply discounted than alcohol and food (Odum & Rainaud, 2003), health more steeply than money (Chapman & Elstein, 1995), and environmental outcomes differently to health outcomes (Hardisty & Weber, 2009).

For some commodities, it is difficult to use real outcomes. Researchers are unable to deliver large amounts of money or provide financial outcomes over very long delays. It would be unethical to manipulate outcomes involving a person's health or the environment, so hypothetical outcomes must be used. However, researchers have found that people discount real and hypothetical outcomes similarly (Horn & Freund, 2021; Locey et al., 2011; Madden et al., 2003; Robertson & Rasmussen, 2018). Hypothetical scenarios are more frequently used for health and environmental outcomes where they may give insight into people's preferences, motivations, and behaviours, allowing governments to use the information to encourage safer or healthier habits (Attema, 2012). Where possible, risk-taking should be measured through realistic examples, as they are a better predictor of actual behaviour than self-report measures or behavioural tasks (Bran & Vaidis, 2020). To examine risk-taking through a realistic example of decision-making, participants are usually given a description of a situation and then asked to choose between two options. For example, Bleichrodt et al. (2016) asked participants to choose between two treatment options varying in efficacy, as they were described to be experiencing chronic back pain. Treatment A was offered immediately and Treatment B at a point in the future, but Treatment B was more effective in treating the back pain than Treatment A, which is a smaller-sooner, or larger-later scenario (Bleichrodt et al., 2016). As the time to receiving Treatment B increased, participants were more likely to choose the less effective option, Treatment A, to treat their back pain (Bleichrodt et al., 2016).

Risk-taking is very subjective, with people accounting for whether the loss would cause significant impacts, and their own capability, skills, and experience to navigate the risk (Bran & Vaidis, 2020). People who have large financial savings or earnings may perceive the loss of a sum of money as less significant compared to someone living on a tight budget. Someone who has completed a snake identification and handling course will likely perceive picking up a snake differently to someone who cannot identify whether the snake is venomous or not. Thus, in the study of risk-taking, measures which lower the subjectivity of risk should be used: situations should present a loss which would be significant for most, and where possible skills and experience do not provide an advantage (Bran & Vaidis, 2020). Risk-taking measures should also be real-world examples of decisions people make to ensure that scenario-based discounting is a useful tool for exploring hypothetical choices.

As scenarios vary a little from the binary choice discounting ‘would you rather this or that’ questions, the response mechanisms also vary. Similar to using a fill-in-the-blank procedure, Kaplan et al. (2014) used a visual analogue scale (VAS) for participant responses instead of a binary choice. The VAS is a subjective measure which allows participants to rate their behaviour on a line, representing a 0-100 scale, usually with qualifiers on each end. In their research on environment concerns, Kaplan et al. (2014) asked participants to rate their concern about, and how likely they would be to act to prevent, an environmental outcome across different discounting dimensions. The participants’ indication on the scale is then their subjective value (or indifference point). By using hypothetical scenarios, researchers can determine which factors influence decision-making, by providing the participant with the context of the decision. Using scenarios allows for researchers to explore risk-taking through discounting in a wider range of situations.

Summary

Risky decision-making seems to be influenced by social factors such as peer presence (O'Brien et al., 2011) or even assumed presence (Weigard et al., 2014). While peer presence is thought to have a negative effect on decision-making leading to more risky choices, it remains unclear whether the effect of peer presence is similar to when a peer is encouraging risk (peer influence). In addition, peers may also provide a protective effect, for example, when provided with a risk-averse opinion, a person's decision-making may change to reflect a safer, healthier choice. Therefore, we were interested in exploring why peer presence is assumed to be negative, and whether the presence of peers can be negated by providing a risk-averse opinion. Given that there are differences in the way peer influence is defined in the literature, it is crucial to investigate the nuances between the effect of present peers, and peers who provide an opinion.

Furthermore, although it appears young people are affected by peers, it is still unclear whether older adults are affected to the same degree as young adults. There is some evidence which suggests that decision-making by adults is less affected by peers, although the term peers in the peer-influence literature often implies friends. Therefore, we considered whether the influence of peers differs across relationship types (e.g., friends or partners) as people age, rather than decreasing entirely.

In addition, it remains unclear whether men are more susceptible to peer influence than women, and, if so, whether they are more susceptible to both negative and positive peer influence. In summary, the effect of peers and the role of age and gender on peer influence is still misunderstood, in particular what decisions are affected, and whether social influence factors change by age and gender.

Overview of Studies

To address the gaps in understanding of the effects of peers, age, and gender on risky decision-making, we designed the series of studies presented in this thesis which focus on these three factors. More specifically, we aimed to examine whether there was a difference between peer presence and peer influence on decision-making, determine the effects of positive and negative peer influence on behaviour in relation to peer presence and peer absence, and whether the type of peer affects decision-making. Furthermore, we aimed to understand the effects of age and gender on decision-making, and gain further insight into whether younger people, or men, are more susceptible to the effects of peers.

In Study 1, we used a similar procedure to O'Brien et al. (2011) by exploring whether the physical presence of a same-age, same-gendered peer influenced delay-discounting behaviour. We also aimed to examine whether delay-discounting behaviour differed by age or gender.

We experienced several methodological issues with Study 1, such as small sample size and uneven gender distribution. Therefore, in an attempt to overcome recruitment difficulties, we recruited participants for our subsequent studies using Amazon's Mechanical Turk (mTurk). Furthermore, we took a broader approach to assessing decision-making in subsequent studies using real-world examples of where peers may be present, as participant's peers are unlikely to be involved in their monetary decision-making. Therefore, in Studies 2.1-3.2, we used a scenario-based probability-discounting task as a measure of risky decision-making.

Study 2.1 investigated the difference in the effect of peer presence compared to negative peer influence (a risk-promoting opinion given by a peer), alongside a peer-absent condition. Study 2.2 extended Study 2.1 by comparing positive peer influence (risk-averse opinion) to decision-making in peer-absent, peer-present, and negative peer influence (risk-promoting opinion) conditions. Both Studies 2.1 and 2.2 also examined whether peer presence, or peer influence, either positive or negative, differ by age or gender.

Studies 3.1 and 3.2 in Article 3 examined broader social influence on risky decision-making. In early 2020, a global pandemic was declared in response to COVID-19. As a relevant topic at the time of these studies, the scenarios described in Article 3 focus on whether people would be willing to break lockdown requirements in three different contexts, under different likelihoods of receiving a fine for not following the health orders (probability discounting). Study 3.1 explored whether there was a difference in risk-taking behaviour under the influence of three different social contacts: parents, partners, and friends. Study 3.2 built on Study 3.1 and explored the relationship between risk-taking and the degree of closeness with the social contact. Participants were asked how likely they would be to risk getting a fine for not following the lockdown requirements, under three different situations, for five social contacts with different levels of closeness (Person #1 being the closest person in the world and #100 being a distant acquaintance). We also explored whether socially influenced risk-taking differed by age and gender.

For the studies presented in this thesis we analysed the data using Equation 3, as Rachlin's (2006) 2-parameter hyperboloid was the best fit for the delay-discounting data in Study 1, and the probability-discounting data in the subsequent studies, where delay was replaced with odds against (calculated using Equation 5). We also calculated the AUC values for each participant using Equation 4 in all studies. Where results using k (calculated from Equation 3) and AUC were similar, we have only presented the findings from the k values throughout this thesis for brevity. In Study 1 comparisons between conditions using AUC and k differed, and therefore analyses using both AUC and k are presented for Study 1 (Chapter 2). No difference in the overall findings from the subsequent studies was observed.

Chapter 2

Article 1

Impulsive decisions can lead to risk-taking behaviour including smoking, drug use, binge drinking, criminal activity, gambling, risky driving behaviours, and unsafe sexual practices (see G. C. Patton et al., 2016, for a review). An impulsive choice is one made without forethought, planning, or consideration for consequences. Impulsive choices may also be risky, where the decision has the potential to lead to negative consequences, such as getting sick, injured, or facing prosecution. Due to the potential harm associated with risk-taking, it is useful to understand factors that influence decision-making that can lead to risky choices.

The presence of peers increases the likelihood of risky or impulsive decisions for adolescents and young adults (e.g., Bingham et al., 2016; de Boer et al., 2016; Gardner & Steinberg, 2005; O'Brien et al., 2011; Simons-Morton et al., 2014; A. R. Smith et al., 2014; van Hoorn et al., 2017). O'Brien et al. (2011) found adolescents observed by two peers discounted future outcomes more steeply, compared to those who were alone. Moreover, participants who simply believed they were being observed by peers in another room showed similar differences, meaning the peers may not need to be physically present to increase impulsivity (Weigard et al., 2014). Risk-taking on laboratory-based measures also increased in the presence of peers (Chein et al., 2011; Gardner & Steinberg, 2005). Somerville et al. (2018) suggests that the effect of peers on decision-making is greater when the peers directly observe the decisions being made, rather than being simply present but unable to observe the choice.

Several studies have also examined the effects of age on decision-making (see Defoe et al., 2015). It is suggested that during the transition from childhood to adulthood, people exhibit greater risk-taking (Duell et al., 2018; Mata et al., 2011). As new opportunities arise that people were unable to experience at an earlier age (e.g., exposure to alcohol), people begin to explore and experience the consequences of these new behaviours (Josef et al., 2016; Mata et al., 2011; Romer et al., 2017). In comparison with adults, impulsive choices and risk-taking behaviours are more common for adolescents and young adults (Bixter & Rogers, 2019; Blakemore, 2018; Defoe et al., 2015; Defoe et al., 2019; Gardner & Steinberg, 2005). However, some measures of impulsivity and risk-taking show differences in age more so than others. Both Olson et al. (2007) and Scheres et al. (2006) found that discount rates decreased with age on a delay-discounting task, but not on a probability-discounting task. Furthermore, younger adults exhibited more risk-taking than older adults on a laboratory-based measure of risk-taking, but the two groups did not differ on two self-reported measures of risk-taking (Wilson et al., 2021). Typically, researchers have found low correlations, or no relationship, between self-report measures and laboratory-based tasks said to assess impulsivity (Cyders & Coskunpinar, 2011; Hasegawa et al., 2019; Odum, 2011b). Additionally, mid-to-late adolescents reported higher real world risk-taking than early adolescents, despite early adolescents exhibiting higher risk-taking than mid-to-late adolescents on laboratory-based tasks (Defoe et al., 2015).

The pattern of impulsivity across age is often described as an inverted U-shape, where impulsivity peaks in adolescence and young adulthood, and decreases in adulthood (Rolison et al., 2014; Steinberg, 2008; Steinberg et al., 2008; Steinberg et al., 2018). Steinberg and colleagues (2008) suggested that during young adolescence, risk-taking increases because young people are more sensitive to rewards, particularly when in the presence of their peers (Albert et al., 2013; Chein et al., 2011; Steinberg, 2008; Steinberg et al., 2008). It is theorised that younger people are more afraid of social rejection from the peer group; thus they are more susceptible to peer influence compared to adults (Andrews et al., 2021; McCoy et al., 2017). Peers add social reinforcement to the decision-making environment, making risk-taking more rewarding, and therefore, more likely to occur (Steinberg, 2008).

As men are over-represented in statistics for substance abuse, dangerous driving, aggression, and delinquency, numerous studies have examined the effects of gender on impulsivity and risk-taking (e.g., Barr et al., 2015; Bener, 2013; Burton et al., 2007; Chen & Jacobson, 2012; Harris et al., 2006; Jianakoplos & Bernasek, 1998; Stoltenberg et al., 2008). Young men tend to be more impulsive than young women and have a higher preference for risk (Byrnes et al., 1999; Cross et al., 2011; de Boer et al., 2016; Dohmen et al., 2011; Gardner & Steinberg, 2005). Similarly to age, these findings also differ across measures. A meta-analysis on gender differences showed that on the BART, men made more risky decisions, but on a delay-discounting task men and women showed no differences (Cross et al., 2011). In addition, whether gender differences are observed may depend on whether hypothetical or real outcomes are used. Some research has shown that women discount hypothetical rewards more steeply than men (Beck & Triplett, 2009; C. Smith & Hantula, 2008; Weafer & de Wit, 2014), however, when a real outcome was involved, men discounted more steeply (e.g., Kirby & Maraković, 1996). Men tend to be more focused on the perceived value rather than frequency or certainty, whereas women tend to choose smaller, but more-certain outcomes (Byrne & Worthy, 2016; Cornwall et al., 2018). Therefore, men and women make different decisions based on the perceived likelihood of an actual outcome occurring.

Men and women also perceive risk differently: men are less likely, and women more likely, to see an activity as risky (Reniers et al., 2016). Additionally, men report a greater willingness to seek out novel experiences than women (Cross et al., 2013). Rice and Winter (2019) found that women were less willing than men to ride in a driverless car and anticipate that this activity would be less enjoyable and of less value. Therefore, men and women perceive both risk and reward differently, which are crucial components of decision-making.

Research suggests that young men are more susceptible to peer influence compared to young women (e.g., de Boer et al., 2016; Defoe et al., 2020). Defoe et al. (2020) showed that young men and women engaged in similar rates of risk-taking behaviour when alone, however, young men exhibited greater risk-taking, compared to young women, in the presence of two same-aged peers of the same gender. de Boer et al. (2016) also found risk-taking between young men and women were similar, except when they were in groups. In groups of three, male adolescents made more risky choices than those who were alone; young women showed a similar pattern, but the difference between those who were alone and those in groups was not significant (de Boer et al., 2016). The gender composition of the groups also had an effect: groups of male-only adolescents showed the highest risk-taking, followed by groups consisting of both young men and women, with female-only adolescent groups showing the least risk-taking (de Boer et al., 2016). These studies show that male adolescents appear to be more susceptible to peer influence, particularly in the presence of other young men. A review on the susceptibility of peer influence by gender found that in approximately half of the reviewed literature, men were more susceptible to peer influence than women (McCoy et al., 2017). In the remaining literature, no gender difference was observed in peer-influence susceptibility (McCoy et al., 2017). Therefore, it is difficult to ascertain whether there is a difference in risk-taking behaviour between men and women, and also whether men are more susceptible to the influence of peers compared to women.

In summary, peers can increase impulsive and risky decisions, however, the effect appears to be moderated by age, where young people are found to be more susceptible to peer influence than adults (Gardner & Steinberg, 2005). Studies generally find that impulsivity and risk-taking are increased during adolescence and decrease with age, however, when this increase occurs depends on how risk-taking and impulsivity are measured. It is unclear whether men make more impulsive or risky choices than women or are more susceptible to peer influence when observed by same-gendered peers. While it seems men and women perceive risk and reward differently in decision-making, gender differences are also inconsistent across measures. Therefore, our aim for the present study was to examine factors influencing decision-making with a focus on peer presence, age, and gender. We investigated whether participants respond differently to a delay-discounting task in the presence of their peers (using a procedure similar to that of O'Brien et al., 2011). Delay discounting has been used to examine the effects of peers (e.g., O'Brien et al., 2011; Weigard et al., 2014), age (e.g., de Water et al., 2014; Olson et al., 2007; Scheres et al., 2006), and gender differences on decision-making (e.g., Cross et al., 2011; Weafer & de Wit, 2014). We expected that participants who were in the presence of peers would take more risks than participants who were alone. We also investigated whether responses on two self-report measures of impulsivity, and performance on a delay-discounting task, differed with age or gender. We hypothesised that younger participants would discount more steeply and exhibit more impulsivity and sensation-seeking than older participants. We expected that men would exhibit more impulsivity and report more sensation-seeking, but discounting would not differ between men and women.

Study 1

Method

Participants

We recruited a total of 197 participants, 97 individual participants, and 50 pairs of participants. Data from seven individuals and one pair were discarded as the data from the self-report measures and the delay-discounting task were unable to be matched, or were incomplete, so the final sample was 90 individual participants (63 women, 27 men; M_{age} = 24.72, 95% CI [22.96, 26.48]) and 49 pairs (78 women, 20 men; M_{age} = 19.53, 95% CI [19.02, 20.04]). Participants were recruited through posters placed around the School of Psychology and via Facebook, where psychology graduate students shared the posters with their friends and family. We initially focused on recruiting single participants for the alone condition, followed by the peer condition where participants were asked to bring a friend of the same age and gender. All participants received either course credit toward an undergraduate psychology course or a draw entry to win a supermarket voucher valued at $50.00 NZD. This project was approved by the University of Waikato's Psychology Research and Ethics Committee (#15.50).

Measures

All participants completed a questionnaire on Qualtrics (https://www.qualtrics.com/). The items included demographic questions and two different self-report measures of impulsivity; the Brief Sensation Seeking Scale (BSSS) and the Barratt Impulsiveness Scale (BIS-11). The BSSS has eight Likert-scale items with five options taken from Zuckerman's Sensation Seeking Scale (Hoyle et al., 2002) intended to show impulsivity within the construct of sensation-seeking. It has two questions from four different concepts related to sensation-seeking – disinhibition, thrill-seeking, experience seeking, and boredom (Hoyle et al., 2002). Participants' answers were summed to give a total score for the BSSS. A higher score indicates higher levels of sensation-seeking, a construct closely related to impulsivity. BSSS scores have been positively correlated with both alcohol and tobacco use (Stephenson et al., 2007). The BSSS has adequate internal consistency, with a Cronbach's alpha of .70 for a sample of 789 participants aged between 18-30 (Stephenson et al., 2007), and .76 in a study of more than 7000 adolescents (Hoyle et al., 2002). The Cronbach's alpha for the current study was .71.

The BIS-11 (Barratt, 1959) is a 30-item self-report measure of impulsivity. Participants are asked how they think and act with a series of statements such as 'I plan trips well ahead of time', 'I am a careful thinker', and 'I act "on impulse."' Participants chose from four response options based on how much these items applied to them (i.e., rarely/never, occasionally, often, or almost always/always). The lowest possible score is 30 and the highest is 120, though a typical score typically falls between 52-71. A higher score is indicative of higher levels of impulsivity (Stanford et al., 2009). Although there are three main subscales of the BIS-11, we used only the total score for each participant. The BIS-11 has adequate internal consistency, with a Cronbach's alpha of .82 for undergraduate students, .79 for substance-abuse patients, .83 for general psychiatric patients, and .80 for prison inmates (J. H. Patton et al., 1995). The Cronbach's alpha for the current study was .75.

To measure decision-making, we used a delay-discounting task with hypothetical monetary outcomes. In delay-discounting tasks, participants typically choose between a smaller, immediate amount of money, or a larger but delayed amount, for example, "would you rather $500 now or $1000 in a week?" (C. Smith & Hantula, 2008). Participants made a total of 54 decisions, nine decisions at each of the six delays. We used an adjusting-amount procedure, where the immediate value systematically changed based on the participant's previous decision, and the delayed option remained constant at $1000 (see Mazur, 1987). For example, if a participant was first presented with "would you rather $200 now or $1000 in one month" and the participant chose $1000, then the new immediate value would change to midway between the previous rejected choice ($200) and $1000. The next question in the series would have an immediate value of $600 now. If the participant had chosen $200 offered now in the initial question, then the following question would be midway between the chosen value and $0, so the next question in the series would read “would you rather $100 now or $1000 in one month.” An example is shown in Table 1.

Table 1

Example of Six Presentations of the Delay Discounting Questions and Answers using the Adjusting Amount Procedure with a Starting Point of $500.

Question	Answer	Calculation for Next Question
Q1: Would you rather $500 now or $1000 in one month?	A1: $1000 in one month	Increase to midpoint between 500-1000
Q2: Would you rather $750 now or $1000 in one month?	A2: $1000 in one month	Increase to midpoint between 750-1000
Q3: Would you rather $875 now or $1000 in one month?	A3: $1000 in one month	Increase to midpoint between 875-1000
Q4: Would you rather $937.50 now or $1000 in one month?	A4: $937.50 now	Decrease to midpoint between 875-937.50
Q5: Would you rather $906.25 now or $1000 in one month?	A5: $1000 in one month	Increase to midpoint between 906.25-937.50
Q6: Would you rather $921.87 now or $1000 in one month?	A6: $1000 in one month	Increase to midpoint between 921.87-937.50

The starting point was randomised for each participant, starting at an immediate value of either $200, $500, or $800. Participants made nine decisions for each of the six delays (1 day, 1 week, 1 month, 3 months, 6 months, 1 year) presented in ascending order. Custom software was written for the current task by University of Waikato technicians, which calculated the next immediate value for participants, and recorded each decision made throughout the task, to allow for calculation of an indifference point at each delay. The indifference point was calculated as the midpoint between the last accepted immediate value and the last rejected immediate value.

Procedure

The recruitment posters included a link for participants to schedule an experimental session. The sessions were held in person, in a small office on the university campus, or another location chosen by the participant where there were minimal distractions, and no people present. When participants came to the session, they were given an information sheet that outlined the study. The information sheet stated that participation was voluntary, they could withdraw from the study at any time, and they could decline to answer any questions.

Participants were told that we were investigating the effects of age on decision-making. Our main aim, which was to investigate differences in decision-making on the delay-discounting task between those in the alone condition and those in the peer condition, was withheld until after the experiment. Participants were asked to sign consent forms and indicate their preference for course credit or draw entry. Each participant was given a unique code to enter into both the questionnaire and to begin the discounting task.

Prior to each experimental session, an internet browser was set up with two tabs, one for the questionnaire on Qualtrics, and one for the web-based discounting task. Participants were seated directly in front of the computer, with a standard mouse and keyboard. Participants completed the questionnaire first, followed by the discounting task. For the discounting task, they entered their assigned code, then answered three trial questions to orient themselves to the task and keyboard responses. These three trial questions were identical to the real questions of the experiment, except for the amount of money presented ($50 now or $100 later). These choices were not recorded. The values swapped left and right sides and the response was made on the keyboard using the Z (left option) and M (right option) keys on the keyboard. Participants then completed the delay-discounting task.

Participants were left alone for approximately 20 minutes to complete the questionnaire and delay-discounting task. An oral debrief was then provided, explaining the purpose of the experiment. The experimental session (including introduction and debrief) lasted approximately 30 min.

The peer procedure was the same as outlined above, however, the role of primary participant was assigned to whomever made contact regarding participating in the experiment. Both participants completed the first part of the experimental session alone (i.e., filling out the demographics and self-report scales). For the delay-discounting task, the primary participant sat in front of the computer and responded using the keyboard. The other participant sat adjacent to the primary participant, in a position where they could see the computer screen. Participants were informed they were allowed to discuss the options during the task.

The debrief included an explanation that this study was focusing on how people make decisions in the presence of peers. Participants were given the option of withdrawing their data from the study if they were unhappy with the deception (of the true aims of the experiment) that had taken place, however, no participant asked to withdraw their data.

Analysis

Data were downloaded from both Qualtrics and Access (linked to the delay-discounting task) and matched using the unique code assigned to each participant. Each participant's data consisted of their demographics, BIS-11 scores, BSSS scores, and the nine choices they made at each delay. Data from seven individual participants and one pair was discarded as the unique code was unable to be matched between datasets (either due to the participant only completing one of the two tasks or incorrectly recording the unique identifier).

For each person in the alone and peer conditions, we calculated total scores for the BIS-11 and the BSSS. For participants in the alone condition, and the primary participant of the peer condition (n = 49), we calculated their indifference points at each delay.

Indifference points were calculated by finding the point at which the participant indicated equal preference for the immediate and delayed reward. The indifference point was the midpoint between the last-accepted and the last-rejected immediate amount (Du et al., 2002). Each participant therefore had six indifference points (one at each delay), which we used to calculate the discount rate. The delays were converted to days: 1, 7, 30, 90, 182, and 365 days.

We used Gilroy et al.'s (2017) Discounting Model Selector (https://www.smallnstats.com) to determine which discounting model best fit the data, by comparing the model fits of the exponential model, Mazur's (1987) hyperbolic model, Myerson and Green's (1995) model, and Rachlin's (2006) 2-parameter hyperboloid model (see Green & Myerson, 1996, for a review). The Discounting Model Selector provided the parameters of each model and three evaluation metrics: Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), root-mean-square error (RMSE). As AIC and BIC were not calculated for every participant for every model assessed, we choose to compare the discounting models using RMSE and found that Rachlin's (2006) 2-parameter model was the best fit, consistent with the findings of McKerchar et al. (2009) and Sargisson and Schöner (2020). Rachlin's (2006) equation is described as:

$$V = A / (1 + kD^s) \tag{3}$$

where V is the participant's indifference point, A is the maximum amount of the reward, D is the delay until the reward can be received, k is the discount rate, and s is free to vary. The discount rate, k, represents the slope fitted to the data; a larger k indicates steeper discounting, and a smaller *k* value indicates shallower discounting, said to represent less impulsive choices (Green & Myerson, 1996).

Non-systematic discounters are often removed from discounting datasets using an algorithm for identifying non-systematic data by Johnson and Bickel (2008), however, when the criteria were applied to the current dataset the sample size was drastically reduced. Thus, we opted to take a less conservative approach compared to removing non-systematic discounters. Consistent with Sargisson et al. (2021), we replaced the discount rates (*k*) with zeros if participants did not discount but did not remove these participants from our analyses. We calculated whether participants discounted by examining if the difference between the indifference point at the shortest delay (1 day) and that of the longest delay (365 days) was equal or greater than $20 (2% difference between the indifference points). In the cases where the difference was less than $20, the discount rate was replaced with zero (n = 14).

We also calculated the AUC values for both conditions, as AUC is considered a theoretically neutral model of discounting (see Myerson et al., 2001). We normalised the data into proportions before plotting it so that when plotted, the ordinate shows the proportion of the maximum undiscounted value, and the abscissa shows the proportion of the maximum possible delay (C. Smith & Hantula, 2008). We then calculated the trapezoids showing the area between two indifferent points at adjacent delays, using Equation 4:

$$X_2 - X_1 \, [(Y_1 + Y_2)/2] \tag{4}$$

The AUC for an individual's discounting behaviour is the product of the summed values of the trapezoids, ranging between 0.0 to 1.0 (Myerson et al., 2001). An AUC value which is closer to 1.0 indicates shallower discounting (lower impulsivity), and an AUC value which is closer to 0.0 represents steeper discounting (greater impulsivity). The relationship between AUC values and *k* values showed a moderate negative correlation, $r_s(138) = -.56$, $p < .001$.

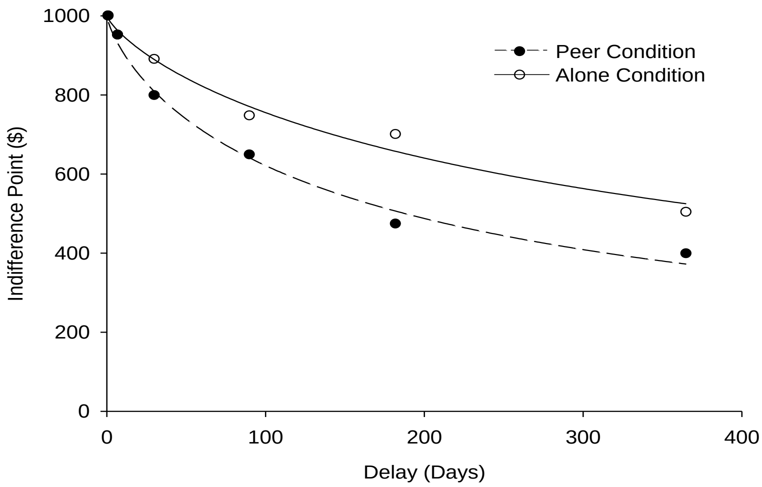
As both *k* and AUC values violated normality ($p < .001$), we used non-parametric analyses for comparisons. We used a Mann-Whitney U test to compare discounting behaviour of participants in the alone condition with those in the peer condition. We used Spearman's correlation to examine whether there were relationships between age, *k* values, AUC values, BIS-11 total scores, and BSSS total scores. We also used Mann-Whitney U tests to compare discounting behaviour, BSSS scores, and BIS-11 total scores, between men and women.

Results

Our main aim was to compare discounting behaviour for those who answered the discounting task alone to those who participated in the presence of their same-age, same-gendered peer. Figure 2 shows the median indifference points across the six temporal delays for participants in the alone (n = 90) and peer conditions (n = 49). As the delay increased, participants' indifference points decreased, meaning as time to the larger reward increased, participants in both conditions were more likely to choose the smaller-sooner reward. Figure 2 shows that participants in the peer condition exhibited steeper discounting, compared to those in the alone condition. However, when we compared the discount rate, *k,* between the two conditions using a Mann-Whitney U test, we found no significant differences between those who answered the discounting task alone (*Mdn* = .02) or those who answered the task alongside a peer (*Mdn* = .01), *U* =2096.00, *Z* = -.376, *p* = .70, *r* = -.03.

Figure 2

Median Indifference Points Across Delays for Alone and Peer Conditions



We also compared discounting between those in the peer condition to those in the alone condition using AUC. Using a Mann-Whitney U test, we found a significant difference between those who answered the discounting task alone (*Mdn* = .59) and those who answered the task alongside a peer (*Mdn* = .47), *U* = 1656.50, *Z* = -2.42, *p* = .02, *r* = -.21. Those in the peer condition showed steeper discounting, therefore producing a significantly lower AUC, compared to those in the alone condition.

As there were differences in the analyses between the discount rate as calculated by Rachlin's equation and the AUC values, exploratory analyses were conducted to examine if there were any differences between the six indifference points, between the alone and peer conditions (Table 2). We found there were significant differences in the indifference points at 182 and 365 days, but no significant differences at the other delays (*p* > .05). Therefore, at the two longest delays, those in the peer condition had significantly lower indifference points, showing a greater tendency to pick the smaller-more immediate option, compared to those in the alone condition.

Table 2

Mann-Whitney U Results Comparing the Indifference Points from the Peer and Alone Conditions by Delay

	1	**7**	**30**	**90**	**182**	**365**
Z	-1.49	-0.38	-1.07	-1.50	-2.80	-2.28
Sig.	.14	.70	.28	.13	**.005**	**.023**
N	139	139	139	139	139	139
R	-0.13	-0.03	-0.09	-0.13	-0.24	-0.19

Participant age (*Mdn* = 19.00, *IQR* = 18.00 - 24.00) was not related to BSSS scores, $r_s(187) = -.09$, $p = .23$, or BIS-11 total scores, $r_s(179) = .03$, $p = .69$. Discount rates (*k*) were also not related to participant age, $r_s(137) = -.11$, $p = .22$, but AUC was weakly negatively correlated with age, $r_s(138) = .19$, $p = .03$, indicating that younger participants made more impulsive choices than older people when using AUC values as a measure of discounting.

We found no significant differences between the scores of male and female participants for the scales (BSSS: $U = 3164.50$, $Z = -.46$, $p = .64$, $r = -.03$, BIS-11: $U = 2789.00$, $Z = .68$, $p = .50$, $r = -.05$), nor for the *k* or AUC values for the delay-discounting task (*k*: $U = 1862.00$, $Z = -.03$, $p = .98$, $r = -.00$, AUC: $U = 1877.00$, $Z = -.05$, $p = .96$, $r = -.00$).

As exploratory analyses, we examined the relationship between the three measures of impulsivity. We found that both discount rate (*k*) and AUC were related to scores on the BIS-11, *k:* $r_s(132) = .18$, $p = .04$, , AUC: $r_s(133) = -.26$, $p = .003$, showing that higher self-reported impulsivity was associated with greater discounting. Discounting was not related to scores on the BSSS, *k*: $r_s(138) = .13$, $p = .13$, AUC: $r_s(139) = -.14$, $p = .10$. Scores on the two self-reported measures were related, meaning higher impulsivity was associated with greater sensation-seeking, $r(180) = .30$, $p < .001$.

In conclusion, when comparing discounting behaviour between those who were alone and those with a peer, we found those who were with a peer had significantly lower AUC values than those who completed the task alone. However, when using *k* as calculated by Rachlin's 2-parameter hyperboloid model we found no difference in the discount rates for those who answered the delay-discounting task alone compared with those who were observed by a peer. In exploratory analyses, we found significantly smaller indifference points (showing more impulsivity) at the two longest delays for those in the peer condition. Furthermore, we found no relationship between age and *k* values, self-reported impulsivity, or sensation-seeking, however we did find a weak, but significant, relationship between age and AUC values. We found no differences between men and women. Discounting behaviour was not correlated with scores on the BSSS but were correlated with those on the BIS-11. Greater self-reported impulsivity was associated with higher discount rates and lower AUC values. Scores on the two self-reported measures were related, meaning participants who reported higher impulsivity also reported greater sensation-seeking.

Discussion

We hypothesised that those who completed the delay-discounting task alone would show shallower discounting than participants who were observed by a peer. Our data showed significantly steeper discounting in the peer condition when comparing the AUC values for those who completed the task alone compared those who were observed by a peer, but no significant difference between *k* values, calculated by Rachlin's equation. Given the inconsistencies in conclusions based on how we measured discounting behaviour (through Rachlin's commonly used discounting model, or through AUC, a theoretically neutral model of discounting), these findings should be treated with caution. We also expected younger participants would exhibit greater discounting behaviour than older participants, however, our findings differed based on the measure of discounting. We found a weak relationship between age and AUC values, showing younger people exhibited greater discounting when discounting was measured by AUC values, but no relationship between age and the discount rate (*k*). Age was not correlated with self-reported impulsivity or sensation-seeking. Furthermore, we expected men would show higher rates of impulsivity and sensation-seeking compared to women. On all three measures, we found no difference between the scores of men and women.

Our main aim was to investigate whether peers affected decision-making on a delay-discounting task, simply by being present. Using similar methodology to O'Brien et al.

(2011), we asked participants to complete in a delay-discounting task either alone, or with one peer present (a same-aged friend of the same gender). We found that while those in the peer condition showed greater rates of discounting, this difference was not statistically significant when using *k* values, but significant differences were observed between AUC values, and between indifference points at the two longest delays. Although we found that there was a difference in AUC values between those in the peer condition and those in alone condition, overall our findings were inconsistent with previous literature which shows the presence of peers leads to more impulsive or risky decisions (e.g., Gardner & Steinberg, 2005; O'Brien et al., 2011; Simons-Morton et al., 2014; A. R. Smith et al., 2014; van Hoorn et al., 2017; Weigard et al., 2014).

Our findings were inconsistent with those of O'Brien et al. (2011), who found that those in the peer condition showed significantly steeper discounting, using discount rates (*k*), than those in the alone condition. We considered whether the methodological differences between our study and that of O'Brien et al. (2011) account for the difference in findings. O'Brien et al. (2011) had a larger sample size (N = 100), more men in their sample (n = 52), and they used two peers instead of one. The small sample size or proportion of men in our sample may explain the difference in findings. If men are more susceptible to peer presence than women (as found by de Boer et al., 2016; Defoe et al., 2020), then the small number of men may have lessened the effect of peer presence on the overall sample. Furthermore, we found it difficult to recruit participants with two same-aged same-gendered peers, so we asked participants to bring only one peer with them. Therefore, we also consider whether O'Brien's (2011) use of two peers may have amplified the effect of peer presence.

It is widely reported that younger participants make more impulsive decisions than adults (Bixter & Rogers, 2019; Defoe et al., 2019; Gardner & Steinberg, 2005; Olson et al., 2007; Romer et al., 2017; Wilson et al., 2021). We expected that impulsivity measured through the BIS-11 and discounting would decrease with age, however, age was only correlated with AUC values, but not discount rates (*k*) in our study. These findings differ from previous studies which have shown differences in delay discounting across age (Bixter & Rogers, 2019; de Water et al., 2014; Olson et al., 2007; Scheres et al., 2006). We consider the whether our sample may explain these findings. Our sample largely consisted of an adult population, with the majority of participants being over the age of 18 years. We also had a truncated sample (*Mdn* = 19.00, *IQR* = 18.00 - 24.00) which could have reduced the size of our correlation coefficients between measures and age. As impulsivity is typically associated with adolescence (Steinberg et al., 2008), it is possible we did not observe a relationship between impulsivity and age as our sample was mostly adults. Furthermore, it is possible that the task type affected our findings. Horn and Freund (2021) compared delay discounting between younger (20-29 years) and older adults (61-82 years) and found no difference in discounting, similar to our findings. Bixter and Rogers (2019) suggests that younger adults are more sensitive to larger magnitudes; younger participants will exhibit higher rates of discounting for smaller rewards but will exhibit lower rates for larger rewards. Therefore, perhaps the outcome magnitude also contributed to finding no relationship between age and discount rates.

For our experiment, participants were asked to discount money. Willoughby et al. (2021) found that early adulthood (19-29 years) was a time where risk-taking was most prevalent over different risk-taking domains (financial, social, health, ethical, and recreational). Young adults were found to take greater risks than adults in all domains, but the difference was only significant for social, recreational, and health outcomes, but not financial or ethical outcomes (Willoughby et al., 2021). Thus, it may be that we did not observe a relationship between age and discounting because we asked participants to discount monetary outcomes and did not examine other types of decisions.

Our results also showed no significant difference between men and women's rates of discounting, which is consistent with previous literature that found no difference between men and women's behaviour on a delay-discounting task (Cross et al., 2011), however, due to our sample being recruited from mostly undergraduate psychology classes, men were under-represented (approximately 28% of the sample). Therefore, further research is needed to explore gender differences using a more evenly split sample across gender, and using different outcomes, to understand whether differences exist between men and women in decision-making.

As impulsivity can lead to risk-taking behaviour where there is a potential to cause negative outcomes, we suggest broadening our approach to the study of decision-making to include risk-taking. Moreover, we suggest broadening the outcomes used in future research to provide insight into how risk-taking differs by outcome. Therefore, researchers could examine whether specific risk-taking domains are more influenced by peers. Furthermore, to answer questions on the effects of both age and gender on risk-taking, we suggest future research should include a sample with a wider range of ages, and a more equal distribution of men and women.

References

Albert, D., Chein, J., & Steinberg, L. (2013). The teenage brain: Peer influences on adolescent decision making. *Current Directions in Psychological Science*, *22*(2), 114-120. https://doi.org/10.1177/0963721412471347

Andrews, J. L., Ahmed, S. P., & Blakemore, S. J. (2021). Navigating the social environment in adolescence: The role of social brain development. *Biological Psychiatry*, *89*(2), 109-118. https://doi.org/10.1016/j.biopsych.2020.09.012

Barr, G. C., Jr., Kane, K. E., Barraco, R. D., Rayburg, T., Demers, L., Kraus, C. K., Greenberg, M. R., Rupp, V. A., Hamilton, K. M., & Kane, B. G. (2015). Gender differences in perceptions and self-reported driving behaviors among teenagers. *Journal of Emergency Medicine*, *48*(3), 366-370. https://doi.org/10.1016/j.jemermed.2014.09.055

Barratt, E. S. (1959). Anxiety and impulsiveness related to psychomotor efficiency. *Perceptual and Motor Skills*, *9*, 191–198.

Beck, R. C., & Triplett, M. F. (2009). Test-retest reliability of a group-administered paper-pencil measure of delay discounting. *Experimental and Clinical Psychopharmacology*, *17*(5), 345-355. https://doi.org/10.1037/a0017078

Bener, A. (2013). The psychological distress and aggressive driving: Age and gender differences in voluntary risk-taking behavior in road traffic crashes. *European Psychiatry*, *28*(S1), 1-1. https://doi.org/10.1016/S0924-9338(13)75901-7

Bingham, C. R., Simons-Morton, B. G., Pradhan, A. K., Li, K., Almani, F., Falk, E. B., Shope, J. T., Buckley, L., Ouimet, M. C., & Albert, P. S. (2016). Peer passenger norms and pressure: Experimental effects on simulated driving among teenage males. *Transportation Research Part F: Traffic Psychology and Behaviour*, *41*, 124-137. https://doi.org/10.1016/j.trf.2016.06.007

Bixter, M. T., & Rogers, W. A. (2019). Age-related differences in delay discounting: Immediate reward, reward magnitude, and social influence. *Journal of Behavioral Decision Making*, *32*(4), 471-484. https://doi.org/10.1002/bdm.2124

Blakemore, S.-J. (2018). Avoiding social risk in adolescence. *Current Directions in Psychological Science*, *27*(2), 116-122. https://doi.org/10.1177/0963721417738144

Burton, L. A., Hafetz, J., & Henninger, D. (2007). Gender differences in relational and physical aggression *Social Behavior and Personality*, *35*(1), 41-50. https://doi.org/10.2224/sbp.2007.35.1.41

Byrne, K. A., & Worthy, D. A. (2016). Toward a mechanistic account of gender differences in reward-based decision-making. *Journal of Neuroscience, Psychology, and Economics, 9*(3-4), 157-168. https://doi.org/10.1037/npe0000059

Byrnes, J. P., Miller, D. C., & Schafer, W. D. (1999). Gender differences in risk taking: A meta-analysis. *Psychological Bulletin, 125*(3), 367-383. https://doi.org/10.1037/0033-2909.125.3.367

Chein, J., Albert, D., O'Brien, L., Uckert, K., & Steinberg, L. (2011). Peers increase adolescent risk taking by enhancing activity in the brain's reward circuitry. *Developmental Science*, *14*(2), F1-F10. https://doi.org/10.1111/j.1467-7687.2010.01035.x

Chen, P., & Jacobson, K. C. (2012). Developmental trajectories of substance use from early adolescence to young adulthood: Gender and racial/ethnic differences. *Journal of Adolescent Health*, *50*(2), 154-163. https://doi.org/10.1016/j.jadohealth.2011.05.013

Cornwall, A. C., Byrne, K. A., & Worthy, D. A. (2018). Gender differences in preference for reward frequency versus reward magnitude in decision-making under uncertainty. *Personality and Individual Differences*, *135*, 40-44. https://doi.org/10.1016/j.paid.2018.06.031

Cross, C. P., Copping, L. T., & Campbell, A. (2011). Sex differences in impulsivity: A meta-analysis. *Psychological Bulletin*, *137*(1), 97.

Cross, C. P., Cyrenne, D.-L. M., & Brown, G. R. (2013). Sex differences in sensation-seeking: A meta-analysis. *Scientific Reports*, *3*, 2486-2486. https://doi.org/10.1038/srep02486

Cyders, M. A., & Coskunpinar, A. (2011). Measurement of constructs using self-report and behavioral lab tasks: Is there overlap in nomothetic span and construct representation for impulsivity? *Clinical Psychology Review*, *31*(6), 965-982. https://doi.org/10.1016/j.cpr.2011.06.001

de Boer, A., Peeters, M., & Koning, I. (2016). An experimental study of risk taking behavior among adolescents: A closer look at peer and sex influences. *The Journal of Early Adolescence*, *37*(8), 1125-1141. https://doi.org/10.1177/0272431616648453

de Water, E., Cillessen, A. H. N., & Scheres, A. (2014). Distinct age-related differences in temporal discounting and risk taking in adolescents and young adults. *Child Development*, *85*(5), 1881-1897. https://doi.org/10.1111/cdev.12245

Defoe, I. N., Dubas, J. S., Dalmaijer, E. S., & van Aken, M. A. G. (2020). Is the peer presence effect on heightened adolescent risky decision-making only present in males? *Journal of Youth and Adolescence*, *49*(3), 693-705. https://doi.org/10.1007/s10964-019-01179-9

Defoe, I. N., Dubas, J. S., Figner, B., & van Aken, M. A. (2015). A meta-analysis on age differences in risky decision making: Adolescents versus children and adults. *Psychological Bulletin*, *141*(1), 48-84. https://doi.org/10.1037/a0038088

Defoe, I. N., Dubas, J. S., & Romer, D. (2019). Heightened adolescent risk-taking? Insights from lab studies on age differences in decision-making. *Policy Insights from the Behavioral and Brain Sciences*, *6*(1), 56-63. https://doi.org/10.1177/2372732218801037

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J., & Wagner, G. G. (2011). Individual risk attitudes: Measurement, determinants, and behavioral consequences. *Journal of the European Economic Association*, *9*(3), 522-550. https://doi.org/10.1111/j.1542-4774.2011.01015.x

Du, W., Green, L., & Myerson, J. (2002). Cross-cultural comparisons of discounting delayed and probabilistic rewards. *The Psychological Record*, *52*(4), 479-492. https://doi.org/10.1007/BF03395199

Duell, N., Steinberg, L., Icenogle, G., Chein, J., Chaudhary, N., Di Giunta, L., Dodge, K. A., Fanti, K. A., Lansford, J. E., Oburu, P., Pastorelli, C., Skinner, A. T., Sorbring, E., Tapanya, S., Uribe Tirado, L. M., Alampay, L. P., Al-Hassan, S. M., Takash, H. M. S., Bacchini, D., & Chang, L. (2018). Age patterns in risk taking across the world. *Journal of Youth and Adolescence*, *47*(5), 1052-1072. https://doi.org/10.1007/s10964-017-0752-y

Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: An experimental study. *Developmental Psychology*, *41*(4), 625-635. https://doi.org/10.1037/0012-1649.41.4.625

Gilroy, S. P., Franck, C. T., & Hantula, D. A. (2017). The discounting model selector: Statistical software for delay discounting applications. *Journal of the Experimental Analysis of Behavior*, *107*, 388-401. https://doi.org/10.1002/jeab.257

Green, L., & Myerson, J. (1996). Exponential versus hyperbolic discounting of delayed outcomes: Risk and waiting time. *American Zoologist*, *36*(4), 496. https://doi.org/10.1093/icb/36.4.496

Harris, C. R., Jenkins, M., & Glaser, D. (2006). Gender differences in risk assessment: Why do women take fewer risks than men? *Judgment and Decision Making*, *1*(1), 48-63.

Hasegawa, A., Somatori, K., Nishimura, H., Hattori, Y., & Kunisato, Y. (2019). Associations between self-reported impulsivity and a latent variable of impulsive action constructed from three laboratory tasks. *Journal of Experimental Psychopathology*, *10*(3). https://doi.org/10.1177/2043808719861894

Horn, S., & Freund, A. M. (2021). Adult age differences in monetary decisions with real and hypothetical reward. *Journal of Behavioral Decision Making*. https://doi.org/10.1002/bdm.2253

Hoyle, R. H., Stephenson, M. T., Palmgreen, P., Lorch, E. P., & Donohew, R. L. (2002). Reliability and validity of a brief measure of sensation seeking. *Personality and Individual Differences*, *32*(3), 401-414. https://doi.org/10.1016/S0191-8869(01)00032-0

Jianakoplos, N. A., & Bernasek, A. (1998). Are women more risk averse? *Economic Inquiry*, *36*(4), 620-630. https://doi.org/10.1111/j.1465-7295.1998.tb01740.x

Johnson, M. W., & Bickel, W. K. (2008). An algorithm for identifying nonsystematic delay-discounting data. *Experimental and Clinical Psychopharmacology*, *16*(3), 264-274. https://doi.org/10.1037/1064-1297.16.3.264

Josef, A. K., Richter, D., Samanez-Larkin, G. R., Wagner, G. G., Hertwig, R., & Mata, R. (2016). Stability and change in risk-taking propensity across the adult life span. *Journal of Personality and Social Psychology*, *111*(3), 430-450. https://doi.org/10.1037/pspp0000090

Kirby, K. N., & Maraković, N. N. (1996). Delay-discounting probabilistic rewards: Rates decrease as amounts increase. *Psychonomic Bulletin & Review*, *3*(1), 100-104.

Mata, R., Josef, A. K., Samanez-Larkin, G. R., & Hertwig, R. (2011). Age differences in risky choice: A meta-analysis. *Annals of the New York Academy of Sciences*, *1235*, 18-29. https://doi.org/10.1111/j.1749-6632.2011.06200.x

Mazur, J. E. (1987). An adjusting procedure for studying delayed reinforcement. In M. L. Commons, J. E. Mazur, J. A. Nevin, & H. Rachlin (Eds.), *Quantitative analyses of behavior: The effect of delay and of intervening events on reinforcement value.* (Vol. 5, pp. 55-73). Erlbaum.

McCoy, S. S., Dimler, L. M., Samuels, D. V., & Natsuaki, M. N. (2017). Adolescent susceptibility to deviant peer pressure: Does gender matter? *Adolescent Research Review*, *4*(1), 59-71. https://doi.org/10.1007/s40894-017-0071-2

McKerchar, T. L., Green, L., Myerson, J., Pickford, T. S., Hill, J. C., & Stout, S. C. (2009). A comparison of four models of delay discounting in humans. *Behavioural Processes*, *81*(2), 256-259. https://doi.org/10.1016/j.beproc.2008.12.017

Myerson, J., & Green, L. (1995). Discounting of delayed rewards: Models of individual choice. *Journal of the Experimental Analysis of Behavior, 64*(3), 263-276.

Myerson, J., Green, L., & Warusawitharana, M. (2001). Area under the curve as a measure of discounting. *Journal of the Experimental Analysis of Behavior*, *76*(2), 235-243. https://doi.org/10.1901/jeab.2001.76-235

O'Brien, L., Albert, D., Chein, J., & Steinberg, L. (2011). Adolescents prefer more immediate rewards when in the presence of their peers. *Journal of Research on Adolescence*, *21*(4), 747-753. https://doi.org/10.1111/j.1532-7795.2011.00738.x

Odum, A. L. (2011). Delay discounting: Trait variable? *Behavioural Processes, 87*(1), 1-9. https://doi.org/10.1016/j.beproc.2011.02.007

Olson, E. A., Hooper, C. J., Collins, P., & Luciana, M. (2007). Adolescents' performance on delay and probability discounting tasks: Contributions of age, intelligence, executive functioning, and self-reported externalizing behavior. *Personality and Individual Differences*, *43*(7), 1886-1897. https://doi.org/10.1016/j.paid.2007.06.016

Patton, G. C., Sawyer, S. M. M. D., Santelli, J. S. M. D., Ross, D. A. P., Afifi, R. P., Allen, N. B. P., Arora, M. P., Azzopardi, P. M., Baldwin, W. P., Bonell, C. P., Kakuma, R. P., Kennedy, E. M. P. H., Mahon, J. P., McGovern, T. J. D., Mokdad, A. H. P., Patel, V. P., Petroni, S. P., Reavley, N. P., Taiwo, K., . . . Viner, R. M. P. (2016). Our future: a Lancet commission on adolescent health and wellbeing. *The Lancet (British Edition)*, *387*(10036), 2423-2478. https://doi.org/10.1016/S0140-6736(16)00579-1

Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the Barratt Impulsiveness Scale. *Journal of Clinical Psychology, 51*(6), 768-774. https://doi.org/10.1002/1097-4679(199511)51:6<768::AID-JCLP2270510607>3.0.CO

Rachlin, H. (2006). Notes on discounting. *Journal of The Experimental Analysis of Behavior*, *85*(3), 425-435. https://doi.org/10.1901/jeab.2006.85-05

Reniers, R. L. E. P., Murphy, L., Lin, A. B., SP, & Wood, S. J. (2016). Risk perception and risk-taking behaviour during adolescence: The influence of personality and gender. *PloS One*, *11*(4). https://doi.org/10.1371/journal.pone.0153842

Rice, S., & Winter, S. R. (2019). Do gender and age affect willingness to ride in driverless vehicles: If so, then why? *Technology in Society*, *58*. https://doi.org/10.1016/j.techsoc.2019.101145

Rolison, J. J., Hanoch, Y., Wood, S., & Liu, P. J. (2014). Risk-taking differences across the adult life span: A question of age and domain. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *69*(6), 870-880. https://doi.org/10.1093/geronb/gbt081

Romer, D., Reyna, V. F., & Satterthwaite, T. D. (2017). Beyond stereotypes of adolescent risk taking: Placing the adolescent brain in developmental context. *Developmental Cognitive Neuroscience*, *27*, 19-34. https://doi.org/10.1016/j.dcn.2017.07.007

Sargisson, R. J., Ankoné, B. A. H., Dijkhuis, M., Eilers, H., Moser, E., Philipp, A. J., & Syafika, A. (2021). By-and-Buy: The effect of social influence on discounting of environmental outcomes. *Sustainability and Climate Change*, *14*(4), 217-226. https://doi.org/10.1089/scc.2021.0003

Sargisson, R. J., & Schöner, B. V. (2020). Hyperbolic discounting with environmental outcomes across time, space, and probability. *The Psychological Record*, *70*(3), 515-527. https://doi.org/10.1007/s40732-019-00368-z

Scheres, A., Dijkstra, M., Ainslie, E., Balkan, J., Reynolds, B., Sonuga-Barke, E., & Castellanos, F. X. (2006). Temporal and probabilistic discounting of rewards in children and adolescents: Effects of age and ADHD symptoms. *Neuropsychologia*, *44*(11), 2092-2103.

Simons-Morton, B. G., Bingham, C. R., Falk, E. B., Li, K., Pradhan, A. K., Ouimet, M. C., Almani, F., & Shope, J. T. (2014). Experimental effects of injunctive norms on simulated risky driving among teenage males. *Health Psychology*, *33*(7), 616-627. https://doi.org/10.1037/a0034837

Smith, A. R., Chein, J., & Steinberg, L. (2014). Peers increase adolescent risk taking even when the probabilities of negative outcomes are known. *Developmental Psychology*, *50*(5), 1564-1568. https://doi.org/10.1037/a0035696

Smith, C., & Hantula, D. (2008). Methodological considerations in the study of delay discounting in intertemporal choice: A comparison of tasks and modes. *Behavior Research Methods*, *40*(4), 940-953. https://doi.org/10.3758/BRM.40.4.940

Somerville, L. H., Haddara, N., Sasse, S. F., Skwara, A. C., Moran, J. M., & Figner, B. (2018). Dissecting "peer presence" and "decisions" to deepen understanding of peer influence on adolescent risky choice. *Child Development*, *90*(6), 2086-2103. https://doi.org/10.1111/cdev.13081

Stanford, M., Mathias, C., Dougherty, D., Lake, S., Anderson, N., & Patton, J. (2009). Fifty years of the Barratt Impulsiveness Scale: An update and review. *Personality and Individual Differences*, *47*, 385-395. https://doi.org/10.1016/j.paid.2009.04.008

Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking. *Developmental Review*, *28*(1), 78-106. https://doi.org/10.1016/j.dr.2007.08.002

Steinberg, L., Albert, D., Cauffman, E., Banich, M., Graham, S., & Woolard, J. (2008). Age differences in sensation seeking and impulsivity as indexed by behavior and self-report: Evidence for a dual systems model. *Developmental Psychology*, *44*(6), 1764-1778. https://doi.org/10.1037/a0012955

Steinberg, L., Icenogle, G., Shulman, E. P., Breiner, K., Chein, J., Bacchini, D., Chang, L., Chaudhary, N., Giunta, L. D., Dodge, K. A., Fanti, K. A., Lansford, J. E., Malone, P. S., Oburu, P., Pastorelli, C., Skinner, A. T., Sorbring, E., Tapanya, S., Tirado, L. M. U., . . . Takash, H. M. S. (2018). Around the world, adolescence is a time of heightened sensation seeking and immature self-regulation. *Developmental Science*, *21*(2). https://doi.org/10.1111/desc.12532

Stephenson, M. T., Velez, L. F., Chalela, P., Ramirez, A., & Hoyle, R. H. (2007). The reliability and validity of the Brief Sensation Seeking Scale (BSSS-8) with young adult Latino workers: implications for tobacco and alcohol disparity research. *Addiction*, *102* (Supplementary 2), 79-91. https://doi.org/10.1111/j.1360-0443.2007.01958.x

Stoltenberg, S. F., Batien, B. D., & Birgenheir, D. G. (2008). Does gender moderate associations among impulsivity and health-risk behaviors? *Addictive Behaviors*, *33*(2), 252-265. https://doi.org/10.1016/j.addbeh.2007.09.004

van Hoorn, J., Crone, E. A., & Van Leijenhorst, L. (2017). Hanging out with the right crowd: Peer influence on risk-taking behavior in adolescence. *Journal of Research on Adolescence*, *27*(1), 189-200. https://doi.org/10.1111/jora.12265

Weafer, J., & de Wit, H. (2014). Sex differences in impulsive action and impulsive choice. *Addictive Behaviors*, *39*(11), 1573-1579.

Weigard, A., Chein, J., Albert, D., Smith, A., & Steinberg, L. (2014). Effects of anonymous peer observation on adolescents' preference for immediate rewards. *Developmental Science*, *17*(1), 71-78. https://doi.org/10.1111/desc.12099

Willoughby, T., Heffer, T., Good, M., & Magnacca, C. (2021). Is adolescence a time of heightened risk taking? An overview of types of risk-taking behaviors across age groups. *Developmental Review*, *61*. https://doi.org/10.1016/j.dr.2021.100980

Wilson, J. M., Sevi, B., Strough, J., & Shook, N. J. (2021). Age differences in risk taking: Now you see them, now you don't. *Aging, Neuropsychology, and Cognition*, 1-15. https://doi.org/10.1080/13825585.2021.1885608

Chapter 3

Article 2

People often involve their friends and family in the big decisions in their lives. Rarely would someone decide to move across the country for a new opportunity, select a treatment for cancer, or choose where to attend university, without discussing the decision with a friend or family member. Simply put, decision-making rarely happens in isolation, regardless of whether the outcomes of the decision have an effect on other people.

Given that people make decisions in the presence of others, it is important to research how the presence of others influences decision-making. Many studies have shown that the presence of peers can increase the likelihood of risky decision-making, particularly for adolescents and young people (e.g., Bingham et al., 2016; Gardner & Steinberg, 2005; Kessler et al., 2017; O'Brien et al., 2011; Simons-Morton et al., 2014; A. R. Smith et al., 2014; van Hoorn et al., 2017). There are two main methods used to research peer influence on decision-making. The first is to provide an opinion of what the peer would do in that situation (e.g., Gilman et al., 2014), and the second assumes influence by comparing decision-making in the presence of a peer, either real or assumed, to decision-making in the absence of peers (e.g., O'Brien et al., 2011; Weigard et al., 2014). Using the first method, informing participants that a peer had chosen the smaller-sooner option (in a delay-discounting task) increased the likelihood of participants (aged 18-25) choosing smaller-sooner rewards (Gilman et al., 2014). Similarly, O'Brien et al. (2011) observed that the discounting curves of 18-to-20-year-old participants were steeper (showing increased risk-taking) when they were in the presence of two peers, than those of participants who were alone. Increased risk-taking in the presence of peers is not limited to a known peer, or the physical presence of a peer (Weigard et al., 2014), but occurs when peers are thought to be actively monitoring the choices made (Somerville et al., 2018). Therefore, both peer presence and peer influence, either physical or virtual, real or assumed, can lead to an increase in risk-taking (Gilman et al., 2014; O'Brien et al., 2011; Weigard et al., 2014).

Young people are thought to be more sensitive to rewards when in the presence of their peers resulting in adolescents showing increased risk-taking (Albert et al., 2013; Shulman et al., 2016; Steinberg et al., 2008; Steinberg & Calkins, 2010; Steinberg & Monahan, 2007). Gardner and Steinberg (2005) found adolescents (13-16 years) and youths (18-22 years) made riskier decisions in the presence of their peers, but adults (over 24 years) were less influenced by the presence of peers. Therefore, although young people show increased risky behaviour in the presence of peers (e.g., O'Brien et al., 2011; Weigard et al., 2014), the response to peer presence appears to change with age (e.g., Gardner & Steinberg, 2005).

Peers can also act as a source of support, providing protection against risk, or even increasing prosocial or healthy decisions (e.g., Cascio et al., 2015; Choukas-Bradley et al., 2015; Simons-Morton et al., 2014; van Hoorn et al., 2014). In some cases, friends and romantic partners can intervene during decision-making, reducing behaviours such as speeding or drunk driving (Buckley & Foss, 2012). Being exposed to risk-averse peers has also led to less risky decisions (e.g., Bingham et al., 2016; Cascio et al., 2015; Simons-Morton et al., 2014; Tomova & Pessoa, 2018). Perceived social support has also been associated with the decisions people make, where participants with higher levels of social support made less risky choices compared to participants with lower levels of social support (Weatherly & Ruthig, 2013). When the outcomes negatively affect others, young people have been found to make less risky monetary decisions (Ertac & Gurdal, 2012). Furthermore, people can be concerned with how peers may perceive them when negative outcomes are more probable, which results in making less risky decisions when others are present (Reniers et al., 2017). Therefore, there is evidence that peers can act as a protection against making risky decisions under certain circumstances (Choukas-Bradley et al., 2015; Reniers et al., 2017; Simons-Morton et al., 2014; Tomova & Pessoa, 2018; van Hoorn et al., 2014; Weatherly & Ruthig, 2013).

Gender also appears to play a role in risk-taking behaviour – young men tend to perceive some activities as less risky than young women, thus taking more risks (Reniers et al., 2016). As an example, young male drivers report they are less likely to wear seatbelts, less likely to insist their passengers wear a seatbelt, and report higher rates of phone use while driving compared to young female drivers (Barr et al., 2015). A review on susceptibility to peer influence found that in about half of reviewed literature, men were reported to be more susceptible to peer influence than women, whilst the remainder found no difference in risk-taking by gender (McCoy et al., 2017). The inconsistencies in findings have been attributed to the measures used to assess risk-taking and peer influence (McCoy et al., 2017; Morgenroth et al., 2017; Rolison & Shenton, 2020), for example, many measures feature more male-dominated activities, thus biasing results. Consequently, it is unclear whether risk-taking differs between men and women.

In summary, the role of the peer in decision-making is complex: previous research has illustrated that peers can sometimes increase the likelihood of risky decision-making (Gardner & Steinberg, 2005; Gilman et al., 2014; Kessler et al., 2017), but conversely peers may also lead to less impulsive choices, providing support for healthier, safer alternatives in some circumstances (Bingham et al., 2016; Buckley & Foss, 2012; Choukas-Bradley et al., 2015; Simons-Morton et al., 2014; Tomova & Pessoa, 2018). Decision-making in the presence of peers may lead to riskier outcomes, particularly when those making the decision are young, but it remains unclear how individual factors such as age and gender contribute to risk-taking in the presence of peers.

In two studies, we aimed to gain insight into the role of the peer in risky decision-making. In Study 2.1, we examined the effect of peer absence, peer presence, and negative peer influence (providing a risk-promoting opinion) in three hypothetical real-world scenarios. We included three diverse scenarios to examine various types of risks people may take while their friends are present. Previously in Study 1, we used financial outcomes, and found that discount rates from participants in the presence of peers did not significantly differ from those who completed the task alone. Alongside the methodological issues (e.g., small sample size and uneven gender distribution) in Study 1, the task may not have been suitable to examine peer presence on decision-making, as people do not typically involve their peers in financial decision-making. Therefore, we wanted to broaden our approach to understanding peer influence on risk-taking to include a range of decisions where peers are typically involved to better reflect actual behaviour. In Study 2.2, we replicated Study 2.1 in a separate sample but included a positive peer-influence condition (providing a risk-averse opinion). In both studies, we explored the role of age and gender on discounting behaviour.

In Study 2.1 we expected that the participants in the peer-absent condition would show less risk-taking (shallower discounting curves) compared to those in the peer-present and the negative peer-influence conditions, with the steepest rates of discounting in the negative peer-influence condition. Lastly, we expected that risk-taking would differ by age and gender, specifically that younger participants and male participants would exhibit greater risk-taking on a probabilistic discounting task.

Study 2.1

Method

Participants

A total of 326 participants, aged between 18-35 years (M_{age} = 27.37, 95% CI[26.84, 27.90]), were recruited from two separate populations. The first sample was recruited through a Human Intelligence Task (HIT) request placed on Amazon's mTurk, via TurkPrime (Litman et al., 2017), and were from either the United States of America or Canada (mTurk;

n = 103; 57 women, 46 men; M_{age} = 28.97, 95% CI[28.22, 29.72]). The remaining participants were recruited through advertisements placed on the student and staff home page for University of Waikato (*n* = 223; 159 women, 63 men; M_{age} = 26.63, 95% CI[25.96, 27.31]). Mechanical Turk participants were compensated US$1.00. All other participants could enter a draw to win a supermarket voucher (NZ$50.00). Our project was approved by the University of Waikato's Division of Arts, Law, Psychology, and Social Science ethics committee (#FS2019-36).

Measures

Participants were asked to complete a questionnaire hosted on Qualtrics (https://www.qualtrics.com). Although the probability-discounting task was one of multiple assessments included in the questionnaire answered by participants; for brevity, we will only discuss the findings of the probability-discounting task.

Risk-taking was assessed using a questionnaire which included a scenario-style probabilistic discounting task, to simulate real-world scenarios of risky decisions. The three risk-taking scenarios were presented to all participants (within-subjects design). Each scenario had three conditions: peer absence, peer presence, and negative peer influence. The three scenarios were presented in a random order, and nested within scenarios, the conditions were also presented in a random order. The scenarios were presented as follows:

> Meeting Scenario:
> You have been invited to be part of the live studio audience for your favourite comedy TV show [with your best friend**]**. You've [both] applied and missed out several times before but this time you made the waiting list, so **a single ticket has** [two tickets have] been made available last minute. You have no plans this evening, but the show goes late, well past when you would normally go to bed. Tomorrow you have an important 8am meeting, which involves meeting with your manager and the CEO to go over an upcoming work assignment, that you have heard could lead to a promotion. If you decide to go to the comedy show, you risk not getting enough sleep and sleeping through your alarm clock. [*Your friend is pleading with you to go because they really want to experience this rare opportunity with you.*] If the likelihood of sleeping in and missing the meeting is X%, how likely is it that you would decide to attend the show?

Food Scenario:

Recently you have had periods of illness where you get severe stomach aches and extreme dizziness for about three days at a time. Your doctor has diagnosed these symptoms as a gluten intolerance, meaning the symptoms are a reaction to gluten in your diet. Not feeling like cooking tonight, you decided to order some gluten-free pizza for **yourself** [for you and your best friend]. You were unsure if the server made a note for the gluten-free pizza base, and it was not noted on your receipt. After getting home, you realise that the pizza looks like it has a regular pizza-base instead of the gluten-free you requested. [*Your friend says "I don't want to have to go grab another pizza. Let's just eat this one, I am sure it will be fine!"*]. If the likelihood of reacting to the food is X%**,** how likely is it that you decide to eat the pizza you have received?

Car Scenario:

You are driving through the desert **alone** [with your best friend] to see your favourite band perform in concert, and you see a sign that says "Next town 400km" (about 250 miles). The last town was approximately 50km ago (31 miles), and you've just realised that you may not have enough petrol/gas to make it to your destination. You need to make the decision whether to continue driving to the concert or turn around to top up the fuel tank. If you turn around, you risk missing some of the concert, but if you continue without getting more fuel, you risk being stranded in the desert. [*Your friend wants to continue driving to the concert without getting fuel so you can see all of the show.*] If the likelihood of running out of petrol/gas in the desert is X%, how likely is it that you decide to continue without getting more fuel?

The peer-absent conditions included the plain text including the text in bold, the peer-present condition additionally included the unitalicised text in square brackets but did not include the bolded text, and the negative peer-influence condition included all text except the bolded text.

Participants answered six questions with differing probabilities (95%, 90%, 50%, 30%, 10%, and 5%), in a descending order, for each scenario and condition. Participants answered on a 0-100 digital VAS, with 0 being "*I would definitely not…*" followed by the specific behaviour for that scenario, and 100 being "*I would definitely…*" The slider bar was set to a middle default position (50). Participants clicked or moved the slider bar left or right to move to the next question. A lower score on the VAS represented lower risk-taking, and a higher score higher risk-taking, for ease of understanding for participants (scores were inversed for data analysis).

Procedure

The recruitment advertisements included a link to the questionnaire. The first page provided a brief introduction to the study including the aims and information about participation. Participants who were over 18 years old and consented were presented with a set of instructions asking them to maximise their browser window, complete the questionnaire in a single sitting, and to not engage in other tasks while participating. Participants were asked to report their age and gender and were then presented with the risk-taking scenarios in a random order. The three conditions (peer absence, peer presence, and negative peer influence, presented in random order) for the same scenario were then shown, before the scenario changed. The questionnaire took approximately 10 minutes to complete.

Analysis

Data were downloaded from Qualtrics, and participants who did not complete all questions were removed. As the probabilistic discounting task was a free-choice procedure, each response on the VAS provided the participant's likelihood of taking the risk (known as their subjective value). Participants had six subjective values for each scenario and condition, one for each of the probabilities (of the negative outcome of the risk occurring). These six subjective values (within a scenario and condition) were inversed and plotted as a curve, showing the decreasing likelihood to choose the safer option (i.e., not taking the risk) as the odds against a negative outcome increased, producing a discounting curve.

Odds against was calculated using Equation 5 where ϴ represents odds against, and p is the percent chance (likelihood of the outcome occurring). The odds for the outcomes in this study were .053, .111, 1, 2.33, 9, and 19.

$$\Theta = (1 - p) / p \qquad (5)$$

Using Gilroy et al.'s (2017) open-source software, the Discounting Model Selector (https://www.smallnstats.com), we compared four models of discounting: The exponential model, Mazur's (1987) hyperbolic model, Myerson and Green's (1995) model, and Rachlin's (2006) 2-parameter hyperboloid. Using RMSE as the measure of best fit, we found that Rachlin's 2-parameter model best fit the majority of the data (consistent with the findings of McKerchar et al., 2009; Sargisson & Schöner, 2020). Therefore, we fitted Rachlin's 2-parameter hyperboloid to each set of six subjective values. The equation for Rachlin's (2006)

2-parameter hyperboloid, Equation 3 rewritten for probability discounting, is:

$$V = A / (1 + kx^s) \quad (6)$$

where *V* is the participant's subjective value, *A* is the undiscounted maximum (100), *x* is the odds against occurrence, *k* is the discounting rate, and *s* is a free parameter which indicates sensitivity to variations in the size of the outcome. A total of nine *k* values were computed for each participant (3 scenarios x 3 conditions). As *k* represents the discount rate, a larger *k* value reflects steeper discounting (risk-taking) and a smaller *k* value reflects shallower discounting or less risk-taking (Green & Myerson, 1996, 2004).

As mathematical models rely on systematic discounting behaviour, it is important to recognise non-systematic discounters. We applied Johnson and Bickel (2008)'s algorithm for identifying non-systematic data, however, we found the criteria captured a large number of our participants. Therefore, we took a less conservative approach. In accordance with Sargisson et al. (2021), discount rates (*k*) as calculated by the Discounting Model Selector were replaced with zeros if discounting was not reflected in the participants' data. Specifically, *k* values were replaced with zero where data at the smallest probability (5%) was less than two points away from data at the highest probability (95%).

We then compared the adjusted *k* values across the three conditions (peer absence, peer presence, and negative peer influence) within each scenario type using Friedman's tests, followed by post-hoc analyses using Wilcoxon signed-rank tests. We applied a Bonferroni correction to the post-hoc test which resulted in a critical *p* value of $p < .017$. In addition, we compared *k* values between male and female participants using a Mann-Whitney U test. Finally, we examined the relationship between risk-taking behaviour (*k* values) and the participant's age, using Spearman's correlation coefficient.

Table 3 shows the percentage of participants who did not discount across conditions by scenario. The percentage of participants who did not discount was lower in the negative peer-influence condition, compared to the peer-absent and peer-present conditions. The percentage of participants who did not discount was slightly higher in the peer-absent condition compared to the peer-present condition. The number of participants who did not discount was lower in the meeting scenario compared to the food and car scenarios, but the car scenario appeared to have more variation in the percentage of people discounting across the conditions.

Table 3

Percentage of Participants Who Did Not Discount in Study 2.1

	Absent	Present	Negative Influence
Meeting	18	17	15
Food	28	27	25
Car	25	21	17

Results

Figure 3 shows the median subjective values by the odds against values for the different scenarios. As the odds against the perceived negative event increased (meaning the negative event is less likely to happen), the likelihood of choosing not to take the risk decreased (risk-taking increased). We fitted Equation 6 to the data from each condition. For all three scenarios, there was a consistent pattern in the fitted functions; the discounting function was steepest in the negative peer-influence conditions, and shallowest in the peer-absent conditions (as predicted). Figure 4 shows the median *k* values, calculated by Equation 6 for all scenarios and conditions. The median *k* values in the peer-influence conditions were greater than those in the peer-present and peer-absent conditions, and the peer-absent condition produced the lowest median *k* values. The percentage of participants who did not discount by condition showed a similar pattern, where more people did not discount in the peer-absent and more people did discount in the negative peer-influence condition (see Table 3). People who did not discount generally chose the safer option every time, meaning in the absence of peers, people took less risks.

There was greater variability in *k* between the conditions for the meeting and car scenarios, compared to the food scenario. Participants exhibited riskier decision-making in the meeting scenario, compared to the food and car scenarios, and the least risk-taking was exhibited in the car scenario.

Figure 3

Median Subjective Values of Risk Avoidance for Study 2.1

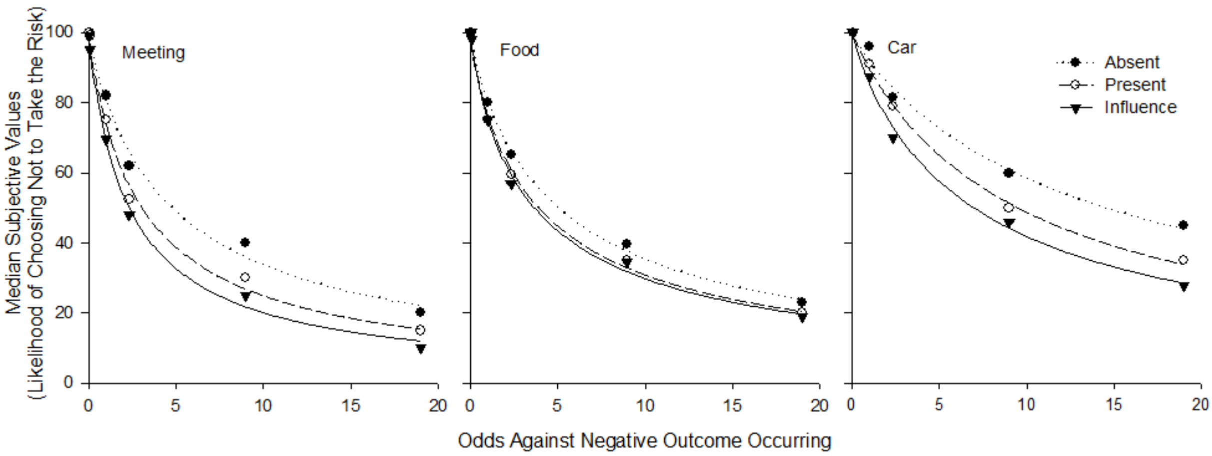
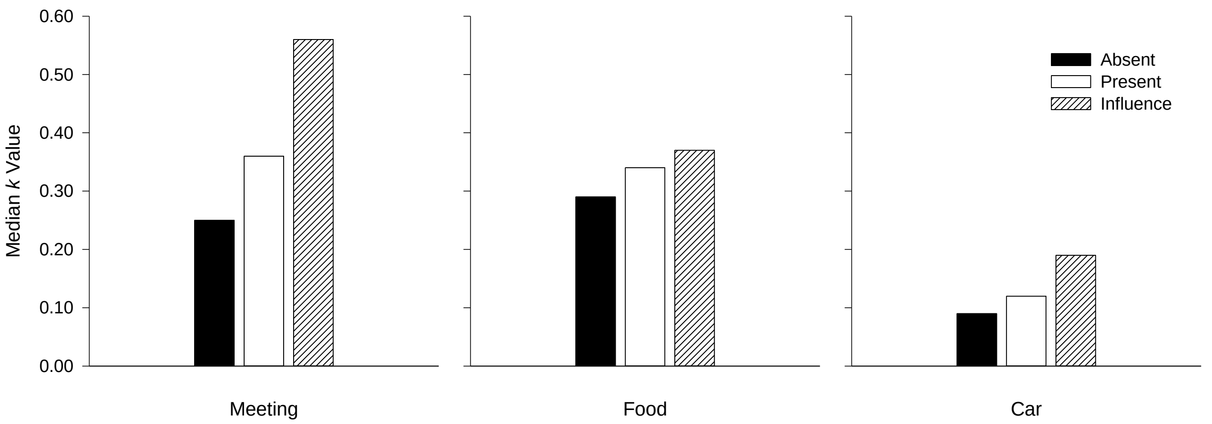


Figure 4

The k Values resulting from the Median Subjective Values for Study 2.1



There were significant differences in risk-taking across the three conditions within each of the three scenarios; meeting: $\chi^2(2) = 78.22$, $p < .001$, food: $\chi^2(2) = 13.31$, $p = .001$, and car: $\chi^2(2) = 61.36$, $p < .001$. Risk-taking was significantly higher (larger *k* values) in the negative peer-influence conditions compared to the peer-absent conditions, and risk-taking was significantly higher in the peer-present conditions when compared to the peer-absent conditions, in all three scenarios (Table 4). Risk-taking was also significantly higher in the negative peer-influence conditions than the peer-present conditions in the meeting and car scenarios but not for the food scenario.

Table 4

Wilcoxon Signed-Rank Post-Hoc Analyses of k Values for Study 2.1

	Absent - Present	***Absent - Influence***	***Present - Influence***
Meeting Scenario			
Z	-2.42	-7.51	-6.91
Sig.	**.016**	**<.001**	**<.001**
N	320	319	322
r	-0.14	-0.42	-0.38
Food Scenario			
Z	-2.61	-3.05	-0.47
Sig.	**.009**	**.002**	.64
N	322	321	323
r	-0.15	-0.17	-0.03
Car Scenario			
Z	-2.41	-6.86	-5.42
Sig.	**.016**	**<.001**	**<.001**
N	316	315	316
r	-0.14	-0.39	-0.30

Note. Bonferroni correction applied resulting in a critical *p* value of $p < .017$.

There were no significant differences between *k* values for male and female participants across conditions in any of the scenarios (see Tables A.1 and A.2 in Appendix A). We found a weak, but significant association between age and discounting rate in the food scenario for the peer-absent and negative peer-influence conditions. As age increased, risk-taking decreased; peer absence: $r_s(322) = -.13$, $p = .02$, peer presence, $r_s(326) = -.09$, $p = .10$, *ns*, and negative peer influence, $r_s(323) = -.14$, $p = .01$. Age was not associated with risk-taking for the meeting or car scenarios (see Table A.3 in Appendix A).

In conclusion, negative peer influence had a significant effect on discounting behaviour in all three scenarios. We observed increased risk-taking (higher median *k* values) in the negative peer-influence condition compared to the peer-absent condition, and in two of the three scenarios compared to the peer-present condition. Additionally, we found no significant differences between the discount rates of men and women. We found that younger participants showed increased risk-taking, however, the finding was not consistent across conditions and scenarios.

Discussion

We aimed to further understand the role that peers play in the decision-making process, and whether that role leads to riskier choices. Using probability-discounting scenarios, we examined whether discounting under peer presence and negative peer influence differed to discounting in the absence of peers. We hypothesised that we would observe shallower discounting curves (less risk-taking) in the peer-absent condition, compared to the peer-present and the negative peer-influence conditions, with the steepest rates of discounting (greatest risk-taking) in the negative peer-influence condition. Our data supported these hypotheses. We also wanted to examine whether there were differences in risk-taking based on age and gender, and we found no gender differences in risk-taking, and no strong relationship between age and risk-taking.

Although studies have investigated negative peer influence in two different ways – the first, using peer presence to assume peer influence (e.g., O'Brien et al., 2011; Weigard et al., 2014), and second, offering a direct opinion from a peer (e.g., Gilman et al., 2014) – to the best of our knowledge, this present study is the first to directly compare discounting behaviour between peer presence and negative peer influence, and to determine whether they both increase risk-taking. Consistent with previous findings, we found that peer presence (e.g., O'Brien et al., 2011; A. R. Smith et al., 2014; Weigard et al., 2014), and negative peer influence (e.g., Gilman et al., 2014; van Hoorn et al., 2014), increased risky choices. We found the discount rate (k) was significantly higher in the negative peer-influence condition than in the peer-present condition for two of the three scenarios. Therefore, the opinion of peers, in favour of the risky option, increased risky decision-making compared to when hypothetical peers were simply present.

The discounting curves were steeper in the peer-present conditions compared to the peer-absent conditions across all three scenarios, indicating that people take greater risks solely because their peers are present. Somerville et al. (2018) argued that just being present is not enough for peers to have an influence on risk-taking, instead they must be monitoring the behaviour (in their case, seeing the choice being made on the computer screen as opposed to being present but unable to see the choices made). The hypothetical scenarios used in the current study meant the decision made by participants would affect their peers. Thus, in both the peer-present and negative peer-influence conditions, the peers were going to be directly impacted by the choices made, rather than just observing the decision. In designing these scenarios, we found that peers could not be present without being part of the environment in which the decision is made, which is perhaps a better reflection of decision-making in a real-world context.

As we found that negative peer influence had a greater effect than simply being present, we questioned whether positive peer influence would be similar to risk-taking behaviour when alone. Since there is evidence that peers may have a protective effect against making risky decisions when they speak out (e.g., Choukas-Bradley et al., 2015; Osmont et al., 2021; Reniers et al., 2017; Tomova & Pessoa, 2018), we decided to introduce a positive peer-influence condition to examine whether participants show less risk-taking when provided with an opinion from a risk-averse peer, compared to when a peer is simply present. Therefore, our aim for Study 2.2 was to examine whether positive peer influence would be associated with lower risk-taking than peer presence and negative peer influence. We also examined the effects of both age and gender on risk-taking As in Study 2.1, we expected less risk-taking in the peer-absent condition, compared to the peer-present and negative peer-influence conditions. We also expected that when participants were provided with a risk-promoting opinion (negative peer influence), they would exhibit greater risk-taking compared to when peers are simply present. Additionally, we expected to see that risk-taking when peers provide a risk-averse opinion (positive peer influence) is similar to when peers are absent.

Study 2.2

Method

Participants

We recruited 406 participants, however, as almost 30% of the sample was under 20 years (n = 119), we randomly selected 10 participants under 20 years of age to remove from our sample, to align the mean age of participants in Study 2.2 with that of Study 2.1. Therefore, the final Study 2.2 sample had 396 participants aged between 18-35 years (M_{age} = 26.39, 95% CI [25.81, 26.96]). Participants were recruited from both mTurk (n = 226) and the University of Waikato (n = 170). There were 246 women and 147 men. As in Study 2.1, mTurk participants were compensated US$1.00. Participants from the University of Waikato either received one bonus course mark towards their undergraduate psychology course, or they could enter a draw to win a supermarket voucher (valued at NZ$50.00). Our project was approved as an amendment to Study 2.1 (#FS2019-36), by the University of Waikato's Division of Arts, Law, Psychology, and Social Science ethics committee.

Measures

In addition to the three conditions for the three scenarios described in Study 2.1 (peer absence, peer presence, negative peer influence), Study 2.2 had a fourth condition in each scenario, positive peer influence. As with Study 2.1, participants were presented with the same three scenarios in a random order, and, within the scenarios, all conditions were presented in a random order. In each condition, the question was presented with six probabilistic values (95%, 90%, 50%, 30%, 10%, and 5%, as described in Study 2.1) in a descending order. The scenarios were the same as Study 2.1, however in the positive peer-influence condition, the following statements were added:

> Meeting: *Your friend encourages you to stay home tonight to prepare for your meeting, and get a good night's sleep so you can impress management tomorrow.*
>
> Food: *Your friend says "You should go back to the store to get a new pizza made, just to be sure!"*
>
> Car: *Your friend wants to turn around for petrol so you won't end up stranded in the desert.*

Participants answered all questions on the VAS scale, as described in Study 2.1. All other parts of the method remained identical to the previous study.

Procedure and Analysis

The procedure was the same as described in Study 2.1, with the additional positive peer-influence condition being randomly presented amongst the other three conditions (peer absence, peer presence, and negative peer influence). The analysis was the same as the previous study, Study 2.1. From the data gathered we calculated 12 k values, one per condition for each scenario, using Equation 6. Given that we had four conditions, applying the Bonferroni correction meant that our critical p value was $p < .008$ for post-hoc analyses comparing the discount rate (k).

Table 5 shows the percentage of participants who did not discount across the four conditions by scenario. The percentage of participants who did not discount was lowest in the negative peer-influence condition, and highest in the positive peer-influence condition.

Table 5

Percentage of Participants Who Did Not Discount in Study 2.2

	Absent	Present	Negative Influence	Positive Influence
Meeting	21	20	17	25
Food	22	24	19	29
Car	23	22	20	32

Results

The median subjective values across each of the odds against values, for each condition, are shown in Figure 5. The likelihood of choosing the not to take the risk decreased (risk-taking increased) as the odds against the perceived negative event increased. For all scenarios, the discounting function was steepest for the negative peer-influence condition, indicating higher levels of risk-taking, and shallowest in the positive peer-influence condition (less risk-taking). Figure 5 shows similar moderately declining discounting functions for the peer-absent and the peer-present conditions in the food and car scenarios. In both the meeting and food scenarios, the discounting function for the peer-present condition was shallower than for the negative peer-influence condition, but steeper than those for both the peer-absent and positive peer-influence conditions. In the car scenario, there was no observable difference between the discounting functions for the peer-present and peer-absent conditions.

Figure 5

Median Subjective Values of Risk Avoidance for Study 2.2

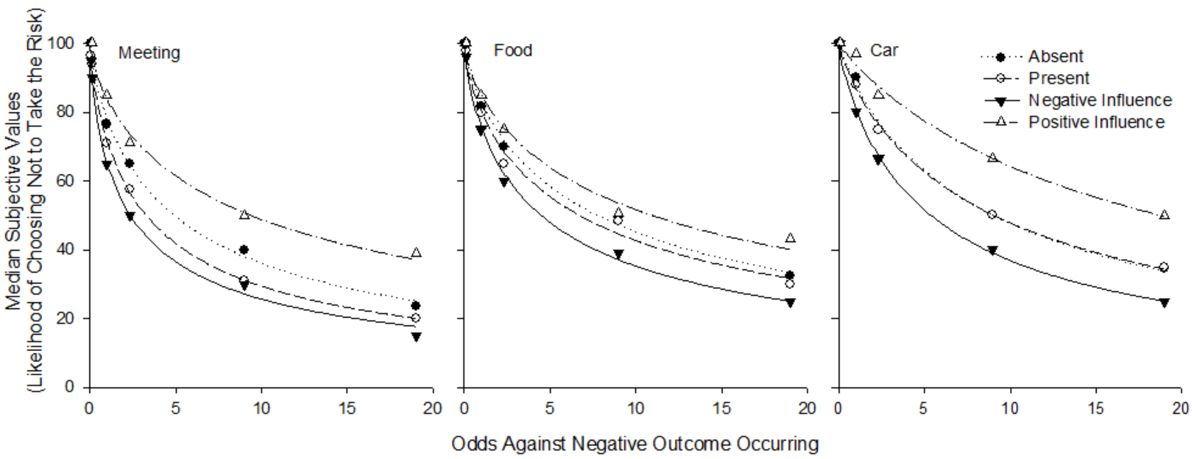
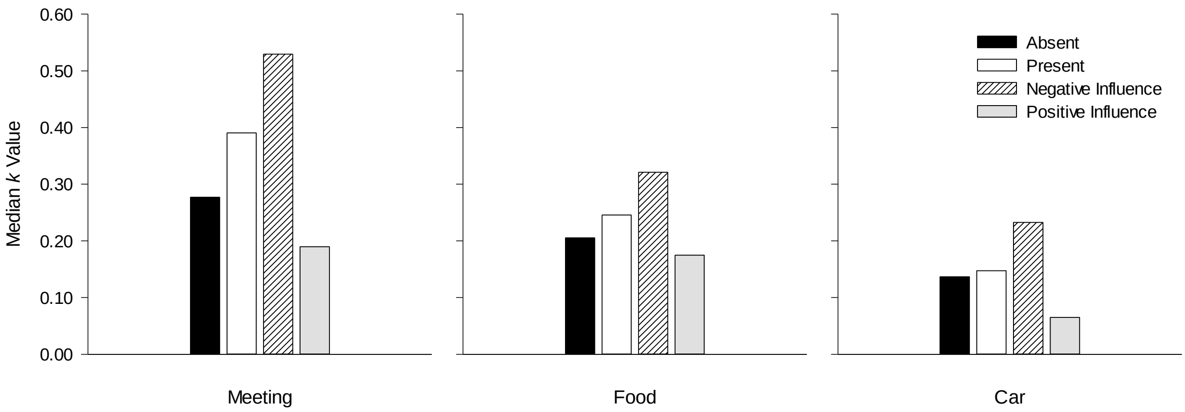


Figure 6 shows the median *k* values, calculated by Equation 6, for the conditions across all three scenarios. The median *k* values in the negative peer-influence conditions were greater than for the other three conditions. In all three scenarios, positive peer influence produced the lowest median *k* values. The median *k* values for the peer-absent conditions were higher than those for the positive peer-influence conditions, but lower than those for the peer-present conditions. The median *k* values for the negative and positive peer-influence conditions also reflect the percentage of participants who did not discount as indicated in Table 5. Participants showed riskier decision-making in the meeting scenario, having larger median *k* values, compared to the food and car scenarios, and participants discounted much less (smaller *k* values) in the car scenario, showing less risky behaviour (Figure 6).

Figure 6

The k Values resulting from the Median Subjective Values for Study 2.2



There were significant differences in median *k* values across the conditions within each of the three scenarios: meeting: χ^2 (3) = 143.14, $p < .001$, food: χ^2 (3) =80.41, $p < .001$ and car: χ^2(3) =132.06, $p < .001$. Wilcoxon signed-rank post-hoc results are shown in Table 6. Significantly more risk-taking was observed in the negative peer-influence conditions, compared to the peer-absent, peer-present, and positive peer-influence conditions in all three scenarios. Risk-taking was also significantly higher in the peer-present conditions compared to the positive peer-influence conditions for all scenarios, and the peer-absent condition in one of the three scenarios (meeting). Furthermore, risk-taking was also significantly higher in the peer-absent condition compared to the positive peer-influence condition in all three scenarios (Table 6).

Table 6

Wilcoxon Signed-Rank Post-Hoc Analyses of k Values for Study 2.2

	Peer Absent - Peer Present	***Peer Absent - Negative Influence***	***Peer Absent - Positive Influence***	***Peer Present - Negative Influence***	***Peer Present - Positive Influence***	***Negative Influence - Positive Influence***
Meeting Scenario						
Z	-3.64	-6.24	-4.41	-4.34	-6.85	-8.77
Sig.	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**
N	391	391	391	390	392	390
r	-0.18	-0.32	-0.22	-0.22	-0.35	-0.44
Food Scenario						
Z	-0.47	-4.96	-3.86	-5.52	-4.86	-8.38
Sig.	.64	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**
N	384	384	384	388	389	388
r	-0.02	-0.25	-0.20	-0.28	-0.25	-0.43
Car Scenario						
Z	-2.03	-6.54	-4.25	-6.26	-5.90	-9.35
Sig.	.43	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**
N	387	383	383	387	386	382
r	-0.10	-0.33	-0.22	-0.32	-0.30	-0.48

Note. Bonferroni correction applied resulting in a critical p value of $p < .008$.

As participants took fewer risks in the car scenario (indicated by smaller *k* values), compared to the food and meeting scenarios, we wanted to explore this difference. To explore why the discounting rates were lower for the car scenario, we compared the other free parameter in Equation 6, *s*, which is supposed to indicate the participants' sensitivity to variations in the magnitude of the outcome. We compared the median *s* value across scenarios using Wilcoxon signed-rank post-hoc analyses (with Bonferroni correction applied $p < .017$). We found that the median *s* value significantly differed across scenarios for both the peer-absent, $\chi^2(2) = 13.27$, $p = .001$, and negative peer-influence conditions, $\chi^2(2) = 9.16$, $p = .01$, where the median *s* value was higher in the car scenario compared to the food scenario (Table 7). In the peer-present condition, the median *s* values from the three scenarios differed from one another, $\chi^2(2) = 24.01$, $p < .001$, with the car scenario having the highest median *s* value. Within the positive peer-influence condition, there were no differences between the median *s* values across the scenarios, $\chi^2(2) = .70$, $p = .70$, *ns*. Therefore, there was more sensitivity to variations in the magnitude of the outcome (higher *s* value) for the car scenario across most condition types (see Table B.3 in Appendix B for descriptive statistics).

Table 7

Wilcoxon Signed-Rank Post-Hoc Analyses of s Values for Study 2.2

	Meeting - Food	***Meeting - Car***	***Food - Car***
	Peer Absence		
Z	-0.64	-2.22	-3.86
Sig.	.52	.03	**<.001**
N	382	386	377
r	-0.03	-0.11	-0.2
	Peer Presence		
Z	-2.68	-2.87	-4.44
Sig.	**.007**	**.004**	**<.001**
N	388	390	387
r	-0.14	-0.15	-0.23
	Negative Peer Influence		
Z	-1.14	-2.11	-3.36
Sig.	.25	.04	**.001**
N	384	384	383
r	-0.06	-0.11	-0.17
	Positive Peer Influence		
Z	-1.52	-0.56	-1.33
Sig.	.13	.58	.18
N	338	385	382
r	-0.08	-0.03	-0.07

Note. Bonferroni correction was applied to the comparisons of *s* values between scenarios, resulting in a critical *p* value of $p < .017$, which is different to prior analyses of *k* values.

No significant differences between median *k* values for male and female participants were observed for any of the conditions in the meeting or car scenarios (see Tables B.1 and B.2 in Appendix B). In one condition (negative peer influence) of the food scenario, men produced lower *k* values showing less risk-taking (*Mdn k* = .15) compared to women (*Mdn k* = .29), $U = 14882.50$, $Z = -2.46$, $p = .014$, $r = .12$. We observed a significant but weak relationship between age and risk-taking behaviour (indicated by *k* values) in most conditions and scenarios (Table 8). As age increased, risk-taking decreased.

Table 8

Spearman's rho Correlation Coefficients Between Age and k Values for Study 2.2

		Correlation Coefficient **(r_s)**	**Sig.** **(2-tailed)**	***N***
Meeting	*Absent*	-0.10	**.045**	393
	Present	-0.16	**.001**	394
	Negative	-0.15	**.002**	392
	Positive	-0.09	.08	394
Food	*Absent*	-0.11	**.034**	386
	Present	-0.13	**.008**	391
	Negative	-0.14	**.007**	389
	Positive	-0.15	**.003**	391
Car	*Absent*	-0.15	**.003**	388
	Present	-0.17	**<.001**	392
	Negative	-0.23	**<.001**	388
	Positive	-0.17	**<.001**	387

In summary, we found the least risk-taking in the positive peer-influence condition in all three scenarios, and greatest risk-taking when participants were in the negative peer-influence condition. Younger age was associated with greater risk-taking in most scenarios and conditions. Furthermore, we found very few differences in risk-taking behaviour exhibited by men and women.

Discussion

We hypothesised that participants would show greater risk-taking in the negative peer-influence condition, and a similar pattern between the peer-absent, peer-present, and negative peer-influence conditions as in Study 2.1, where less risk-taking was exhibited in the absence of peers, and more risk-taking occurred when peers were present, or negatively influencing decisions. Our data supported these hypotheses. Furthermore, we hypothesised that discounting in the positive peer-influence condition would be similar to discounting in the peer-absent condition, however our data showed some differences between these conditions. Participants exhibited shallower discounting in the positive peer-influence condition compared to the peer-absent condition across all three scenarios.

As negative peer influence has been well studied and documented (e.g., Gardner & Steinberg, 2005; Gilman et al., 2014; Kessler et al., 2017; O'Brien et al., 2011; A. R. Smith et al., 2014; van Hoorn et al., 2017; Weigard et al., 2014), the main aim of Study 2.2 was to investigate whether positive peer influence produced lower risk-taking than peer presence and negative peer influence, showing peer influence can also be positive when a risk-averse opinion is provided. Research into direct positive peer influence has shown that when presented with a risk-averse statement from a peer, participants show less risk-taking behaviour for both the BART (e.g., Tomova & Pessoa, 2018), and for simulated driving tasks (e.g., Bingham et al., 2016; Cascio et al., 2015; Simons-Morton et al., 2014). Our study directly compared negative peer influence and positive peer influence by examining the willingness to take risks, when provided with an opinion from a peer in three different hypothetical scenarios. We found participants were much less likely to take risks under positive peer influence, consistent with previous findings (e.g., Bingham et al., 2016; Cascio et al., 2015; Simons-Morton et al., 2014; Tomova & Pessoa, 2018). Therefore, we may see a reduction in harmful risk-taking behaviour by encouraging people to speak up when their peers are making risky choices.

We found risk-taking differed between the scenarios: people took less risks in the car scenario compared to the meeting and food scenarios. One potential explanation for this difference is perhaps that participants were more sensitive to variations in the magnitude of the outcome in the car scenario, hence, we conducted an exploratory analysis of the free parameter s from Equation 6. Rachlin (2006) likened the s parameter to an individual's sensitivity to a physical stimulus. When $s = 0$, an individual is not sensitive to changes in the intensity of a stimulus, with sensitivity increasing as the value of s increases (Rachlin, 2006). Rachlin (2006) states that in psychophysical studies, the s value across individuals changes according to the modality of the stimulus. Our median s parameter was consistently higher for the car scenario, compared to the s values for both the meeting and food scenarios. The car scenario involved running out of fuel, and being stranded in the desert, which could have more extreme consequences than missing an important meeting or getting sick for a few days. Therefore, it is perhaps unsurprising that participants would be more sensitive (higher s values) to the outcomes described in the car scenario which may explain the variations in risk-taking behaviour across scenarios.

In conclusion, when peers suggested the safer alternative, our participants made less risky decisions. As we found lower rates of risk-taking under positive peer influence compared to risk-taking in the absence of a peer, having positive social influence during decision-making may be beneficial, rather than the decision-maker deciding in isolation. Therefore, harnessing positive social influence in the decision-making process might minimise risk-taking when negative outcomes are possible.

General Discussion

With these two studies, we aimed to increase understanding of the effects of peer influence. In Study 2.1, we examined the differences between influence types – peer presence (simply being present, without direct opinion) and negative peer opinion (to encourage risk-taking behaviour). In Study 2.2 we also examined the effect of positive peer influence. We observed similar patterns in the data for both studies. Both peer presence and negative peer influence were associated with greater risk-taking behaviour, compared to when participants were alone. Positive peer influence produced the lowest amounts of risk-taking, even more than when participants were alone.

Previous research has found that the presence of peers can increase risky decision-making (e.g., O'Brien et al., 2011; A. R. Smith et al., 2014; Weigard et al., 2014), and when a peer provides a risk-promoting opinion, risk-taking also increases (Gilman et al., 2014; van Hoorn et al., 2017). As the presence of peers has been shown to negatively influence risk-taking behaviour, campaigns which focus on resisting risky decision-making associated with negative peer influence should also include ways to reduce the passive influence of peers who are merely present.

Although it has been demonstrated that peers can have a positive influence in the lives of their friends, by helping them to make safer decisions (e.g., Buckley & Foss, 2012), only a few studies have directly compared positive and negative peer influence (e.g., Bingham et al., 2016; Cascio et al., 2015; Simons-Morton et al., 2014; Tomova & Pessoa, 2018). Furthermore, most of the research into positive and negative peer influence has examined how young people behave in simulated driving situations when observed by a risk-accepting, or a risk-averse peer (e.g., Bingham et al., 2016; Cascio et al., 2015; Simons-Morton et al., 2014). We examined the behaviour of participants under both positive and negative peer influence, alongside both peer absence and peer presence, in a range of hypothetical scenarios. We found negative peer influence increased risk-taking behaviour, however, positive peer influence reduced risk-taking beyond peer absence, meaning participants were less likely to take risks, choosing the safer option instead under positive peer influence, indicating that involving peers in decision-making does not always increase risk-taking and lead to negative outcomes. Therefore, encouraging positive peer relationships could be a useful way to reduce harmful risk-taking behaviour. Future research should examine whether we can prevent peers from having a negative influence (either passively or actively) on behaviour, and ways to encourage peers to discuss alternative choices, reducing harmful risk-taking behaviour.

We hypothesised that we would see greater risk-taking from men across the discounting task in both studies. In Study 2.1, we found no difference in risk-taking by men and women. In Study 2.2, we found very few differences, finding a difference in risk-taking between men and women in only one condition. Previous research suggests that men partake in more risky behaviour, largely attributed to men perceiving activities as being less risky (Reniers et al., 2016). Rolison and Shenton (2020) argue that men and women perceive risk similarly, however, women are often less willing to take risks. In addition, there has been criticism of measures of risk attitudes and preferences, as measures tend to include risk-based activities that men engage in more readily (such as betting on sports, playing poker, and high-risk sports), thus biasing results and leading to the conclusion men take more risks (Morgenroth et al., 2017). When risk-taking measures include a wide range of risk-based activities (e.g., horse-riding, impulse spending, gambling on scratch cards), men do not take more risks than women (Morgenroth et al., 2017). Gender differences have been described as very context specific: risk type, cost-benefit analysis, and framing of the question impact heavily on whether findings show gender differences or similarities (McCoy et al., 2019; Rolison & Shenton, 2020). Given our findings, it is possible that there is no difference in risk-taking between men and women, and the way in which risk-taking has been historically examined may contribute to the inconsistencies between our studies and previous research.

Previous literature has presented mixed findings regarding the relationships between age and risk-taking. We hypothesised that age would be associated with discounting (younger participants take greater risks). In Study 2.1, younger age was weakly associated with increased risk-taking across the conditions of the food scenario, and in Study 2.2, we found younger age was very weakly associated with greater risk-taking in most conditions. Steinberg and colleagues (2007; 2008) believe that younger participants are more reward seeking (and therefore take more risks), especially in the presence of their peers (Shulman et al., 2016; Steinberg & Calkins, 2010). Furthermore, Gardner and Steinberg (2005) found that younger participants were more influenced by the presence of their peers compared to adults. However, Bixter and Rogers (2019) found that discount rates were similar between younger (18-24 years) and older adults (65-79 years), when collaborating on a delay-discounting task with a same-aged peer, of the same gender, showing neither younger nor older adults were more susceptible to the influence of peers. Although our findings were not consistent across the two studies, we did find that the presence and influence of peers effected our sample of adults (aged 18-35). Therefore, our findings show that adults are susceptible to negative peer influence, consistent with the findings of Bixter and Rogers (2019). Due to our inconsistent findings across our two studies, and the limited age range of our participants, it remains unclear whether the effects of peer presence and peer feedback differ by age.

A strength of our studies is that we used scenarios that focused on real-world decisions that may involve peers. Given that it is impractical, and unethical, to study risk-taking behaviour with real scenarios where participants would be exposed to negative or harmful outcomes, hypothetical scenarios are commonly used as a substitute in decision-making research (e.g., Berry et al., 2017; Hardisty & Weber, 2009; Kaplan et al., 2014; Sargisson et al., 2021; Sargisson & Schöner, 2020; Weatherly & Ruthig, 2013). Although there have been some concerns about the use of hypothetical scenarios in decision-making research, studies have shown participants make decisions in hypothetical situations similarly to when they are exposed to real outcomes (e.g., Horn & Freund, 2021; Kühberger et al., 2002; Locey et al., 2011; Madden et al., 2003; Robertson & Rasmussen, 2018). Though, due to the contextual nature of the scenarios, participants who were perhaps unfamiliar with deserts, food intolerances, or important meetings, may have had more difficulty imagining themselves in the scenarios, and therefore how they would act in these scenarios. Given the differences between conditions, our results show that participants at least considered the role their peer may have on their choice.

In conclusion, our findings demonstrate that peers can have a positive influence on risky decision-making. Although peers are typically thought to increase risky decision-making, our results showed that peers can also provide a positive, risk-averse influence, indicating peer intervention could be an effective way of preventing harmful risk-taking behaviour for young people. To better understand the effect of peers on decision-making, it is crucial that peer influence is clearly defined, that is, whether peers are merely present (and silent), or whether peers are providing an opinion on the choice made, and whether that opinion was risk-promoting (positive peer influence) or risk-averse (negative peer influence). Furthermore, it would be good to understand whether the effects of peers differ by how they are affected by the consequences of the decision being made. Further research examining the influence of others (e.g., work colleagues, partners) on risk-taking, would provide a more comprehensive understanding of social influence on risky decision-making. Many decisions take place within a social context, therefore an important conclusion from this research is that peers can be beneficial by reducing harmful risk-taking behaviour.

References

Albert, D., Chein, J., & Steinberg, L. (2013). The teenage brain: Peer influences on adolescent decision making. *Current Directions in Psychological Science*, *22*(2), 114-120. https://doi.org/10.1177/0963721412471347

Barr, G. C., Jr., Kane, K. E., Barraco, R. D., Rayburg, T., Demers, L., Kraus, C. K., Greenberg, M. R., Rupp, V. A., Hamilton, K. M., & Kane, B. G. (2015). Gender differences in perceptions and self-reported driving behaviors among teenagers. *Journal of Emergency Medicine*, *48*(3), 366-370. https://doi.org/10.1016/j.jemermed.2014.09.055

Berry, M., Nickerson, N., & Odum, A. (2017). Delay discounting as an index of sustainable behavior: Devaluation of future air quality and implications for public health. *International Journal of Environmental Research and Public Health*, *14*(9), 997. https://doi.org/10.3390/ijerph14090997

Bingham, C. R., Simons-Morton, B. G., Pradhan, A. K., Li, K., Almani, F., Falk, E. B., Shope, J. T., Buckley, L., Ouimet, M. C., & Albert, P. S. (2016). Peer passenger norms and pressure: Experimental effects on simulated driving among teenage males. *Transportation Research Part F: Traffic Psychology and Behaviour*, *41*, 124-137. https://doi.org/10.1016/j.trf.2016.06.007

Bixter, M. T., & Rogers, W. A. (2019). Age ‐ related differences in delay discounting: Immediate reward, reward magnitude, and social influence. *Journal of Behavioral Decision Making*, *32*(4), 471-484. https://doi.org/10.1002/bdm.2124

Buckley, L., & Foss, M. S. (2012). Protective factors associated with young passenger intervening in risky driving situations. *Journal of Safety Research*, *43*(5-6), 351-356. https://doi.org/10.1016/j.jsr.2012.10.007

Cascio, C. N., Carp, J., O'Donnell, M. B., Tinney, F. J., Bingham, C. R., Shope, J. T., Ouimet, M. C., Pradhan, A. K., Simons-Morton, B. G., & Falk, E. B. (2015). Buffering social influence: Neural correlates of response inhibition predict driving safety in the presence of a peer. *Journal of Cognitive Neuroscience*, *27*(1), 83-95. https://doi.org/10.1162/jocn_a_00693

Choukas-Bradley, S., Giletta, M., Cohen, G. L., & Prinstein, M. J. (2015). Peer influence, peer status, and prosocial behavior: An experimental investigation of peer socialization of adolescents' intentions to volunteer. *Journal of Youth and Adolescence*, *44*(12), 2197-2210. https://doi.org/10.1007/s10964-015-0373-2

Ertac, S., & Gurdal, M. Y. (2012). Deciding to decide: Gender, leadership and risk-taking in groups. *Journal of Economic Behavior and Organization, 83*(1), 24-30. https://doi.org/10.1016/j.jebo.2011.06.009

Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: An experimental study. *Developmental Psychology, 41*(4), 625-635. https://doi.org/10.1037/0012-1649.41.4.625

Gilman, J. M., Curran, M. T., Calderon, V., Stoeckel, L. E., & Evins, A. E. (2014). Impulsive social influence increases impulsive choices on a temporal discounting task in young adults. *PLoS One*, *9*(7). https://doi.org/10.1371/journal.pone.0101570

Gilroy, S. P., Franck, C. T., & Hantula, D. A. (2017). The discounting model selector: Statistical software for delay discounting applications. *Journal of the Experimental Analysis of Behavior*, *107*, 388-401. https://doi.org/10.1002/jeab.257

Green, L., & Myerson, J. (1996). Exponential versus hyperbolic discounting of delayed outcomes: Risk and waiting time. *American Zoologist*, *36*(4), 496. https://doi.org/10.1093/icb/36.4.496

Green, L., & Myerson, J. (2004). A discounting framework for choice with delayed and probabilistic rewards. *Psychological Bulletin*, *130*(5), 769-792. https://doi.org/10.1037/0033-2909.130.5.769

Hardisty, D. J., & Weber, E. U. (2009). Discounting future green: Money versus the environment. *Journal of Experimental Psychology: General*, *138*(3), 329-340. https://doi.org/10.1037/a0016433

Horn, S., & Freund, A. M. (2021). Adult age differences in monetary decisions with real and hypothetical reward. *Journal of Behavioral Decision Making*. https://doi.org/10.1002/bdm.2253

Johnson, M. W., & Bickel, W. K. (2008). An algorithm for identifying nonsystematic delay-discounting data. *Experimental and Clinical Psychopharmacology*, *16*(3), 264-274. https://doi.org/10.1037/1064-1297.16.3.264

Kaplan, B., Reed, D., & McKerchar, T. (2014). Using a visual analogue scale to assess delay, social, and probability discounting of an environmental loss. *The Psychological Record*, *64*(2), 261-269. https://doi.org/10.1007/s40732-014-0041-z

Kessler, L., Hewig, J., Weichold, K., Silbereisen, R. K., & Miltner, W. H. (2017). Feedback negativity and decision-making behavior in the balloon analogue risk task (BART) in adolescents is modulated by peer presence. *Psychophysiology*, *54*(2), 260-269. https://doi.org/10.1111/psyp.12783

Kühberger, A., Schulte-Mecklenbeck, M., & Perner, J. (2002). Framing decisions: Hypothetical and real. *Organizational Behavior and Human Decision Processes*, *89*(2), 1162-1175. https://doi.org/10.1016/S0749-5978(02)00021-3

Litman, L., Robinson, J., & Abberbock, T. (2017). TurkPrime.com: A versatile crowdsourcing data acquisition platform for the behavioral sciences. *Behavior Research Methods*, *49*(2), 433-442. https://doi.org/10.3758/s13428-016-0727-z

Locey, M. L., Jones, B. A., & Rachlin, H. (2011). Real and hypothetical rewards in self-control and social discounting. *Judgment and Decision Making*, *6*(6), 522-564.

Madden, G. J., Begotka, A. M., Raiff, B. R., & Kastern, L. L. (2003). Delay discounting of real and hypothetical rewards. *Experimental and Clinical Psychopharmacology*, *11*(2), 139-145. https://doi.org/10.1037/1064-1297.11.2.139

Mazur, J. E. (1987). An adjusting procedure for studying delayed reinforcement. In M. L. Commons, J. E. Mazur, J. A. Nevin, & H. Rachlin (Eds.), *Quantitative analyses of behavior: The effect of delay and of intervening events on reinforcement value.* (Vol. 5, pp. 55-73). Erlbaum.

McCoy, S. S., Dimler, L. M., Samuels, D. V., & Natsuaki, M. N. (2017). Adolescent susceptibility to deviant peer pressure: Does gender matter? *Adolescent Research Review*, *4*(1), 59-71. https://doi.org/10.1007/s40894-017-0071-2

McKerchar, T. L., Green, L., Myerson, J., Pickford, T. S., Hill, J. C., & Stout, S. C. (2009). A comparison of four models of delay discounting in humans. *Behavioural Processes*, *81*(2), 256-259. https://doi.org/10.1016/j.beproc.2008.12.017

Morgenroth, T., Fine, C., Ryan, M. K., & Genat, A. E. (2017). Sex, drugs, and reckless driving: Are measures biased toward identifying risk-taking in men? *Social Psychological and Personality Science*, *9*(6), 744-753. https://doi.org/10.1177/1948550617722833

Myerson, J., & Green, L. (1995). Discounting of delayed rewards: Models of individual choice. *Journal of the Experimental Analysis of Behavior*, *64*(3), 263-276.

O'Brien, L., Albert, D., Chein, J., & Steinberg, L. (2011). Adolescents prefer more immediate rewards when in the presence of their peers. *Journal of Research on Adolescence*, *21*(4), 747-753. https://doi.org/10.1111/j.1532-7795.2011.00738.x

Osmont, A., Camarda, A., Habib, M., & Cassotti, M. (2021). Peers' choices influence adolescent risk-taking especially when explicit risk information is lacking. *Journal of Research on Adolescence*, *31*(2), 402-416. https://doi.org/10.1111/jora.12611

Rachlin, H. (2006). Notes on discounting. *Journal of The Experimental Analysis of Behavior*, *85*(3), 425-435. https://doi.org/10.1901/jeab.2006.85-05

Reniers, R. L. E. P., Beavan, A., Keogan, L., Furneaux, A., Mayhew, S., & Wood, S. J. (2017). Is it all in the reward? Peers influence risk-taking behaviour in young adulthood. *British Journal of Psychology*, *108*(2), 276-295. https://doi.org/10.1111/bjop.12195

Reniers, R. L. E. P., Murphy, L., Lin, A. B., SP, & Wood, S. J. (2016). Risk perception and risk-taking behaviour during adolescence: The influence of personality and gender. *PLoS One*, *11*(4). https://doi.org/10.1371/journal.pone.0153842

Robertson, S. H., & Rasmussen, E. B. (2018). Comparison of potentially real versus hypothetical food outcomes in delay and probability discounting tasks. *Behavioural Processes*, *149*, 8-15. https://doi.org/10.1016/j.beproc.2018.01.014

Rolison, J. J., & Shenton, J. (2020). How much risk can you stomach? Individual differences in the tolerance of perceived risk across gender and risk domain. *Journal of Behavioral Decision Making*, *33*(1), 63-85. https://doi.org/10.1002/bdm.2144

Sargisson, R. J., Ankoné, B. A. H., Dijkhuis, M., Eilers, H., Moser, E., Philipp, A. J., & Syafika, A. (2021). By-and-Buy: The effect of social influence on discounting of environmental outcomes. *Sustainability and Climate Change*, *14*(4), 217-226. https://doi.org/10.1089/scc.2021.0003

Sargisson, R. J., & Schöner, B. V. (2020). Hyperbolic discounting with environmental outcomes across time, space, and probability. *The Psychological Record*, *70*(3), 515-527. https://doi.org/10.1007/s40732-019-00368-z

Shulman, E. P., Smith, A. R., Silva, K., Icenogle, G., Duell, N., Chein, J., & Steinberg, L. (2016). The dual systems model: Review, reappraisal, and reaffirmation. *Developmental Cognitive Neuroscience*, *17*, 103-117. https://doi.org/10.1016/j.dcn.2015.12.010

Simons-Morton, B. G., Bingham, C. R., Falk, E. B., Li, K., Pradhan, A. K., Ouimet, M. C., Almani, F., & Shope, J. T. (2014). Experimental effects of injunctive norms on simulated risky driving among teenage males. *Health Psychology*, *33*(7), 616-627. https://doi.org/10.1037/a0034837

Smith, A. R., Chein, J., & Steinberg, L. (2014). Peers increase adolescent risk taking even when the probabilities of negative outcomes are known. *Developmental Psychology*, *50*(5), 1564-1568. https://doi.org/10.1037/a0035696

Somerville, L. H., Haddara, N., Sasse, S. F., Skwara, A. C., Moran, J. M., & Figner, B. (2018). Dissecting "peer presence" and "decisions" to deepen understanding of peer influence on adolescent risky choice. *Child Development*, *90*(6), 2086-2103. https://doi.org/10.1111/cdev.13081

Steinberg, L., Albert, D., Cauffman, E., Banich, M., Graham, S., & Woolard, J. (2008). Age differences in sensation seeking and impulsivity as indexed by behavior and self-report: Evidence for a dual systems model. *Developmental Psychology*, *44*(6), 1764-1778. https://doi.org/10.1037/a0012955

Steinberg, L., & Calkins, S. D. (2010). A dual systems model of adolescent risk-taking. *Developmental Psychobiology*, *52*(3), 216-224. https://doi.org/10.1002/dev.20445

Steinberg, L., & Monahan, K. C. (2007). Age differences in resistance to peer influence. *Developmental Psychology*, *43*(6), 1531-1543. https://doi.org/10.1037/0012-1649.43.6.1531

Tomova, L., & Pessoa, L. (2018). Information about peer choices shapes human risky decision-making. *Scientific Reports*, *8*(1), 5129. https://doi.org/10.1038/s41598-018-23455-7

van Hoorn, J., Crone, E. A., & Van Leijenhorst, L. (2017). Hanging out with the right crowd: Peer influence on risk-taking behavior in adolescence. *Journal of Research on Adolescence*, *27*(1), 189-200. https://doi.org/10.1111/jora.12265

van Hoorn, J., van Dijk, E., Meuwese, R., Rieffe, C., & Crone, E. A. (2014). Peer influence on prosocial behavior in adolescence. *Journal of Research on Adolescence*, *26*(1), 90-100. https://doi.org/10.1111/jora.12173

Weatherly, J. N., & Ruthig, J. (2013). Degree of delay discounting as a function of who receives the outcome and the discounter's perceived level of social support. *A Journal for Diverse Perspectives on Diverse Psychological Issues*, *32*(1), 1-17. https://doi.org/10.1007/s12144-012-9160-3

Weigard, A., Chein, J., Albert, D., Smith, A., & Steinberg, L. (2014). Effects of anonymous peer observation on adolescents' preference for immediate rewards. *Developmental Science*, *17*(1), 71-78. https://doi.org/10.1111/desc.12099

Chapter 4

Article 3

In March 2020, the World Health Organization declared a global pandemic for the SARS-CoV-2 virus (COVID-19; World Health Organization, 2020b). In response to the call from the World Health Organization, governments around the world imposed public health measures in accordance with their disease-prevention plans. Governments asked that people change their behaviour by practicing social (physical) distancing, cancelling mass gatherings, and to stay home where possible. New Zealand entered a nationwide Level 4 Lockdown on 25 March 2020, which meant people could only leave their houses for essential goods (e.g., food and pharmaceuticals), for short walks around their neighbourhood, or to go to work if they worked in an essential service (such as the manufacture and sale of essential items, healthcare, law enforcement; Ardern, 2020). Schools, childcare centres, playgrounds, and shopping malls closed, and most people began working from home. Australia, Europe, and parts of the USA and Asia, also shut down for long periods to control the spread of the virus.

Advice from the World Health Organization for COVID-19 was based on disease prevention responses to past epidemics, and emerging information about the new virus (World Health Organization, 2020a). Adherence to previous public health measures across the world had varied during other disease outbreaks, from 0% in Taiwan for the SARS outbreak, to 93% in Australia during the 2009 H1N1 Swine flu pandemic (Webster et al., 2020). Similarly, adherence to measures to prevent the spread of COVID-19 also differed. For COVID-19, adherence around avoiding mass gatherings was as high as 92.8% in Italy (Carlucci et al., 2020). In Norway, overall adherence was reported to be around 42%, but was highest in April (soon after measures were implemented), around 66%, and decreased in subsequent months (May through to July) to 33-38% (Steens et al., 2020). In the Democratic Republic of Congo, 37% did not adhere to the COVID-19 recommendations (Kabamba Nzaji et al., 2020). Adherence differed across individual demographics, for example, men showed lower rates of adherence than women (Algara et al., 2021; Nivette et al., 2021; Pollak et al., 2020; L. E. Smith et al., 2020a). Rates of adherence in North America and Europe also differed across measures of disease prevention; adherence was reported to be as low as 66% for maintaining a 2-m distance, 74% for limiting contact with family members not in the same household, and as high as 90% for avoiding non-essential gatherings, outings, crowds, and seeing friends in person (Coroiu et al., 2020). Adherence rates were higher for those who had COVID-19 symptoms (Nivette et al., 2021; Steens et al., 2020). People who believed they had previously had COVID-19 reported lower adherence than those who believed they had not yet contracted COVID-19 (L. E. Smith et al., 2020b).

Non-adherence was also associated with greater past risk-taking behaviour and impulse control (DeAngelis et al., 2022; Lloyd et al., 2021; Pollak et al., 2020; Steca et al., 2022). As adherence to public health measures required people to forgo their usual activities, and delay gratification (such as seeing friends and family, travelling, or leisure activities) until measures were relaxed, adherence was linked to people's ability to discount future outcomes (Byrne et al., 2021; Camargo et al., 2021; Lloyd et al., 2021). Discounting of monetary rewards predicted people's adherence to COVID-19 guidelines, meaning those who exhibited steeper delay discounting were less likely to adhere to the guidelines, and those that had shallower discounting were more likely to adhere (DeAngelis et al., 2022; Lloyd et al., 2021).

People often reported higher adherence for themselves but perceived lower adherence rates for others (Al-Hasan et al., 2020; Williams et al., 2020). Factors linked to adherence with measures to prevent the spread of COVID-19 included having good information about COVID-19, and people's perceived risk of COVID-19 (Al-Hasan et al., 2020; Algara et al., 2021; Carlucci et al., 2020; Pollak et al., 2020). Preventative behaviour was also associated with geographical distance of the spread of disease, if known cases of COVID-19 were closer, people were more likely to follow health advice, compared to if the disease affected a distant country (Blauza et al., 2021). Furthermore, people who trusted their government's response showed greater adherence (Carlucci et al., 2020), and those who did not trust in their government reported lower adherence (Williams et al., 2020). Unsurprisingly, the ability to work from home, having financial assistance to stay home, and having someone to run errands (if quarantining) also assisted people to follow the public health advice (L. E. Smith et al., 2020a; Webster et al., 2020). People were also much more likely to adhere to the recommendations if they felt that following the advice was making a difference, for example, seeing case numbers decrease (L. E. Smith et al., 2020a). People acted in accordance to how their friends and family were responding to the public health advice, which is known as following social norms (Al-Hasan et al., 2020; L. E. Smith et al., 2020a; Tunçgenç et al., 2021; Webster et al., 2020).

It has been well-documented that social norms play a role in influencing decision-making and behaviour (McDonald & Crandall, 2015). Social norms are informal rules that govern behaviour (Feldman, 1984); following the social norm will often result in a positive social consequence, like approval from others, and not following will result in a negative consequence such as disapproval from others (Bicchieri et al., 2022; Feldman, 1984). Essentially, social norms are an example of what is considered socially acceptable behaviour by a person's social network (Bicchieri et al., 2022; McDonald & Crandall, 2015). Social norms form part of the social context in which a decision is made (Bicchieri et al., 2022). Therefore, during the COVID-19 outbreak, it is unsurprising that social norms influenced people's reactions to public health guidance (L. E. Smith et al., 2020a; Tunçgenç et al., 2021). Seeing that others were adhering to the isolation procedures was associated with greater adherence to lockdown or self-isolation, and people were less likely to adhere to the rules if those in their own social circles also did not adhere (L. E. Smith et al., 2020a; Tunçgenç et al., 2021). Furthermore, people were concerned about the social implications of not following the social norms exhibited by their social network (L. E. Smith et al., 2020a). People reported that they felt a sense of responsibility to follow the guidelines, a moral duty to stay home to protect others, and they worried what their friends and family would think if they did not adhere to the rules and recommendations (Coroiu et al., 2020; L. E. Smith et al., 2020a; Williams et al., 2020).

Social norms are more influential if they come from someone within the same social network (Bellato, 2020; Brechwald & Prinstein, 2011; van Bavel et al., 2020). A social network can be a family unit, a group of colleagues, or a peer group. When people select their social network, or peer group, they typically choose peers who have similar values, attitudes, and behaviours to themselves (homophily), such as a non-smoker selecting a non-smoking peer group (Brechwald & Prinstein, 2011; Kandel, 1978). Some researchers maintain that people are more likely to be influenced by the groups' social norm when they have greater identification with the group, through shared values and attitudes (Bellato, 2020; Cruwys et al., 2020). Homophily has been associated with increased uptake of health prevention measures, as the social network provides social support for the behaviour (Centola, 2011). People respond similarly to those in their social networks (such as adhering to public health advice), as they are likely to experience social consequences (e.g., validation or exclusion) depending on whether their behaviour is congruent with those around them. The length of the relationship between people in a social group is also a factor in the strength of influence on behaviour. Over time, people become more similar to their peers through socialisation, so behaviours align more with their peers, as a result of experience of consequences from their peers (Brechwald & Prinstein, 2011). As following social norms is reinforced, people are more likely to conform to the social norms in the future (Brechwald & Prinstein, 2011).

Research on the influence of others on behaviour has often asked about similarities between an individual and their peer group. For example, researchers asked participants to report on their peers' behaviour and their own, to determine whether a higher rate of risky behaviour by a peer group is associated with greater risky behaviour of the participant (e.g., Haynie, 2002; Haynie et al., 2005; Lonardo et al., 2008). Peer-report has come under criticism, however, as it can be difficult for participants to know their peers' behaviour (Haynie, 2002). One solution is to ask the primary participant to nominate peers to self-report their own behaviour (e.g., Carter et al., 2014; Geber et al., 2019; Kiuru et al., 2010). Researchers have also studied direct social influence, by measuring risky decision-making in the presence of a peer (e.g., Kessler et al., 2017; O'Brien et al., 2011; van Hoorn et al., 2017). Another way to investigate social influence is to determine whether behaviour on a risk-taking task differs based on whether a hypothetical peer is present or informs the participant of their opinion (risk-promoting or risk-averse). We previously compared risk-taking behaviour in the context of peer absence, peer presence, and peer influence (Studies 2.1 and 2.2). Participants produced lower rates of risk-taking when alone, compared to when participants were hypothetically with a peer, or experienced risk-promoting peer influence. We also found that participants took fewer risks when positively influenced by their hypothetical risk-averse peers, compared to when they were alone.

Although the effect of peers on decision-making has been widely researched, the influence of other social contacts has not. Booth et al. (2000) found that participants' physical activity was associated with the frequency of their partner's, friends', and family's engagement in physical activity. Romantic partners influence a number of behaviours; the behaviour of one partner or spouse has been associated with the other (e.g., alcohol consumption; Leonard & Mudar, 2003; Leonard & Mudar, 2004; Windle & Windle, 2018), marijuana use (Homish et al., 2007; Windle & Windle, 2018), and health behaviours such as eating habits, getting regular health check-ups, and exercise (Homish & Leonard, 2008). Parents are also known to influence their adolescent children. As an example, young drivers who see their parents' distracted driving behaviour (e.g., responding to text messages while driving), or perceive their parents to partake in distracted driving, are themselves more likely to drive distractedly (Carter et al., 2014). Children of parents who regularly binge drink are also more likely to engage in problem drinking behaviour (Casswell et al., 2002; Mares et al., 2011). Although friends, partners, and parents can influence behaviour, there is limited evidence that compares the strength of that influence across types of relationships.

Young people are particularly susceptible to peer influence, taking greater risks in the presence of friends than they do alone (e.g., Kessler et al., 2017; O'Brien et al., 2011; Padrón et al., 2016; van Hoorn et al., 2017). During adolescence, the influence of peers is greater than the influence of parents (Yurasek et al., 2018), however, this may change with relationship status. Lonardo et al. (2008) found that, for young people, delinquent behaviour was better predicted by partner delinquency, rather than parent or peer delinquency. Leonard and Mudar (2003) studied drinking behaviour of couples in their first year of marriage and found that partner behaviour was more predictive of an individual's drinking behaviour, compared to their peers. Furthermore, couples who did drink were also likely to have peers exhibiting drinking behaviour, which could be attributed to peer selection (selecting peers who have similar behaviour to one's own), or the joining of social networks between partners, so together the couple has more friends who drink (Leonard & Mudar, 2003). Therefore, with time, influence from partners and peers may become similar as they share social connections, values, and interests.

The influence of a known other is stronger than that of a stranger (e.g., Salvy et al., 2007; Ziegler & Tunney, 2012). Salvy et al. (2007) found that people adjusted their eating to match the consumption of a familiar other, but not an unfamiliar other. Participants, when paired with an unfamiliar person, ate fewer snacks than when paired with someone they knew, indicating that familiarity of the other affects behaviour (Salvy et al., 2007). Furthermore, when people are making choices that affect others, they are more likely to choose to minimise risk to their friend than a stranger (Montinari & Rancan, 2018). Participants' emotional ties to their friends changed how much risk they were willing to take; they were more likely to risk a negative outcome when the outcome affected a stranger, and less likely to risk a negative outcome when the outcome affected a friend (Montinari & Rancan, 2018). Therefore, the recipient of the outcome factors into the decision-making process.

Familiarity, or closeness, may also play a role in people's decision-making. On a delay-discounting task where participants chose between a smaller amount of money offered sooner, or a larger amount of money offered in the future, Ziegler and Tunney (2012) found that participants' discount rates varied systematically with the degree of genetic closeness with another person, where participants chose more sooner-smaller rewards for those closest to them. The closer the person was to the participant genetically, the more the choice resembled how they would make decisions when they themselves were receiving the money (Ziegler & Tunney, 2012). Furthermore, when comparing discounting for friends and strangers (both genetically unrelated), discounting for friends was more similar to decision-making for a close relative; therefore, the degree of closeness, familiarity, and kinship all affected decision-making for others (Ziegler & Tunney, 2012). Thus, kinship, familiarity, and social connection affect the influence a person has during the decision-making process. How people respond to different types of social influences, specifically friends, partners, and parents, is an area that remains understudied.

In summary, adherence to COVID-19 public health recommendations such as lockdowns is influenced in part by social norms (L. E. Smith et al., 2020a). As people are more likely to behave in a way that is similar to those around them, social norms are more influential when demonstrated by a person's closest social contacts (Bellato, 2020; Tunçgenç et al., 2021). COVID-19 presents a situation where people are being asked to stay at home, however, there are often social ties to friends, family, and a person's partner which may mean adherence is tested. People are influenced by others within their social networks, with the closeness of that relationship being a potential factor (Leonard & Mudar, 2003; Lonardo et al., 2008; Tunçgenç et al., 2021; Ziegler & Tunney, 2012).

Adherence to COVID-19 prevention measures have usually been measured through self-report of past behaviour, such as whether people have left the house in the past 2 weeks (e.g., Carlucci et al., 2020; Coroiu et al., 2020; Nivette et al., 2021; Pollak et al., 2020). Self-report of past behaviour relies on participant recall and does not take the circumstances of their decisions into account. In previous studies (2.1 and 2.2), we used probabilistic discounting to measure risk-taking in specific situations, to determine the effects of the social environment on behaviour. Probabilistic discounting has been used to examine how people respond to monetary rewards (e.g., Chapman & Elstein, 1995), health behaviours (e.g., Chapman & Elstein, 1995), environmental concerns (e.g., Kaplan et al., 2014; Sargisson et al., 2021), and in risk-taking scenarios (e.g., Hayashi et al., 2018; Strickland et al., 2022). In probabilistic discounting, the researcher asks participants to evaluate a risk, and how likely they would be to take the risk given the described circumstances (e.g., Hayashi et al., 2018; Strickland et al., 2022). Adherence to public health guidance has been linked to discounting behaviour (see DeAngelis et al., 2022; Lloyd et al., 2021; Nese et al., 2022; Strickland et al., 2022). Vaccination against COVID-19 has also been associated with discounting behaviour, with shallower discounting of monetary rewards predicting vaccination status (Halilova et al., 2022). Perceived likelihood of adhering to public health advice for COVID-19 decreased over the time that the public health measures were in effect, and at low likelihoods of contracting the disease (Harman, 2021; Nese et al., 2022; Strickland et al., 2022). By using a probabilistic discounting task, we can examine risk-taking behaviour by asking people whether they would break adherence rules (and risk receiving a fine) in response to requests from different social contacts.

In two separate studies, we investigated whether people take more risks (breaking adherence to a COVID-19 style lockdown) when influenced by a friend, parent, or partner (Study 3.1), and additionally whether risk-taking differed by subjective closeness to the influencer (Study 3.2). We hypothesised that, based on prior research, risk-taking would differ by relationship type in a social-influence probabilistic discounting task. We hypothesised that people would be more likely to take risks for their partners and parents than for friends. Furthermore, we hypothesised that risk-taking would differ across social proximity (degree of closeness), with people taking greater risks for others with whom they have a subjectively closer relationship. Consistent with our previous studies, in both Studies 3.1 and 3.2 we also investigated differences in socially influenced risk-taking by age and gender.

Study 3.1

Method

Participants

Participants (*n* = 230; 110 men and 120 women; M_{age} = 35.44, 95% CI[33.78, 37.11]) were recruited via Amazon's mTurk and the University of Waikato. Participants had to be over the age of 18 to participate. A Human Intelligence Task (HIT) was advertised to mTurk users, using the Cloud Research platform by TurkPrime (https://www.cloudresearch.com), in the United States of America (Litman et al., 2017). mTurk participants (*n* = 150) were compensated US$1.00. An additional 80 participants were recruited from the University of Waikato. These participants could enter a draw to win a supermarket voucher (NZ$50.00). The project was approved by the University of Waikato's Division of Arts, Law, Psychology, and Social Sciences Human Research Ethics Committee (#FS2020-19).

Measures

Participants were asked to complete a 20-min questionnaire on Qualtrics (https://www.qualtrics.com). Although participants completed other measures, only the findings of the discounting task as a measure of risk-taking will be discussed in this article for brevity.

The probabilistic discounting task, that included three different scenarios themed around a viral outbreak, asked participants whether they would break ‘lockdown’, risking a fine of $2000. Each scenario was presented three times, with the request coming from a person with a different relationship (friend, parent, or partner/significant other) to the participant each time. Participants worked through all three scenarios and conditions. The scenarios were presented in a random order, and within each scenario type, the conditions were also randomly presented.

Participants were all shown a definition of lockdown, which applied to all three scenarios. The definition of lockdown was:

> For all the following hypothetical scenarios, your country is experiencing a viral outbreak and your city has been placed in "lockdown" – this is defined as a situation in which you are required to remain indoors and can only have contact with members of your household. Sharing items between households is not permitted. You can leave your place of residence to get exercise by walking around your block, get essential supplies (food and pharmaceuticals), or work (if you work in an essential service). The fine for breaching lockdown is $2000 NZD [$1200 USD (approx. $2000 NZD)]. You can view this definition as you move through the following questions by hovering your mouse over the word *lockdown*. The following scenarios are situations where your friends, family, or partner/significant other are requesting something of you which means breaching the lockdown. We are asking you to imagine that your friends, family, or partner/significant other do not currently live in your household and that you, your friends, family, and significant other are currently well, have no symptoms of the virus, or underlying health conditions.

The scenarios were as follows:

Visit:

Your country is experiencing a viral outbreak, and your city has been placed in lockdown. Your friend [parents (aged under 60 years), partner/significant other] really wants to see you, as they haven’t seen you in a few weeks. Despite being asked to remain indoors and physically isolated from other people, they really want to come to your house to see you. If the likelihood of you receiving a fine for breaching lockdown is X%, how likely is it that you would let your friend come visit you in your house?

Garden:

Your country is experiencing a viral outbreak, and your city has been placed in lockdown. Your friend has [parents (aged under 60 years) have, partner/significant other has] asked whether they can borrow some gardening equipment and return it the next day. You are aware that you should not be sharing or lending items right now, but they are wanting to make use of the lockdown period to tidy their garden which they have neglected for a while. If the likelihood of you receiving a fine for breaching lockdown is X%, how likely are you to lend the gardening equipment to your friend?

Medical:

Your country is experiencing a viral outbreak, and your city has been placed in lockdown. Your friend [parent (aged under 60 years), partner/significant other] has hurt their ankle and has asked you to drive them to the medical centre for an x-ray. You will need to drive across town to their house, pick them up, and drive them to the medical centre. You know this would be in breach of the lockdown, however they are refusing to use a taxi service as they are concerned about the outbreak. If the likelihood of you receiving a fine for breaching lockdown is X%, how likely are you to drive your friend to the medical centre?

Participants answered six questions for each scenario and condition, which varied by the likelihood (X%) of receiving the fine for breaching lockdown (95%, 90%, 50%, 30%, 10%, and 5%), presented in a descending order within the condition type. Participants responded on a digital VAS ranging from 0 to 100, with the starting position set at 50. The left-most position on the scale (0) had the qualifier of *"I would definitely not…"* and the right-most position (100) *"I would definitely…"* followed by a scenario-specific behaviour (e.g., "let them visit"). Participants clicked or moved the slider bar from the starting position (50) to move onto the next question. Responses from participants on the discounting task were inversed for analysis. The six questions allowed for a discount rate (as a measure of risk-taking) to be calculated for each condition (friend, parent, partner).

Procedure

The link to the questionnaire was provided on the recruitment advertisement. When opened, participants saw a brief introduction to the study, stating participants would be asked to make decisions in hypothetical risk-taking scenarios centred around a viral outbreak similar to COVID-19. Participants were told they could withdraw from the study at any point during the data collection process by closing the survey window. Participants who consented to the study were shown a list of instructions asking them to maximise their browser window, complete the questionnaire in a single setting, and not to perform other tasks while answering the questions. Participants were asked to provide their age and gender before completing all risk-taking scenarios in a random order.

Analysis

The questionnaire responses were downloaded from Qualtrics. As participants answered each question on a 0-100 VAS, their responses to each question gave their likelihood of taking the risk (known as the subjective value). For each scenario and condition pairing, participants had six subjective values, one for each probability of the outcome occurring. We inversed the subjective values and plotted them on a curve, showing the likelihood of choosing the safer alternative (i.e., not taking the risk) against the probability of the negative outcome occurring. The probability of the negative outcome occurring was converted to an odds against ratio, using the following equation:

$$\Theta = (1 - p) / p \qquad (5)$$

where Θ represents odds against, and p is the percent chance of likelihood of the negative outcome occurring. For the current study, these were 95%, 90%, 50%, 30%, 10%, and 5%, therefore the calculated odds against values were .053, .111, 1, 2.33, 9, and 19.

Typically, as the odds against the monetary fine occurring increases, the likelihood of choosing the safe option (an inversed subjective value) decreases. Using the open-source Discounting Model Selector (https://www.smallnstats.com; Gilroy et al., 2017) software, we compared four models fits of the data. We compared the exponential model, Mazur's (1987) hyperbolic model, Myerson and Green's (1995) model, and Rachlin's (2006) 2-parameter hyperboloid (see Green & Myerson, 1996). The Discounting Model Selector provides the information needed to compare the fit of each model. We choose to compare the models using RSME, as both AIC and BIC were not calculated for each participant's dataset. The lowest median RSME was observed with Rachlin's 2-parameter hyperboloid, therefore providing the best fit for majority of our data, consistent with reports from McKerchar et al.

(2009), and Sargisson and Schöner (2020). Therefore Rachlin's 2-parameter hyperboloid function was fitted to each set of six subjective values. The equation for Rachlin's (2006) 2-parameter hyperboloid is:

$$V = A / (1 + kx^s) \tag{6}$$

where *V* is the participant's subjective value, *A* is 100 (the undiscounted maximum value), *x* is the odds against occurrence, *k* is the discount rate, and *s* is a free parameter, representing the participant's sensitivity to variations in the magnitude of the outcome. For each participant, we calculated nine *k* values – one for each scenario and condition pairing (3 x 3) – that describe the relationship between the participants' subjective values and the odds against the fine occurring. Larger *k* values reflect a steeper discounting function, indicating participants were more willing to take risks as the likelihood of receiving a fine decreased.

We used the approach of Sargisson et al. (2021) to identify non-systematic discounting, as we have previously found this to be a less conservative approach in previous studies (Studies 1, 2.1, and 2.2) than the criteria applied by Johnson and Bickel (2008). For participants whose subjective values at 5% probability were not at least two points less than their subjective value at 95% probability within the same condition, we replaced *k* with zero, as they did not discount across the probabilities. The percentage of participants who did not discount across conditions is shown in Table 9. Table 9 shows the percentage of participants who did not discount was greater in the visit and garden scenarios, compared to the medical scenario. Additionally, the percentage of participants who did not discount was lower in both the partner and parent conditions, compared to the friend condition. The percentage of participants who did not discount in the friend condition varied more across scenarios, compared with the other conditions (partner or parent).

Table 9

Percentage of Participants Who Did Not Discount by Scenario and Condition

	Friend	Partner	Parent
Visit	60	42	48
Garden	53	45	47
Medical	41	43	47

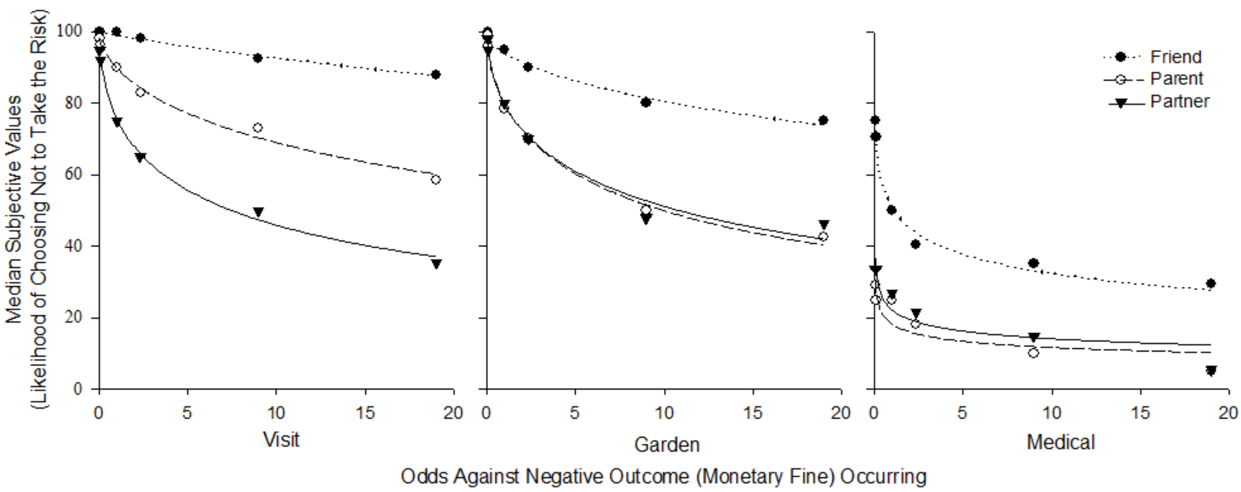
As the *k* values violated normality ($p < .001$), we compared discount rate (*k*) as a measure of risk-taking across the different relationship types (friend, parent, partner) using Friedman's test, followed by Wilcoxon signed-rank post-hoc analyses with a Bonferroni correction (critical $p < .017$). To explore gender differences for socially influenced risk-taking, we used a Mann-Whitney U test to compare the median k values for men and women, and to explore the relationship between the participant's age and their risk-taking behaviour, we used Spearman's correlation coefficients.

Results

We aimed to examine whether different social relationships affected discounting similarly. We compared discounting under the influence of three social relationships: friends, parents, and partners. Figure 7 shows the median subjective values across each of the odds against values for the three scenarios, for each social relationship. In all three scenarios, we observed that as the odds against the perceived negative event increased (meaning the negative event is less likely to happen), the likelihood of choosing not to take the risk decreased (risk-taking increased). For all three scenarios, the discounting function was least steep for the friend condition compared to those for partner and parent. For the visit scenario, the greatest risk-taking was observed for the partner condition. For both the garden and medical scenario, although risk-taking appeared very similar, we observed slightly greater risk-taking for the parent conditions compared to the partner conditions.

Figure 7

Median Subjective Values of Risk Avoidance for Study 3.1



Within each scenario, risk-taking differed significantly across the different social relationships; Visit: $\chi^2(2) = 63.91$, Garden: $\chi^2(2) = 34.09$, Medical: $\chi^2(2) = 34.67$, all *p*s $< .001$. For all three scenarios, risk-taking was significantly lower for friends, compared with that for both partners and parents. In the visit scenario, risk-taking was significantly greater for partners compared to parents, but risk-taking for parents was still significantly greater than that for friends (Table 10). For the garden and medical scenarios, although we observed significantly less risk-taking in the friend condition, there were no significant differences between risk-taking for partners or parents (Figure 8). Figure 8 shows the median *k* values as calculated by Equation 6.

Table 10

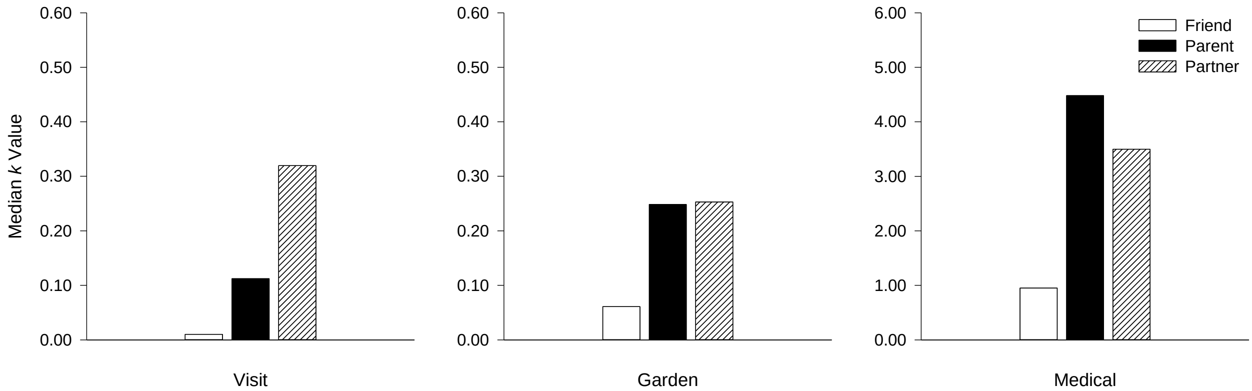
Wilcoxon Signed-Rank Post-Hoc Analyses of k Values for Study 3.1

	Visit Scenario			**Garden Scenario**			**Medical Scenario**		
	Friend - Parent	*Friend - Partner*	*Parent - Partner*	*Friend - Parent*	*Friend - Partner*	*Parent - Partner*	*Friend - Parent*	*Friend - Partner*	*Parent - Partner*
Z	-4.15	-6.35	-3.72	-3.99	-4.24	-0.05	-3.81	-4.31	-1.24
Sig.	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	.96	**<.001**	**<.001**	.21
N	223	223	222	227	224	223	229	229	230
r	-0.28	-0.43	-0.25	-0.26	-0.28	0.00	-0.25	-0.28	-0.08

Note. Bonferroni correction applied resulting in a critical *p* value of $p < .017$.

Figure 8

The k Values resulting from the Median Subjective Values for Study 3.1



Less risk-taking for friends was also reflected the percentage of participants who did not discount (shown in Table 9). The percentage of non-discounters was higher in the friend condition, and lower in the partner and parent conditions, for both the visit and garden scenarios. Percentages of non-discounters were more similar across conditions in the medical scenario, which had greater rates of discounting compared both the visit and garden scenarios.

As Figures 7 and 8 show higher *k* values in the medical scenario compared to the visit or garden scenario, we explored differences in discounting across scenarios by analysing the free parameter, *s*, calculated by Equation 6. Participant's *s* values are said to represent their sensitivity to differences in the magnitude of the scenario outcome. We found no significant differences in median *s* values across the three scenario types (see Tables C.1 and C.2 in Appendix C).

We explored demographic factors to test whether risk-taking differed by gender or age. We found no significant differences between risk-taking for men and women in any scenario or condition.

We found no correlation between age and risk-taking in most scenarios and conditions. Age was positively correlated with risk-taking when driving a parent to the medical centre, showing older participants exhibited greater risk-taking (higher *k* values) $r_s(230) = -.15$, $p = 0.03$. In all other conditions, there was no relationship between age and risk-taking behaviour, *p*s > .05.

In conclusion, we found lower risk-taking when requests came from friends, compared to parents and partners. The differences between partner and parent influence changed between scenario types. In the visit scenario, participants showed greatest risk-taking when the requests came from their partner, and lowest risk-taking when asked by friends, but in both the garden and medical scenarios, there was no significant difference in risk-taking when influenced by a parent or partner. We also found no differences in risk-taking by gender, and no consistent relationship between age and risk-taking. Overall, we observed much greater risk-taking in the medical scenario compared to the visit and garden scenarios.

Discussion

We aimed to determine whether people took more risks when influenced by their friends, partners, or parents. We hypothesised that people would take more risks for their parents and their partners compared to their friends. Our data supported our hypothesis.

Overall, participants took fewer risks for friends, and more for parents and romantic partners. The finding that decision-making differs between relationship types is consistent with previous research. Previous research found that decision-making changed between the presence of partners and strangers (Salvy et al., 2007), between friends and strangers (Montinari & Rancan, 2018), and even between different relatives (Ziegler & Tunney, 2012).

There are several explanations for why people would exhibit more risk-taking for partners and parents. People may have been wary of the social consequences of not following the social norm. Since the request is coming from a parent or partner, it is evident that they (parent or partner) are not following the 'rules' regarding the lockdown, thereby setting a social norm, or standard, of non-adherence. Participants may consider the negative social implications of not following the request from their parents or partners (e.g., not wanting to damage the relationship), but are less concerned with these outcomes when it comes to a friend. Additionally, it is possible that seeing a partner or family member may be of higher value to the participants, compared to seeing a friend. Participants may have felt more obligated to fulfil requests from parents, particularly when it comes to caring for them when they are injured or are requesting something. People may feel obligated to give back to those who raised them, or to maintain a future relationship (Stuifbergen & van Delden, 2010). Socialisation and imitation of family behaviours may also play a part in why risk-taking for parents is greater than that of friends, as the duration of relationship is typically longer. Given these explanations, it is unsurprising that we observed increased risk-taking behaviour under parent and partner influence compared to that of friends, including overall rates of discounting behaviour, as opposed to non-discounting.

People tend to have a higher degree of trust towards people they are closest to or identify with the most, which is likely to include close family and romantic partners (Cruwys et al., 2020). People also typically believe their friends and family to pose less health risk to them (e.g., that there is less risk of contracting a communicable disease such as COVID-19), therefore, people may feel as if the social distancing rules are unnecessary when it comes to parents and partners (Hult Khazaie & Khan, 2020; Schlager & Whillans, 2022). Furthermore, participants may believe that their parents and partners are following other public health advice such as keeping up with good hygiene, staying home, and avoiding large gatherings, and with that belief, they may be more willing to take a risk despite the risk of being fined (Cruwys et al., 2020). Additionally, if the participants have high trust in parents and partners, they may believe that their partner or parent would not have asked something of them which is likely to lead to a negative outcome (monetary fine) for them, and therefore they accept the request while misjudging the risk.

An interesting finding from Study 3.1 was that older age was associated with greater risk-taking for the parent condition in the medical scenario, as generally research shows younger age is associated with greater risk-taking behaviour (Defoe et al., 2019; Duell et al., 2018; Gardner & Steinberg, 2005; Mamerow et al., 2016). One reason for this finding might be that perhaps older participants also have older parents, so the medical issue is perceived as more serious. We had attempted to eliminate this as a factor in our methodology by specifying that the parents age was under 60 years to reduce the risk of severity of the injury, or subsequently catching the disease (similar to early discussions regarding COVID-19), however, we question whether participants still considered their actual parents age when making their decisions.

One of the main limitations of Study 3.1 was that the scenarios focussed on a hypothetical relationship between the participant and their friend, partner, or parent. Participants were asked to imagine these relationships and how they may respond to the requests. We did not collect information on participants' social connections; therefore, we do not know whether participants have a relationship which they would consider close with their friend, partner, or parent. More information on participants' relationships with the people in their social circles might help to provide an explanation for the differences seen between risk-taking when influenced by friends, parents, or a partner.

To address the limitation of hypothetical relationships, we conducted a follow-up study (3.2) to examine whether risk-taking under social influence was affected by social proximity to the requester. Foreman et al. (2019) previously examined whether risk-taking differed across social proximity by using a combination of delay discounting (discounting across temporal delays) and social discounting. Foreman et al. (2019) asked participants to identify five social contacts at different levels of social proximity, and then how likely they would be, when driving, to respond to a text message from these contacts. Participants were more likely to answer the text message if the person was a close contact, and less likely if the person was ranked as more socially distant (Foreman et al., 2019). Asking participants to identify their own social relationships on a scale of social proximity would address concerns around hypothetical relationships. Therefore, for Study 3.2, we used probabilistic discounting, combined with aspects of social discounting, to compare social influence across different social proximity positions, similar to Foreman et al.'s (2019) study.

Social discounting methods have been used to assess the use of face masks as a COVID-19 prevention method while around social contacts (Strickland et al., 2022). They asked people to indicate their likelihood of wearing a face mask around five social contacts of different social proximities, in three scenarios (when the participant was either: asymptomatic, symptomatic but no positive test, and symptomatic with a positive test). People were less likely to wear a face mask around a closer social contact, and more likely to wear a face mask around a more distant social contact (Strickland et al., 2022). They theorised that this finding may suggest that people valued seeing their closer social contacts without masks more (Strickland et al., 2022), which indicates that were more willing to see a closer social contact despite taking the risk of passing on the virus to their close friends and family.

To combine both probability and social discounting in Study 3.2, we asked participants to think about 100 people from their social network, ranking them from closest family member or friend at #1, to an acquaintance at #100. Participants were not required to make the list, but instead think about five specific positions on the list (#1, #10, #25, #50, and #100), and identify who would be in those positions from their social network. We then used a similar scenario-based probabilistic discounting task to Study 3.1, where we asked participants to consider their social contacts in the scenarios and varied the likelihood of receiving a monetary fine if the participant chose to see their social contact. By varying the likelihood of receiving the fine, we were able to compare risk-taking across social proximities. Based on Foreman et al.'s (2019) and Strickland et al.'s (2022) results, we expected that risk-taking would vary systematically as a function of who the request comes from, and that participants would exhibit greater risk-taking when requests came from someone of closer social distance and less risk-taking for a social contact with greater social distance.

Study 3.2

Method

Participants

We recruited 231 participants from mTurk (M_{age} = 41.94, 95% CI [40.41, 43.46]). The sample was 123 women and 107 men, all residing in the United States of America. Participants were compensated US$1.00. Our project was approved as an amendment to Study 3.1 (#FS2020-19), by the University of Waikato's Division of Arts, Law, Psychology, and Social Sciences' Human Research Ethics Committee.

Measures

Participants answered the questionnaire on Qualtrics as part of a wider survey on behaviour however, only the results of the probability-discounting task are discussed.

For the probability-discounting task participants were first asked to imagine they had created a list of 100 people that they knew (adapted from Rachlin & Jones, 2008).

> Imagine that you have made a list of the 100 people closest to you in the world ranging from your best friend or close family member at position #1 to an acquaintance at #100. The person at #1 would be someone you know well and is your closest friend or relative – someone that provides support for you in times of need. The person at #100 might be someone you recognize and encounter but do not know well. You do not have to physically create the list of 100 people—just imagine that you have done so. The following questions will ask you about five positions on this list so think carefully about these five positions and identify a person for each.

The positions were 1, 10, 25, 50, and 100. Participants identified the relationship they had with each person from a dropdown list (e.g., friend, partner/spouse, parent, sibling, colleague, neighbour, or acquaintance). Participants were asked whether they would take risks for these five people, during a probabilistic discounting task in a series of hypothetical scenarios. Three scenarios were used. The first two were the garden and medical scenarios from Study 3.1 worded identically. The visit scenario used in Study 3.1 was replaced with a birthday party scenario, as it seemed less realistic that someone of further social distance might visit the participant. The birthday scenario was framed around receiving an invitation to attend a birthday dinner, as follows:

> Your country is experiencing a viral outbreak, and your city has been placed in lockdown. #Y has invited you to their birthday dinner celebration at their house. Despite being asked to remain indoors and physically isolated from other people, they really want to celebrate their birthday with a dinner indoors. If the likelihood of you receiving a fine for breaching lockdown is X%, how likely is it that you would attend the birthday dinner celebration for #Y?

In each scenario (birthday, garden, and medical), X% was the probability of receiving a fine, 95%, 90%, 50%, 30%, 10%, and 5%, presented in a descending order, and #Y varied by the five social proximity positions. Participants then answered questions on a 0 – 100 VAS with qualifiers at either end, e.g., at 0 '*I would definitely not attend*' or at 100 '*I would definitely attend*' for the birthday celebration scenario. The starting position of the VAS was set to 50 and participants responded by dragging the slider left or right to indicate their likelihood of taking the risk. The five conditions (different social proximity indicating different levels of closeness) were presented in a random order, nested within the presentation of the three scenarios (also presented in a random order).

Procedure and Analysis

A factorial analysis of variance (ANOVA) was conducted on the raw subjective values using the five levels of closeness (#1, #10, #25, #50, and #100), and six levels of probability (95%, 90%, 50%, 30%, 10%, and 5%), for each of the scenarios. Mauchly's test showed data for each scenario violated sphericity (*p*s <.001), so Greenhouse-Giesser correction was applied ($\varepsilon < .75$).

We also followed a similar procedure to that as described in Study 3.1, where the subjective values were inversed, and then we calculated *k* by fitting Rachlin's (2006) 2-parameter hyperboloid model to the data. We calculated five *k* values per scenario (15 total), one for each of the conditions within a scenario.

We corrected *k* values as outlined in the method for Study 3.1. The percentage of participants who did not discount is shown in Table 11. The percentage of participants who did not discount was lower in the medical scenario, but this varied across social distance. Additionally, the percentage of participants who did not discount was higher for Person #1, and Person #100 compared to other social distance positions. This is likely due to participants choosing that they would always take Person #1 to the medical centre (regardless of the likelihood of the fine), therefore the discounting functions started and stayed low indicating no discounting. Whereas for Person #100, the discounting functions started high and stayed high indicating no discounting, as people would not take Person #100 to the medical centre (regardless of the likelihood of the fine). The percentage of participants who did not discount in the medical condition was still lower than those that did not discount across all social proximities in the birthday and garden scenarios.

Table 11

Percentage of Participants Who Did Not Discount by Social Proximity

	1	**10**	**25**	**50**	**100**
Birthday	39	46	56	68	78
Garden	37	32	41	52	66
Medical	51	29	29	37	54

We compared the *k* values across the different social proximities using Friedman's tests, with Wilcoxon signed-rank post-hoc analyses applying a Bonferroni correction ($p < .005$).

For Study 3.2, we also examined the data by social distance, across probabilities. Using the raw subjective values, we calculated *k* across the six probabilities, using Equation 6, with *x* as the social distance, which showed how participants discounted across changes in probability. For each participant, we calculated six *k* values for each of the three scenarios, one for each of the probabilities used (18 total). We corrected *k* values as outlined in Study 3.1. The percentage of participants who did not discount is shown in Table 12. The percentage of participants who did not discount (by probability) was lower in the in the medical scenario, compared to the birthday and garden scenarios. Across all three scenarios, the percentage of participants who did not discount decreased across the probabilities of receiving a fine (Table 12). We compared the *k* values across probabilities using Friedman's tests, with Wilcoxon signed-rank post-hoc analyses with Bonferroni correction applied ($p < .003$). This analysis allows for comparison to social discounting studies where *k* was calculated using social distance.

Table 12

Percentage of Participants Who Did Not Discount by Probability

	95	**90**	**50**	**30**	**10**	**5**
Birthday	51	49	42	35	29	26
Garden	50	47	38	32	28	27
Medical	21	19	17	16	16	18

Results

For Study 3.2, we aimed to compare risk-taking when responding to a request from five people, at varying degrees of social proximity. Table 13 shows frequency (%) of the type of relationship identified by participants, as a percentage for each social proximity rating. The relationship varied by social proximity, for example, 62% of participants identified their significant other as their #1 person. At the #10 position, 55% identified a friend. Friend was also common at Position #25 (35%) followed by 24% of participants identifying a co-worker at #25. The most common relationship between participants at their #50 and #100 positions was acquaintance.

Table 13

Percentage of Each Relationship Type Across the Five Social Proximity Positions

Relationship type	**#1**	**#10**	**#25**	**#50**	**#100**
Partner/ Significant Other	61.90	2.60	0.40	0.00	0.40
Parent	12.10	5.20	4.30	3.00	1.30
Friend	11.70	54.50	35.10	15.60	3.90
Sibling	9.10	10.40	5.60	1.30	1.30
Other Family	4.30	10.40	3.00	1.70	0.40
Employer	0.40	1.30	2.60	2.60	3.50
Co-workers	0.00	10.00	24.20	18.60	11.70
Flatmate/ Roommate	0.40	0.40	0.00	3.00	1.30
Neighbour	0.00	2.60	11.70	17.30	17.30
Acquaintance	0.00	2.20	12.60	35.50	55.40
Other	0.00	0.40	0.40	1.30	3.50

Figure 9 shows the mean subjective values (likelihood of taking the risk) against the odds against ratio (calculated by Equation 5) for each social proximity. Figure 9 shows that for all three scenarios, participants showed greater risk-taking for those they were closer to, and less for someone of a further social distance, however, when the risk of the fine was high (low odds against ratio), participants took less risks. When the risk of the fine was low (higher odds against ratio), participants took more risks.

The factorial ANOVA using the subjective values for the birthday scenario showed that there was a significant main effect for closeness, $F(1.71,854.64) = 154.59$, $p < .001$, $\eta_p^2 = .40$, a significant main effect for probability, $F(1.34,854.64) = 125.31$, $p < .001$, $\eta_p^2 = .35$, and a significant interaction between probability and closeness on the participant's subjective values, $F(3.72,854.64) = 34.14$, $p < .001$, $\eta_p^2 = .13$. For the garden scenario, significant main effects of closeness, $F(1.95,1195.33) = 155.48$, $p < .001$, $\eta_p^2 = .40$, and probability, $F(1.24, 1195.33) = 143.83$, $p < .001$, $\eta_p^2 = .39$, were observed. There was also a significant interaction effect between probability and closeness on the subjective values, $F(5.20, 1195.33) = 30.31$, $p < .001$, $\eta_p^2 = .17$. For the medical scenario, we also observed significant main effects for closeness, $F(2.24,1133.47) = 293.40$, $p < .001$, $\eta_p^2 = .56$, probability, $F(1.28, 1133.47) = 200.45$, $p < .001$, $\eta_p^2 = .47$, and between the interaction between probability and closeness, $F(4.93, 1133.47) = 12.91$, $p < .001$, $\eta_p^2 = .05$, on the participant's subjective values. The factorial ANOVA results show that the likelihood of the negative outcome occurring, and the social proximity to the social contact making the request, affected how likely participants were to take risks; increasing the odds against a negative outcome (monetary fine) and having increased social closeness, both resulted in increased risk-taking. People were therefore more likely to take risks for a closer social contact (e.g., #1), when the likelihood of receiving a fine was low, and less likely to take risks for more distant social contacts, but especially when the likelihood of receiving a fine was high (e.g., 95%; see Figure 9).

Figure 9

Mean Subjective Ratings of the Likelihood of Choosing to Take the Risk Across the Odds Against the Negative Outcome Occurring by Social Proximity

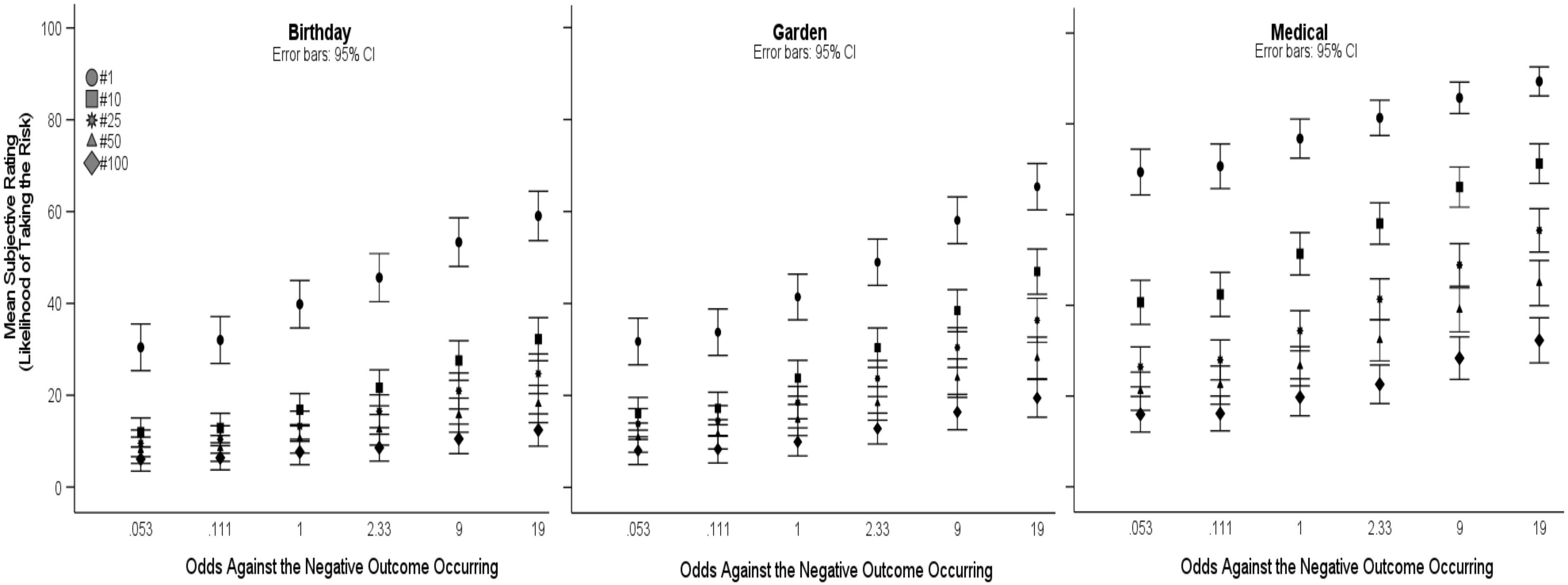
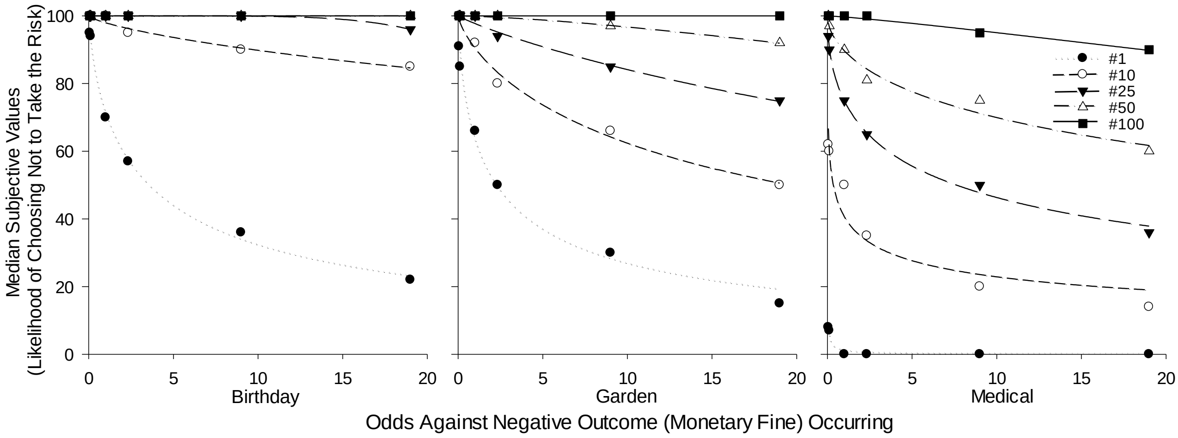


Figure 10 shows the median subjective values (inversed) across each of the odds against values (calculated by Equation 5) for the three scenarios for each social proximity with Equation 6 fitted to the data. In all three scenarios as the odds against the negative outcome increased (monetary fine), the likelihood of choosing the safe choice decreased (meaning risk-taking increased). For all scenarios in Figure 10, the discounting curve is steeper, meaning people exhibited greater risk-taking, for people of closer social distance (#1) compared to people at a further social distance (#100).

Figure 10

Median Subjective Values of Risk Avoidance for Study 3.2



Within each scenario type, risk-taking differed by social proximity, Birthday: χ^2 (4) = 270.35, Garden: χ^2 (4) = 229.66, Medical: χ^2 (4) = 165.26, all *p*s < .001. Wilcoxon signed-rank post-hoc analyses showed significant differences between the median *k* values for each social proximity rating in all conditions, except between #1 and #10 in the medical scenario (Table 14). In every scenario, the median *k* value was highest for the person of closer social distance (#1), and lowest for the person of furthest social distance (#100), meaning greater risk-taking was exhibited for those who were socially closer, compared to those more socially distant.

Table 14

Wilcoxon Signed-Rank Post-Hoc Analyses of k Values for Study 3.2

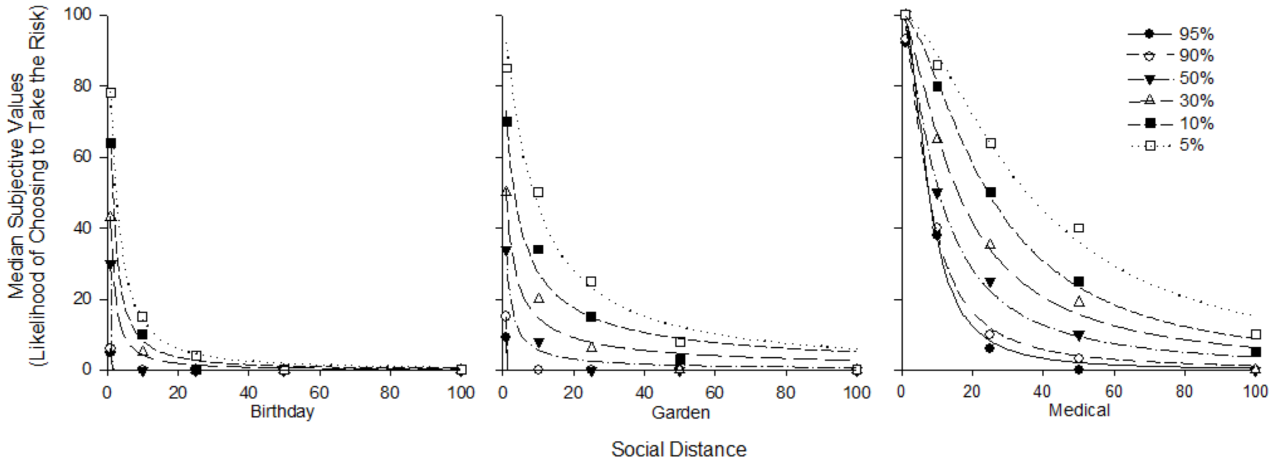
	#1 - #10	#1 - #25	#1 - #50	#1 - #100	#10 - #25	#10 - #50	#10 - #100	#25 - #50	#25 - #100	#50 - #100
Birthday Scenario										
Z	-6.18	-7.27	-8.14	-8.82	-4.92	-7.49	-8.42	-4.87	-7.11	-4.60
Sig.	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**
N	221	223	223	223	226	226	226	228	228	229
r	-0.42	-0.49	-0.55	-0.59	-0.33	-0.50	-0.56	-0.32	-0.47	-0.30
Garden Scenario										
Z	-4.30	-5.99	-7.17	-8.81	-5.34	-7.36	-8.84	-4.69	-8.21	-5.66
Sig.	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**
N	223	223	222	219	225	224	221	224	221	221
r	-0.29	-0.40	-0.48	-0.60	-0.36	-0.49	-0.59	-0.31	-0.55	-0.38
Medical Scenario										
Z	-2.04	-3.77	-4.94	-6.46	-7.13	-8.14	-8.98	-5.44	-7.97	-7.18
Sig.	.04	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**
N	228	226	224	224	226	224	222	222	220	219
r	-0.14	-0.25	-0.33	-0.43	-0.47	-0.54	-0.60	-0.37	-0.54	-0.49

Note. Bonferroni correction applied resulting in a critical p value of $p < .005$.

We also calculated *k* using social proximities to compare *k* across probabilities. Figure 11 shows the median subjective values (the likelihood of choosing to take the risk) across each of the social proximities for the three scenarios, for each probability value, with Equation 6 fitted to the data. In the birthday and garden scenarios, Figure 11 shows very low rates of risk-taking across probabilities. For the medical scenario, discounting changed based on social distance. For the participant’s closest contact (#1), participants were likely to take them regardless of the likelihood of receiving a fine (the likelihood of taking the risk was at the maximum of 100 for all probabilities). However, for more distant social contacts (#10, #25, #50, and #100), as the probability of the fine increased, participants were less likely to take the risk. In contrast, although participants did not respond differently to variations in the likelihood of receiving a fine for Person #1 in the medical scenario, participants did differ in their responses for #1 across differences in probability of receiving a fine in both the birthday and garden scenarios (the intercept of the function decreased with increasing likelihood of a fine). Risk-taking differed by the likelihood of the negative event occurring in all three scenarios (*p*s < .001). *k* values differed across probabilities in all scenarios but not in a consistent pattern (see Table D.1 in Appendix D).

Figure 11

Median Subjective Values of Risk-Taking by Social Distance for Study 3.2



Greater discounting in the medical scenario (compared to the birthday or garden scenarios) as shown by Figure 11 are consistent with the percentage of participants who did not discount as shown in Table 12. The rate of participants who discounted was consistent across probabilities for the medical scenario, whereas for the birthday and garden, people were less likely to discount at higher likelihoods of the fine, compared to when there was a lower likelihood of receiving a fine (see Table 12).

Furthermore, we explored the *s* values, or sensitivity to differences in the magnitude of the scenario outcome, across scenarios. As with Study 3.1, the analysis of *s* values did not provide any insights into understanding the patterns in discounting across scenarios (see Tables D.2 and D.3 in Appendix D).

Table 15 shows the Mann-Whitney U results of gender differences in risk-taking (*k* values). In four conditions of the birthday scenario (for social proximity positions #1, #10, #25, and #100), men exhibited greater risk-taking than women. In the garden scenario, men showed greater risk-taking than women only for a social proximity rating of #50. No differences between the risk-taking of men and women were observed in the medical scenario (see Table D.4, for descriptive statistics, in Appendix D).

Table 15

Mann-Whitney U Analyses Comparing Risk-Taking Between Men and Women

	Birthday				
	#1	#10	#25	#50	#100
Z	-2.70	-2.48	-2.39	-1.88	-2.82
Sig.	**.01**	**.01**	**.02**	.06	**.01**
N	223	226	228	229	229
r	-0.18	-0.16	-0.16	-0.12	-0.19
	Garden				
Z	-0.27	-1.70	-0.63	-2.28	-1.92
Sig.	.79	.09	.53	**.02**	.05
N	225	227	227	226	223
r	-0.02	-0.11	-0.04	-0.15	-0.13
	Medical				
Z	-0.25	-1.20	-0.66	-0.88	-0.38
Sig.	.80	.23	.51	.38	.71
N	229	228	226	224	223
r	-0.02	-0.08	-0.04	-0.06	-0.03

Older age was associated with less risk-taking, but only for close social contacts (Table 16). Participant age had a significant relationship with *k* in two conditions (social proximity #1 and #10) for the birthday and medical scenarios, and for social proximity #1 in the garden scenario.

Table 16

Spearman's rho Correlation Coefficients Between Age and k Values for Study 3.2

	Distance	**Correlation Coefficient (r_s)**	**Sig.**	***N***
Birthday	*#1*	-0.23	**<.001**	224
	#10	-0.17	**.011**	227
	#25	-0.13	.06	229
	#50	-0.12	.08	230
	#100	-0.11	.10	230
Garden	*#1*	-0.14	**.031**	226
	#10	-0.11	.09	228
	#25	-0.09	.20	228
	#50	-0.10	.15	227
	#100	-0.07	.30	224
Medical	*#1*	-0.17	**.010**	230
	#10	-0.21	**.001**	229
	#25	-0.08	.21	227
	#50	-0.10	.13	225
	#100	-0.04	.51	224

In conclusion, people took greater risks for closer social contacts compared to someone of further social distance. In all three scenarios, there was significant main effect of closeness, probability, and an interaction between closeness and probability on the participants subjective rating of whether they would take the risk. Both increasing the odds against receiving a monetary fine and having a closer relationship, resulted in increased risk-taking. Older age was associated with less risk-taking for close social contacts, however, the relationship between age and *k* values was only statistically significant in some conditions.

Men took greater risks than women in the birthday scenario. Participants exhibited the most risk-taking in the medical scenario, compared to the birthday and garden scenarios.

Discussion

We aimed to examine whether people would exhibit greater risk-taking for a person with whom they have a closer relationship. Our results supported our hypothesis. Participants showed greatest risk-taking for those they were closer to, and showed the least risk-taking for those more socially distant, however risk-taking also depended on the likelihood of the fine. When the likelihood of the fine was low, participants were more likely to take risks for their closer social contacts and when the likelihood of receiving a fine increased, participants were less likely to take risks for any social contact. Therefore participants' behaviour was not only governed by the degree of closeness with the social contact, but the likelihood of receiving a fine, and the interaction between closeness and the probability of the negative outcome occurring.

In situations where risk-taking leads to positive social consequences, people are more likely to take risks (Stone & Allgaier, 2008). In our hypothetical scenarios, when the request is made, the person making the request is defying lockdown rules and therefore encouraging the participant to take the risk (behaviour which may lead to receiving a fine). The participant may then believe that taking the risk, acting in accordance with their social contact, will result in social validation for risk-taking. Additionally, it is likely that participants perceive the consequences differently in relation to their family and friends who were identified as their closest person (#1 on their social proximity list), to those who are more distant (such as an acquaintance). The majority of participants reported the closest person to be their significant other/partner (n = 143; 62%), and the person they were least close to (#100 on their list) was typically an acquaintance (n = 128; 55%). People are likely to be more concerned about negative outcomes (such as being ostracised) from not taking the risk for a person with whom they have a closer relationship. Therefore, it makes sense that when participants think about the expected social consequences, risk-taking is increased for a person closer to them, than that of a person of greater social distance (Brechwald & Prinstein, 2011; van Bavel et al., 2020).

Furthermore, it is likely that participants perceive greater value in interactions with a close friend or family member than with a more distant social contact. People were found to be more willing to see a closer social contact than a stranger without a face covering, despite the risk of potentially passing on the COVID-19 virus (Strickland et al., 2022). Therefore, this indicates that people value seeing their close friends or family members, despite potential consequences. Furthermore, Charlton et al. (2012) found participants were less willing to wait for a social interaction with someone at a closer social distance, than someone at a greater social distance, suggesting participants perceived social interaction with someone they are closer to as being more valuable. During the COVID-19 pandemic, governments have been asking citizens to social distance (physically distance from others) and delay their interactions with loved ones. Therefore, it is unsurprising that participants are more willing to meet the requests of closer friends and family simply because they value seeing or helping close friends and family more than distant others.

People also make more risk-averse decisions for others, as they do not want to expose people they know to negative outcomes (Montinari & Rancan, 2018; Ziegler & Tunney, 2012). Montinari and Rancan (2018) found participants were less likely to take risks that may result in a loss of money for their friends compared to strangers, therefore they were more willing to expose strangers to negative outcomes. In the current study, the scenarios did not inform the participants of any consequences to them, or their social contacts, however, participants may have considered potential consequences regardless, particularly around transmission of the hypothetical virus. In our study, this may mean the participant was more willing to take the risk of a fine to make their close friend or family member happy, saving them from a potential negative outcome (e.g., being sad on their birthday). Therefore, it is unsurprising that participants took more risks for their close social contacts, as they did not want to let them down or upset them, meaning the effect on their social contact would also impact the participant's response.

Furthermore, our studies did not mention any risks regarding catching the virus, however, people consider closer social contacts, such as a friend or family member, to be less likely to pass on COVID-19 compared to a stranger (Schlager & Whillans, 2022). Therefore, another possible explanation for our findings, that people took greater risks for their closer social contacts, is that they perceived the risk of catching the disease as lower from closer social contacts and higher from more distant social contacts as found by Schlager and Whillans (2022), and therefore, disregarding the likelihood of the fine.

We also explored discounting across social distance by calculating k from the subjective values across distance, rather than probability. We found participants were less likely to take risks when the likelihood of receiving a fine was higher and were more likely to take risks when the likelihood of receiving a fine was lower. When exploring participant responses by social discounting across probability of the fine, our participants were very unlikely to take any risks in the birthday or garden scenarios (demonstrated by the percentage of non-discounters). The pattern in the medical scenario differed, as we saw differences in behaviour across social proximity; for Person #1 participants were willing to take the risk regardless of the probability of the fine, and for the other four more distant social contacts, as the probability of the fine increased, our participants were less likely to take risks for more distant social contacts. Similar to the findings when we analysed by probability, participants were more likely to take risks for someone they were closer to, and less likely to take risks for someone at a greater distance. Results showed that when there was an increased likelihood of the fine, and a greater social distance to the requester, participants exhibited lower risk-taking, compared to when requests were made by a closer social contact, and the risk of receiving a fine was low. Overall, more differences in discounting were observed within the medical scenario through both methods. Despite low rates of discounting behaviour in the birthday and garden scenarios, the absence of risk-taking is positive, as it indicates people are following the public health guidance.

As social networks may affect decision-making, public health organisations should consider how social connections can be used in public messaging on disease prevention. Many public health messages place emphasis on practicing social distancing (physically distancing oneself) from strangers, which likely reinforces people's tendency to belief that their friends and family are not at high risk of transmitting the virus to them (Cruwys et al., 2020; Schlager & Whillans, 2022). We found that, although in these scenarios people are usually unwilling to take risks, when they do, they are more likely to take risks for a person with whom they have a closer relationship. Public health messaging during COVID-19 (and subsequent health crises) should consider how to combat the influence of close social contacts on harmful risky behaviour.

General Discussion

We aimed to understand the influence of relationship type and relationship closeness on risky decision-making. In Study 3.1, people took greater risks for their parents and partners than their friends. Risk-taking was greater for partners than parents in the visit scenario, and greater for parents than partners in the medical scenario, but there was no difference between risk-taking for parents and partners in the garden scenario. People can be influenced by their friends (e.g., O'Brien et al., 2011; A. R. Smith et al., 2014; van Hoorn et al., 2017), parents (e.g., Carter et al., 2014; Casswell et al., 2002; Mares et al., 2011), and partners (e.g., Homish & Leonard, 2008; Homish et al., 2007; Leonard & Mudar, 2003;

Windle & Windle, 2018), but very few have actually compared social influence across different relationships. As we found participants were more influenced by their partners and parents than their friends, we investigated whether this was due to the closeness of that relationship. For Study 3.2, we found that participants' risk-taking increased systematically with the degree of social proximity, meaning they took greater risks for those they were closest to and fewer risks for those they were socially further from. These results were consistent with those of Foreman et al. (2019), who found risk-taking in the form of replying to a text while driving decreased as the social distance to the sender increased. From understanding that risk-taking changes with social closeness, researchers interested in reducing harmful risk-taking should consider how to reduce the negative influence of close others, rather than focusing on one relationship type, such as friends.

We found participants took very few risks across both studies. Although some research has indicated a relationship between steeper discounting and adherence to public health measures (e.g., Byrne et al., 2021; Camargo et al., 2021; DeAngelis et al., 2022; Lloyd et al., 2021), some have shown the inverse, meaning that greater impulsivity was associated with greater adherence (e.g., Calluso et al., 2021; Hudson et al., 2022; Strickland et al., 2022; Wismans et al., 2021). Hudson et al. (2022) found delay discounting predicted some behaviours and not others, for example, discount rates were associated with increased mask-wearing and hygiene behaviours, but did not predict social (physical) distancing, or vaccination. One theory to explain the positive association between discount rates and public health is that people reframed the behaviour to protect themselves from a virus like COVID-19 (Calluso et al., 2021). Therefore perhaps people see higher expected value in choosing the safer option, in our case that is to not take the risk (Byrne et al., 2021). We found that the percentage of people who did not discount generally increased across social proximity, suggesting that people made conscious choices based on the context provided, rather than just arbitrarily responding. For the medical scenario, the percentage of participants who did not discount would capture those that would always take the risk and those who would never take the risk, which may explain why the medical scenario deviated from the increasing pattern seen in the other scenarios. Furthermore, as the COVID-19 pandemic also created some economic uncertainty, people may have been less willing, or completely unwilling, to risk such a substantial fine given the described similarities between the COVID-19 pandemic and our scenarios. Future research could examine whether similar observations are made under variation of fine magnitudes.

Although risk-taking was very low across the studies, people were more likely to take risks in the medical scenario. Many actions during the pandemic are seen as morally good (e.g., isolating when symptomatic) and therefore have a greater chance of reinforcement from the public (Francis & McNabb, 2022; Prosser et al., 2020). Adherence is purported as a civic duty (Webster et al., 2020), so in the case of driving an injured friend or family member to the medical centre, the choice may be morally ambiguous. Although staying home is seen as good, helping a friend or family member in need may be viewed as an exception, in that more people are likely to be understanding and commend this action. Furthermore, if participants did get stopped by law enforcement, perhaps they feel as if they could justify their non-adherence to the public health guidelines in this medical scenario, more so than a social visit like a birthday, and not get punished for the action.

Caring for others is also a behaviour that has been socially reinforced. Webster et al. (2020) mentioned that adherence to isolation and quarantine measures during the Ebola outbreak in West Africa was affected by culture, where it was the norm to care for those who were sick despite the risk associated with providing care. Although people may be willing to put themselves at risk, they are also concerned for the health of those around them, and report feeling a sense of responsibility to their community to follow the public health guidance (Wolf et al., 2020). The medical scenario confounds caring for the community by staying home, with caring for an injured family member or friend (a person of closer social proximity). Furthermore, the medical scenario may be perceived as having a low-risk (to the community), through a mostly isolated drive to the medical centre, but a high-benefit to the person in need. In Study 3.2, people took greater risks for those they were closer to, however, it is likely they were considering more than just the likelihood of the fine in their decision-making. People are likely also considering the implications – risks and benefits – of their choice on those closest to them, and their wider community, alongside both the fine and how the choice may affect the individual and their relationship in the future. Therefore, perhaps it is unsurprising that we would see greater risk-taking in a scenario based around responding to a plea for help.

We also explored whether socially influenced risk-taking differed by age or gender in both studies. We found no relationship between risk-taking behaviour and age in Study 3.1, however, in Study 3.2, in some conditions, risk-taking was negatively associated with age, meaning younger participants took greater risks. This relationship between age and risk-taking was significant for the person of closest social proximity (#1) in all three scenarios, and #10 in two of the scenarios.

Furthermore, we found no significant differences between the risk-taking of men and women in Study 3.1, however, in Study 3.2, in the birthday scenario men took more risks than women. Previous research on risk-taking shows, in some studies, men have higher risk-taking compared to women (e.g., Reniers et al., 2016; van Leijenhorst et al., 2008), and, in others, there is no difference in risk-taking between men and women (McCoy et al., 2017). Morgenroth et al. (2017) suggested that the finding whereby men exhibit greater risk-taking is due to biases in measures of risk-taking. We previously found no consistent gender differences using novel risk-taking scenarios (see Studies 2.1 and 2.2). For the current studies, our scenarios were novel but based on adherence to a lockdown. Our finding that men took more risks in the birthday scenario is consistent with literature showing men reported less adherence to COVID-19 restrictions than women, indicating greater risk-taking regarding COVID-19 for men (Nivette et al., 2021; Pollak et al., 2020; L. E. Smith et al., 2020a). Given that we found no differences between men and women in Study 3.1, and inconsistent differences across scenarios in Study 3.2, differences in risk-taking behaviour of men and women may be specific to the context in which the decision is occurring, as reported by McCoy et al. (2017) and Morgenroth et al. (2017).

Our studies add to the literature on social influence by comparing how different relationships affect decision-making. In addition, social closeness is associated with greater influence over behaviour. These studies both used hypothetical scenarios which may be similar to what participants are facing during COVID-19, with restrictions on seeing others in person (non-household contacts). Hypothetical discounting scenarios have been used previously to measure the likelihood of adherence to social-distancing over the time that the measures are required (Harman, 2021; Nese et al., 2022), and the probability of contracting COVID-19 (Nese et al., 2022). The use of hypothetical scenarios may be seen as a limitation, as it may be difficult for participants to respond in a way which accurately reflects their behaviour. As in the current study, it is not always safe or practical to use real outcomes in decision-making research, therefore hypothetical scenarios have been widely used (e.g., Horn & Freund, 2021; Kühberger et al., 2002; Locey et al., 2011; Madden et al., 2003; Robertson & Rasmussen, 2018). The decisions participants make for hypothetical outcomes are similar to those made for real outcomes (e.g., Horn & Freund, 2021; Kühberger et al., 2002; Locey et al., 2011; Madden et al., 2003; Robertson & Rasmussen, 2018). Another limitation of the scenarios is that we did not present any additional facts about the virus, and as data were collected during the 2020 COVID-19 pandemic, people may have had preconceived ideas about the virus based on COVID-19. From what is known about COVID-19, it can affect people differently, especially if they have existing health conditions (Flaherty et al., 2020). Therefore, it is likely that people interpret the risk of contracting COVID-19 or transmitting the virus to friends and family who may have existing conditions, differently. Due to the differences in risk perception for COVID-19, we focused on the risk of a monetary fine for breaking lockdown during a viral outbreak, as this risk is less affected by personal risk factors to COVID-19.

The findings contributed to the existing discounting literature by combining two existing methods to examine differences in social influence on risk-taking behaviour, and although we focused on hypothetical risk-taking during a viral outbreak, this approach may have other applications. The combination of social and probabilistic discounting methods could be used to assess various types of risk-taking in scenarios where social influence occurs, such as risky driving, substance use, or other unhealthy, harmful, or unsafe decisions. Furthermore, we were able to show systematic differences in risk-taking behaviour, dependent on social proximity, and differences in risk-taking dependent on the type of relationship. As people often use the views of friends and family to aid in decision-making, researchers should examine whether wider social contacts can also positively influence people to make safer decisions. Previously, we found that peers could have a positive influence on risk-taking when a risk-averse opinion was given (see Study 2.2). It would be interesting to determine whether positive social influence extends beyond just peers, investigating the extent to which social contacts of various levels of social closeness can positively influence behaviour. Furthermore, to encourage people to adhere to the public health rules, researchers should examine how to increase adherence through encouraging people to model positive social norms. Public health teams may also be able to counter the influence of close social contacts if they understand the increased risk from closer social contacts. By educating people about different sources of social influence, and providing alternative actions, this information may help to curb some harmful risk-taking behaviour, particularly when disease prevention requires it.

In conclusion, we conducted two studies to examine how people respond to social influence in a lockdown scenario. We found that participants' risk-taking behaviour during a lockdown scenario differed by relationship type and closeness, finding people were more influenced by their partners, and the closest people in their lives. Understanding the effects of negative social influences on behaviour is useful as a first step to reducing harmful risk-taking behaviour as a result of social influence. Furthermore, combining social and probabilistic discounting allows for a novel way to examine the effects of social influence on risk-taking.

References

Al-Hasan, A., Yim, D., & Khuntia, J. (2020). Citizens' adherence to COVID-19 mitigation recommendations by the government: A 3-country comparative evaluation using web-based cross-sectional survey data. *Journal of Medical Internet Research*, *22*(8). https://doi.org/10.2196/20634

Algara, C., Fuller, S., Hare, C., & Kazemian, S. (2021). The interactive effects of scientific knowledge and gender on COVID-19 social distancing compliance. *Social Science Quarterly*, *102*(1), 7-16. https://doi.org/10.1111/ssqu.12894

Ardern, J. (2020, March 23). *Prime Minister: COVID-19 alert level increased* [Speech]. Beehive.govt.nz. https://www.beehive.govt.nz/speech/prime-minister-covid-19-alert-level-increased

Bellato, A. (2020). Psychological factors underlying adherence to COVID-19 regulations: A commentary on how to promote compliance through mass media and limit the risk of a second wave. *Social Sciences & Humanities Open*, *2*(1). https://doi.org/10.1016/j.ssaho.2020.100062

Bicchieri, C., Dimant, E., Gächter, S., & Nosenzo, D. (2022). Social proximity and the erosion of norm compliance. *Games and Economic Behavior*, *132*, 59-72. https://doi.org/10.1016/j.geb.2021.11.012

Blauza, S., Heuckmann, B., Kremer, K., & Büssing, A. G. (2021). Psychological distance towards COVID-19: Geographical and hypothetical distance predict attitudes and mediate knowledge. *Current Psychology*, 1-12. https://doi.org/10.1007/s12144-021-02415-x

Booth, M. L., Owen, N., Bauman, A., Clavisi, O., & Leslie, E. (2000). Social–cognitive and perceived environment influences associated with physical activity in older Australians. *Preventive Medicine, 31*(1), 15-22. https://doi.org/10.1006/pmed.2000.0661

Brechwald, W. A., & Prinstein, M. J. (2011). Beyond homophily: A decade of advances in understanding peer influence processes. *Journal of Research on Adolescence*, *21*(1), 166-179. https://doi.org/10.1111/j.1532-7795.2010.00721.x

Byrne, K. A., Six, S. G., Anaraky, R. G., Harris, M. W., & Winterlind, E. L. (2021). Risk-taking unmasked: Using risky choice and temporal discounting to explain COVID-19 preventative behaviors. *PLoS One*, *16*(5), e0251073. https://doi.org/10.1371/journal.pone.0251073

Calluso, C., Grande, E., Erario, A., Tosoni, A., & Committeri, G. (2021). Effects of individual discount rate and uncertainty perception on compliance with containment measures during the COVID-19 pandemic. *Brain Sciences*, *11*(10), 1256. https://www.mdpi.com/2076-3425/11/10/1256

Camargo, J., Passarelli, D. A., de Oliveira, M. A., & de Rose, J. C. (2021). Probability discounting and adherence to preventive behaviors during the COVID-19 pandemic. *PsyArXiv*. https://doi.org/10.31234/osf.io/p4a76

Carlucci, L., D'Ambrosio, I., & Balsamo, M. (2020). Demographic and attitudinal factors of adherence to quarantine guidelines during COVID-19: The Italian Model. *Frontiers in Psychology*, *11*(2702). https://doi.org/10.3389/fpsyg.2020.559288

Carter, P. M., Bingham, C. R., Zakrajsek, J. S., Shope, J. T., & Sayer, T. B. (2014). Social norms and risk perception: Predictors of distracted driving behavior among novice adolescent drivers. *Journal of Adolescent Health*, *54*(5, Supplement), S32-S41. https://doi.org/10.1016/j.jadohealth.2014.01.008

Casswell, S., Pledger, M., & Pratap, S. (2002). Trajectories of drinking from 18 to 26 years: Identification and prediction. *Addiction*, *97*(11), 1427-1437. https://doi.org/10.1046/j.1360-0443.2002.00220.x

Centola, D. (2011). An experimental study of homophily in the adoption of health behavior. *Science*, *334*(6060), 1269-1272. https://doi.org/10.1126/science.1207055

Chapman, G. B., & Elstein, A. S. (1995). Valuing the future: Temporal discounting of health and money. *Medical Decision Making*, *15*(4), 373-386. https://doi.org/10.1177/0272989X9501500408

Charlton, S. R., Gossett, B. D., & Charlton, V. A. (2012). Effect of delay and social distance on the perceived value of social interaction. *Behavioural Processes*, *89*(1), 23-26. https://doi.org/10.1016/j.beproc.2011.10.003

Coroiu, A., Moran, C., Campbell, T., & Geller, A. C. (2020). Barriers and facilitators of adherence to social distancing recommendations during COVID-19 among a large international sample of adults. *PLoS One*, *15*(10), e0239795. https://doi.org/10.1371/journal.pone.0239795

Cruwys, T., Stevens, M., & Greenaway, K. H. (2020). A social identity perspective on COVID-19: Health risk is affected by shared group membership. *British Journal of Social Psychology*, *59*(3), 584-593. https://doi.org/10.1111/bjso.12391

DeAngelis, B. N., Ben Salah, A., & al'Absi, M. (2022). Stress and COVID-19 related behaviours: The mediating role of delay discounting. *Stress and Health*, *38*(1), 140-146. https://doi.org/10.1002/smi.3060

Defoe, I. N., Dubas, J. S., & Romer, D. (2019). Heightened adolescent risk-taking? Insights from lab studies on age differences in decision-making. *Policy Insights from the Behavioral and Brain Sciences*, *6*(1), 56-63. https://doi.org/10.1177/2372732218801037

Duell, N., Steinberg, L., Icenogle, G., Chein, J., Chaudhary, N., Di Giunta, L., Dodge, K. A., Fanti, K. A., Lansford, J. E., Oburu, P., Pastorelli, C., Skinner, A. T., Sorbring, E., Tapanya, S., Uribe Tirado, L. M., Alampay, L. P., Al-Hassan, S. M., Takash, H. M. S., Bacchini, D., & Chang, L. (2018). Age patterns in risk taking across the world. *Journal of Youth and Adolescence*, *47*(5), 1052-1072. https://doi.org/10.1007/s10964-017-0752-y

Feldman, D. C. (1984). The development and enforcement of group norms. *The Academy of Management Review*, *9*(1), 47-53. https://doi.org/10.5465/amr.1984.4277934

Flaherty, G. T., Hession, P., Liew, C. H., Lim, B. C. W., Leong, T. K., Lim, V., & Sulaiman, L. H. (2020). COVID-19 in adult patients with pre-existing chronic cardiac, respiratory and metabolic disease: A critical literature review with clinical recommendations. *Tropical Diseases, Travel Medicine and Vaccines*, *6*(1), 16. https://doi.org/10.1186/s40794-020-00118-y

Foreman, A. M., Hayashi, Y., Friedel, J. E., & Wirth, O. (2019). Social distance and texting while driving: A behavioral economic analysis of social discounting. *Traffic Injury Prevention*, *20*(7), 702-707. https://doi.org/10.1080/15389588.2019.1636233

Francis, K. B., & McNabb, C. B. (2022). Moral decision-making during COVID-19: Moral judgements, moralisation, and everyday behaviour. *Frontiers in Psychology, 12*. https://doi.org/10.3389/fpsyg.2021.769177

Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: An experimental study. *Developmental Psychology*, *41*(4), 625-635. https://doi.org/10.1037/0012-1649.41.4.625

Geber, S., Baumann, E., Czerwinski, F., & Klimmt, C. (2019). The effects of social norms among peer groups on risk behavior: A multilevel approach to differentiate perceived and collective norms. *Communication Research*. https://doi.org/10.1177/0093650218824213

Gilroy, S. P., Franck, C. T., & Hantula, D. A. (2017). The discounting model selector: Statistical software for delay discounting applications. *Journal of the Experimental Analysis of Behavior*, *107*, 388-401. https://doi.org/10.1002/jeab.257

Green, L., & Myerson, J. (1996). Exponential versus hyperbolic discounting of delayed outcomes: Risk and waiting time. *American Zoologist*, *36*(4), 496. https://doi.org/10.1093/icb/36.4.496

Halilova, J., Fynes-Clinton, S., Green, L., Myerson, J., Wu, J., Ruggeri, K., Addis, D., & Rosenbaum, R. S. (2022). Short-sighted decision-making by those not vaccinated against COVID-19. *PsyArXiv*. https://doi.org/10.31234/osf.io/6uqky

Harman, M. J. (2021). The effects of time framing on compliance to hypothetical social-distancing policies related to COVID-19. *Behavior and Social Issues, 30*(1), 632-647. https://doi.org/10.1007/s42822-020-00041-z

Hayashi, Y., Fessler, H. J., Friedel, J. E., Foreman, A. M., & Wirth, O. (2018). The roles of delay and probability discounting in texting while driving: Toward the development of a translational scientific program. *Journal of the Experimental Analysis of Behavior, 110*(2), 229-242. https://doi.org/10.1002/jeab.460

Haynie, D. L. (2002). Friendship networks and delinquency: The relative nature of peer delinquency. *Journal of Quantitative Criminology*, *18*(2), 99-134. https://doi.org/10.1023/A:1015227414929

Haynie, D. L., Giordano, P., Manning, W., & Longmore, M. (2005). Adolescent romantic relationships and delinquency involvement. *Criminology*, *43*, 177-210. https://doi.org/10.1111/j.0011-1348.2005.00006.x

Homish, G. G., & Leonard, K. E. (2008). Spousal influence on general health behaviors in a community sample. *American Journal of Health Behavior*, *32*(6), 754-763. https://doi.org/10.5555/ajhb.2008.32.6.754

Homish, G. G., Leonard, K. E., & Cornelius, J. R. (2007). Predictors of marijuana use among married couples: the influence of one's spouse. *Drug and Alcohol Dependence*, *91*(2), 121-128. https://doi.org/10.1016/j.drugalcdep.2007.05.014

Horn, S., & Freund, A. M. (2021). Adult age differences in monetary decisions with real and hypothetical reward. *Journal of Behavioral Decision Making*. https://doi.org/10.1002/bdm.2253

Hudson, A., Hall, P. A., Hitchman, S. C., Meng, G., & Fong, G. T. (2022). Cognitive predictors of vaccine hesitancy and COVID-19 mitigation behaviors in a population representative sample. *medRxiv*. https://doi.org/10.1101/2022.01.02.22268629

Hult Khazaie, D., & Khan, S. S. (2020). Shared social identification in mass gatherings lowers health risk perceptions via lowered disgust. *British Journal of Social Psychology*, *59*(4), 839-856. https://doi.org/10.1111/bjso.12362

Johnson, M. W., & Bickel, W. K. (2008). An algorithm for identifying nonsystematic delay-discounting data. *Experimental and Clinical Psychopharmacology*, *16*(3), 264-274. https://doi.org/10.1037/1064-1297.16.3.264

Kabamba Nzaji, M., Ngoie Mwamba, G., Mbidi Miema, J., Kilolo Ngoy Umba, E., Kangulu, I. B., Banza Ndala, D. B., Ciamala Mukendi, P., Kabila Mutombo, D., Balela Kabasu, M. C., Kanyki Katala, M., Kabunda Mbala, J., & Luboya Numbi, O. (2020). Predictors of non-adherence to public health instructions during the COVID-19 pandemic in the Democratic Republic of the Congo. *Journnal of Multidisciplinary Healthcare*, *13*, 1215-1221. https://doi.org/10.2147/jmdh.S274944

Kandel, D. B. (1978). Homophily, selection, and socialization in adolescent friendships. *The American Journal of Sociology*, *84*(2), 427-436. https://doi.org/10.1086/226792

Kaplan, B., Reed, D., & McKerchar, T. (2014). Using a visual analogue scale to assess delay, social, and probability discounting of an environmental loss. *The Psychological Record*, *64*(2), 261-269. https://doi.org/10.1007/s40732-014-0041-z

Kessler, L., Hewig, J., Weichold, K., Silbereisen, R. K., & Miltner, W. H. (2017). Feedback negativity and decision-making behavior in the Balloon Analogue Risk Task (BART) in adolescents is modulated by peer presence. *Psychophysiology*, *54*(2), 260-269. https://doi.org/10.1111/psyp.12783

Kiuru, N., Burk, W. J., Laursen, B., Salmela-Aro, K., & Nurmi, J.-E. (2010). Pressure to drink but not to smoke: Disentangling selection and socialization in adolescent peer networks and peer groups. *Journal of Adolescence*, *33*(6), 801-812. https://doi.org/10.1016/j.adolescence.2010.07.006

Kühberger, A., Schulte-Mecklenbeck, M., & Perner, J. (2002). Framing decisions: Hypothetical and real. *Organizational Behavior and Human Decision Processes*, *89*(2), 1162-1175. https://doi.org/10.1016/S0749-5978(02)00021-3

Leonard, K. E., & Mudar, P. (2003). Peer and partner drinking and the transition to marriage: A longitudinal examination of selection and influence processes. *Psychology of Addictive Behaviors*, *17*, 115-125. https://doi.org/10.1037/0893-164X.17.2.115

Leonard, K. E., & Mudar, P. (2004). Husbands' influence on wives' drinking: Testing a relationship motivation model in the early years of marriage. *Psychology of Addictive Behaviors*, *18*(4), 340-349. https://doi.org/10.1037/0893-164X.18.4.340

Litman, L., Robinson, J., & Abberbock, T. (2017). TurkPrime.com: A versatile crowdsourcing data acquisition platform for the behavioral sciences. *Behavior Research Methods*, *49*(2), 433-442. https://doi.org/10.3758/s13428-016-0727-z

Lloyd, A., McKay, R., Hartman, T. K., Vincent, B. T., Murphy, J., Gibson-Miller, J., Levita, L., Bennett, K., McBride, O., Martinez, A. P., Stocks, T. V. A., Vallières, F., Hyland, P., Karatzias, T., Butter, S., Shevlin, M., Bentall, R. P., & Mason, L. (2021). Delay discounting and under-valuing of recent information predict poorer adherence to social distancing measures during the COVID-19 pandemic. *Scientific Reports*, *11*(1). https://doi.org/10.1038/s41598-021-98772-5

Locey, M. L., Jones, B. A., & Rachlin, H. (2011). Real and hypothetical rewards in self-control and social discounting. *Judgment and Decision Making*, *6*(6), 522-564.

Lonardo, R. A., Giordano, P. C., Longmore, M. A., & Manning, W. D. (2008). Parents, friends, and romantic partners: Enmeshment in deviant networks and adolescent delinquency involvement. *Journal of Youth and Adolescence*, *38*(3), 367-383. https://doi.org/10.1007/s10964-008-9333-4

Madden, G. J., Begotka, A. M., Raiff, B. R., & Kastern, L. L. (2003). Delay discounting of real and hypothetical rewards. *Experimental and Clinical Psychopharmacology*, *11*(2), 139-145. https://doi.org/10.1037/1064-1297.11.2.139

Mamerow, L., Frey, R., & Mata, R. (2016). Risk taking across the life span: A comparison of self-report and behavioral measures of risk taking. *Psychology and Aging*, *31*(7), 711-723. https://doi.org/10.1037/pag0000124

Mares, S. H., van der Vorst, H., Engels, R. C., & Lichtwarck-Aschoff, A. (2011). Parental alcohol use, alcohol-related problems, and alcohol-specific attitudes, alcohol-specific communication, and adolescent excessive alcohol use and alcohol-related problems: An indirect path model. *Addictive Behaviors*, *36*(3), 209-216. https://doi.org/10.1016/j.addbeh.2010.10.013

Mazur, J. E. (1987). An adjusting procedure for studying delayed reinforcement. In M. L. Commons, J. E. Mazur, J. A. Nevin, & H. Rachlin (Eds.), *Quantitative analyses of behavior: The effect of delay and of intervening events on reinforcement value.* (Vol. 5, pp. 55-73). Erlbaum.

McCoy, S. S., Dimler, L. M., Samuels, D. V., & Natsuaki, M. N. (2017). Adolescent susceptibility to deviant peer pressure: Does gender matter? *Adolescent Research Review*, *4*(1), 59-71. https://doi.org/10.1007/s40894-017-0071-2

McDonald, R. I., & Crandall, C. S. (2015). Social norms and social influence. *Current Opinion in Behavioral Sciences*, *3*, 147-151. https://doi.org/10.1016/j.cobeha.2015.04.006

McKerchar, T. L., Green, L., Myerson, J., Pickford, T. S., Hill, J. C., & Stout, S. C. (2009). A comparison of four models of delay discounting in humans. *Behavioural Processes*, *81*(2), 256-259. https://doi.org/10.1016/j.beproc.2008.12.017

Montinari, N., & Rancan, M. (2018). Risk taking on behalf of others: The role of social distance. *Journal of Risk and Uncertainty*, *57*, 81-109.

Morgenroth, T., Fine, C., Ryan, M. K., & Genat, A. E. (2017). Sex, drugs, and reckless driving: Are measures biased toward identifying risk-taking in men? *Social Psychological and Personality Science*, *9*(6), 744-753. https://doi.org/10.1177/1948550617722833

Myerson, J., & Green, L. (1995). Discounting of delayed rewards: Models of individual choice. *Journal of the Experimental Analysis of Behavior*, *64*(3), 263-276.

Nese, M., Riboli, G., Brighetti, G., Sassi, V., Camela, E., Caselli, G., Sassaroli, S., & Borlimi, R. (2022). Delay discounting of compliance with containment measures during the COVID-19 outbreak: A survey of the Italian population. *Journal of Public Health*, *30*(2), 503-511. https://doi.org/10.1007/s10389-020-01317-9

Nivette, A., Ribeaud, D., Murray, A., Steinhoff, A., Bechtiger, L., Hepp, U., Shanahan, L., & Eisner, M. (2021). Non-compliance with COVID-19-related public health measures among young adults in Switzerland: Insights from a longitudinal cohort study. *Social Science & Medicine*, *268*. https://doi.org/10.1016/j.socscimed.2020.113370

O'Brien, L., Albert, D., Chein, J., & Steinberg, L. (2011). Adolescents prefer more immediate rewards when in the presence of their peers. *Journal of Research on Adolescence*, *21*(4), 747-753. https://doi.org/10.1111/j.1532-7795.2011.00738.x

Padrón, I., Rodrigo, M. J., & De Vega, M. (2016). Feedback on health status and peer popularity influences social risk decision-making processes in adolescents and young adults. *European Journal of Developmental Psychology*, *13*(2), 241-253. https://doi.org/10.1080/17405629.2015.1089769

Pollak, Y., Dayan, H., Shoham, R., & Berger, I. (2020). Predictors of non-adherence to public health instructions during the COVID-19 pandemic. *Psychiatry and Clinical Neurosciences*, *74*(11), 602-604. https://doi.org/10.1111/pcn.13122

Prosser, A. M. B., Judge, M., Bolderdijk, J. W., Blackwood, L., & Kurz, T. (2020). 'Distancers' and 'non-distancers'? The potential social psychological impact of moralizing COVID-19 mitigating practices on sustained behaviour change. *British Journal of Social Psychology*, *59*(3), 653-662. https://doi.org/10.1111/bjso.12399

Rachlin, H. (2006). Notes on discounting. *Journal of The Experimental Analysis of Behavior*, *85*(3), 425-435. https://doi.org/10.1901/jeab.2006.85-05

Rachlin, H., & Jones, B. A. (2008). Social discounting and delay discounting. *Journal of Behavioral Decision Making*, *21*(1), 29-43. https://doi.org/10.1002/bdm.567

Reniers, R. L. E. P., Murphy, L., Lin, A. B., SP, & Wood, S. J. (2016). Risk perception and risk-taking behaviour during adolescence: The influence of personality and gender. *PLoS One*, *11*(4). https://doi.org/10.1371/journal.pone.0153842

Robertson, S. H., & Rasmussen, E. B. (2018). Comparison of potentially real versus hypothetical food outcomes in delay and probability discounting tasks. *Behavioural Processes*, *149*, 8-15. https://doi.org/10.1016/j.beproc.2018.01.014

Salvy, S.-J., Jarrin, D., Paluch, R., Irfan, N., & Pliner, P. (2007). Effects of social influence on eating in couples, friends and strangers. *Appetite*, *49*(1), 92-99. https://doi.org/10.1016/j.appet.2006.12.004

Sargisson, R. J., Ankoné, B. A. H., Dijkhuis, M., Eilers, H., Moser, E., Philipp, A. J., & Syafika, A. (2021). By-and-Buy: The effect of social influence on discounting of environmental outcomes. *Sustainability and Climate Change*, *14*(4), 217-226. https://doi.org/10.1089/scc.2021.0003

Sargisson, R. J., & Schöner, B. V. (2020). Hyperbolic discounting with environmental outcomes across time, space, and probability. *The Psychological Record*, *70*(3), 515-527. https://doi.org/10.1007/s40732-019-00368-z

Schlager, T., & Whillans, A. V. (2022). People underestimate the probability of contracting the coronavirus from friends. *Humanities and Social Sciences Communications*, *9*(1), 59. https://doi.org/10.1057/s41599-022-01052-4

Smith, A. R., Chein, J., & Steinberg, L. (2014). Peers increase adolescent risk taking even when the probabilities of negative outcomes are known. *Developmental Psychology*, *50*(5), 1564-1568. https://doi.org/10.1037/a0035696

Smith, L. E., Amlôt, R., Lambert, H., Oliver, I., Robin, C., Yardley, L., & Rubin, G. J. (2020a). Factors associated with adherence to self-isolation and lockdown measures in the UK; a cross-sectional survey. *medRxiv*. https://doi.org/10.1101/2020.06.01.20119040

Smith, L. E., Mottershaw, A. L., Egan, M., Waller, J., Marteau, T. M., & Rubin, G. J. (2020b). The impact of believing you have had COVID-19 on behaviour: Cross-sectional survey. *medRxiv*. https://doi.org/10.1101/2020.04.30.20086223

Steca, P., Adorni, R., Greco, A., Zanatta, F., Fattirolli, F., Franzelli, C., Giannattasio, C., & D'Addario, M. (2022). Impulsivity assessed ten years earlier and sociodemographic factors predict adherence to COVID-19 related behavioral restrictions in old individuals with hypertension. *BMC Public Health*, *22*(1), 185. https://doi.org/10.1186/s12889-022-12624-z

Steens, A., Freiesleben de Blasio, B., Veneti, L., Gimma, A., Edmunds, W. J., Van Zandvoort, K., Jarvis, C. I., Forland, F., & Robberstad, B. (2020). Poor self-reported adherence to COVID-19-related quarantine/isolation requests, Norway, April to July 2020. *Eurosurveillance*, *25*(37), 2001607. https://doi.org/10.2807/1560-7917.ES.2020.25.37.2001607

Stone, E. R., & Allgaier, L. (2008). A social values analysis of self–other differences in decision making involving risk. *Basic and Applied Social Psychology*, *30*(2), 114-129. https://doi.org/10.1080/01973530802208832

Strickland, J. C., Reed, D. D., Hursh, S. R., Schwartz, L. P., Foster, R. N. S., Gelino, B. W., LeComte, R. S., Oda, F. S., Salzer, A. R., Schneider, T. D., Dayton, L., Latkin, C., & Johnson, M. W. (2022). Behavioral economic methods to inform infectious disease response: Prevention, testing, and vaccination in the COVID-19 pandemic. *PLoS One, 17*(1). https://doi.org/10.1371/journal.pone.0258828

Stuifbergen, M. C., & van Delden, J. J. M. (2010). Filial obligations to elderly parents: A duty to care? *Medicine, Health Care and Philosophy, 14*(1), 63-71. https://doi.org/10.1007/s11019-010-9290-z

Tunçgenç, B., El Zein, M., Sulik, J., Newson, M., Zhao, Y., Dezecache, G., & Deroy, O. (2021). Social influence matters: We follow pandemic guidelines most when our close circle does. *British Journal of Psychology*, *112*(3), 763-780. https://doi.org/10.1111/bjop.12491

van Bavel, J. J., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., Crockett, M. J., Crum, A. J., Douglas, K. M., Druckman, J. N., Drury, J., Dube, O., Ellemers, N., Finkel, E. J., Fowler, J. H., Gelfand, M., Han, S., Haslam, S. A., Jetten, J., . . . Willer, R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*, *4*(5), 460-471. https://doi.org/10.1038/s41562-020-0884-z van Hoorn, J., Crone, E. A., & Van Leijenhorst, L. (2017). Hanging out with the right crowd: Peer influence on risk-taking behavior in adolescence. *Journal of Research on Adolescence*, *27*(1), 189-200. https://doi.org/10.1111/jora.12265

van Leijenhorst, L., Westenberg, P. M., & Crone, E. A. (2008). A developmental study of risky decisions on the Cake Gambling Task: Age and gender analyses of probability estimation and reward evaluation. *Developmental Neuropsychology*, *33*(2), 179-196. https://doi.org/10.1080/87565640701884287

Webster, R. K., Brooks, S. K., Smith, L. E., Woodland, L., Wessely, S., & Rubin, G. J. (2020). How to improve adherence with quarantine: Rapid review of the evidence. *Public Health*, *182*, 163-169. https://doi.org/10.1016/j.puhe.2020.03.007

Williams, S. N., Armitage, C. J., Tampe, T., & Dienes, K. (2020). Public perceptions and experiences of social distancing and social isolation during the COVID-19 pandemic: A UK-based focus group study. *BMJ Open*, *10*(7). https://doi.org/10.1136/bmjopen-2020-039334

Windle, M., & Windle, R. C. (2018). A prospective study of mutual influence for substance use among young adult marital dyads. *Psychology of Addictive Behaviors*, *32*(2), 237-243. https://doi.org/10.1037/adb0000329

Wismans, A., Letina, S., Wennberg, K., Thurik, R., Baptista, R., Burke, A., Dejardin, M., Janssen, F., Santarelli, E., Torrès, O., & Franken, I. (2021). The role of impulsivity and delay discounting in student compliance with COVID-19 protective measures. *Personality and Individual Differences*, *179*. https://doi.org/10.1016/j.paid.2021.110925

Wolf, L. J., Haddock, G., Manstead, A. S. R., & Maio, G. R. (2020). The importance of (shared) human values for containing the COVID-19 pandemic. *British Journal of Social Psychology*, *59*(3), 618-627. https://doi.org/10.1111/bjso.12401

World Health Organization. (2020a). *Modes of transmission of virus causing COVID-19: Implications for IPC precaution recommendations: Scientific brief, 29 March 2020.* https://apps.who.int/iris/handle/10665/331616

World Health Organization. (2020b, March 11). *WHO Director-General's opening remarks at the media briefing on COVID-19 – 11 March 2020* [Press Release]. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

Yurasek, A. M., Brick, L., Nestor, B., Hernandez, L., Graves, H., & Spirito, A. (2018). The effects of parent, sibling and peer substance use on adolescent drinking behaviors.

Journal of Child and Family Studies, *28*(1), 73-83. https://doi.org/10.1007/s10826-018-1251-9

Ziegler, F. V., & Tunney, R. J. (2012). Decisions for others become less impulsive the further away they are on the family tree. *PLoS One*, *7*(11). https://doi.org/10.1371/journal.pone.0049479

Chapter 5
General Discussion

As impulsive and risky decision-making have been associated with gambling (Mishra et al., 2010), dangerous or distracted driving (Iversen, 2004; Walshe et al., 2021), and substance abuse (Feldstein & Miller, 2006), we aimed to investigate factors that increased the likelihood of harmful risky choices, such as peers, age, and gender. Specifically, we wanted to understand the differences between the effects of peer presence and peer influence, the effects of positive and negative peer influence, and how the type of peer affects risk-taking. The findings from the series of studies conducted for this thesis are integrated and discussed below.

The Effect of Peers on Decision-making

In previous literature, the term "peers" has been synonymous with friends, but we were curious as to whether peer influence, or more broadly social influence, extended beyond friends, and whether other social contacts would affect decision-making similarly to the way friends do. In Study 3.1, we investigated risk-taking behaviour (risking a fine for breaking lockdown during a viral pandemic) when negatively influenced by friends, partners, or parents. Our results showed risk-taking was lowest for friends, and that participants were more influenced by partners or parents. Previous research has indicated that decision-making differs in the presence of people from different types of relationships (Salvy et al., 2007), or for people of varied degrees of closeness (Montinari & Rancan, 2018; Ziegler & Tunney, 2012). Furthermore, parents and partners affect risk-taking (Carter et al., 2014; Casswell et al., 2002; Homish & Leonard, 2008; Homish et al., 2007; Leonard & Mudar, 2003, 2004; Mares et al., 2011; Windle & Windle, 2018). However, little research had compared influences from partners, parents, and friends on adults.

Our results showed that whether people were more influenced by parents or partners was dependent on the situation described in the scenario. It may be that people perceive greater value in risk-taking for parents or partners, compared to friends. People may spend more time with their partners in usual circumstances, compared to friends and parents, therefore, perceived the act of distancing from them during a pandemic to be much more difficult, and seeing them to be more rewarding. Greater risk-taking for parents may be explained by the parents' age, health concerns, or familial obligations. A persons' parents are likely to be older than their partner, and therefore an injury may be perceived as more severe than an injury for a partner.

Furthermore, parents may have fewer people to provide support to them, and adult children may feel obligated to care for those who raised them (Stuifbergen & van Delden, 2010). Finding that people took fewer risks for friends, and more risks for their parents and partners, means researchers should consider different potential sources of influence. Therefore, studies of peer influence should be broadened to include other social contacts, and understood more generally as the influence of others, as friends are not the only type of social contact that affect decision-making.

Is Peer Presence the Same as Peer Influence?

In the peer-influence literature, peer presence and peer influence are often used interchangeably. In some studies, influence is assumed by peer presence (e.g., O'Brien et al., 2011; Weigard et al., 2014), whereas in other studies, peers provide an opinion that influences the choice (e.g., Gilman et al., 2014). We wanted to explore whether decision-making differed in the presence of peers, and understand whether there was a difference between the effect of peer presence and peer influence on decision-making. Our studies demonstrated that negative peer influence (encouraging risk-taking) increased risk-taking behaviour beyond that of peer presence, meaning there is a difference in the effect that peer presence and peer influence have on risk-taking.

To investigate whether there was a difference between peer presence and peer influence, we provided participants with a description of scenarios where the participant was alone, with their best friend (peer presence), and then experiencing negative peer influence, where their friend encouraged them to choose the riskier option. Across both Studies 2.1 and 2.2, when comparing these three conditions (peer absence, peer presence, and negative peer influence), we had two main findings.

The first finding was that risk-taking in the peer-absent condition was significantly lower than in both the peer-present and negative peer-influence conditions. The findings from both Studies 2.1 and 2.2 were consistent with previous literature showing peer presence (e.g., O'Brien et al., 2011; A. R. Smith et al., 2014; Weigard et al., 2014), and negative peer influence (through providing a risk-promoting opinion) increased risk-taking (e.g., Gilman et al., 2014; Haddad et al., 2014; van Hoorn et al., 2017).

Second, although we found that peers affect risk-taking in both peer conditions, there was a difference between the effects that peer presence and peer influence had on risk-taking. Risk-taking was greater in the peer-present condition compared to the absence of peers, however, risk-taking in the peer-present condition was significantly lower than that in the negative peer-influence condition.

Studies 2.1 and Study 2.2 produced consistent results. Given the consistency in findings in two studies, we conclude that risk-taking is affected by peer presence, albeit the effect of peer influence is significantly greater than that of peer presence. Therefore, the results of these studies show peers affect risk-taking behaviour, however, since there are differences between the effect of peer presence and peer influence, it is important that peer influence is clearly defined in future research. Furthermore, campaigns that aim to reduce harmful risk-taking behaviour should also include ways to counter passive peer influence from present peers.

Positive Versus Negative Influence

We also examined how people responded to positive peer influence. While it was known that peers may reduce risk-taking behaviour in some circumstances (e.g., Bingham et al., 2016; Cascio et al., 2015; Simons-Morton et al., 2014; Tomova & Pessoa, 2018), we thought it would be useful to contrast positive peer influence (a risk-averse opinion) with negative peer influence (a risk-promoting opinion). Study 2.2 included a positive peer-influence condition, alongside peer absence, peer presence, and negative peer influence. Our participants made riskier choices when provided with a risk-promoting opinion, and safer choices when provided with a risk-averse opinion. Furthermore, positive peer influence lowered risk-taking behaviour beyond that of peer absence in two of the three scenarios. Therefore, our results demonstrate that peers can also have a protective effect against risk-taking behaviour.

Only a limited number of studies have examined risk-taking under both positive and negative peer influence (see Tomova & Pessoa, 2018). Most of the comparisons made between positive and negative peer influence have examined the effects on driving behaviours (e.g., Bingham et al., 2016; Cascio et al., 2015; Simons-Morton et al., 2014), with either a risk-promoting or risk-averse peer. Our studies built on and extended Tomova and Pessoa's (2018) study by demonstrating that positive peer influence could also be observed in other types of risk-taking. Tomova and Pessoa (2018) used the BART, whereas, we used novel scenarios which covered a range of risks people may experience, in areas such as their career, health, and recreational activities.

We showed that peers can reduce risk-taking behaviour if they provide positive peer influence by discouraging risk-taking behaviour. Furthermore, as the presence of peers is associated with greater risk-taking behaviour, present peers may be able to counter the harmful effects of their presence by intervening and promoting safer choices. Therefore, it is important researchers clarify what is meant by peer influence (present peers or peers who provide a direct opinion), and distinguish whether the influence is positive (e.g., risk-averse advice) or negative (e.g., risk-promoting). Additionally, it is important that the potential harmful effects of present peers are more widely understood, as well as how to combat harmful risk-taking by speaking-up. People should be encouraged to provide risk-averse advice to prevent harmful risk-taking behaviour, such as delinquency, drink-driving, or substance abuse.

Social Proximity of Peers

We were interested in whether closeness of the relationship was an important factor in socially influenced risk-taking. Thus, Study 3.2 examined whether there were differences in risk-taking under the influence of social contacts with varying degrees of closeness, by combining elements of social and probability discounting. We found that discounting systematically differed based on the closeness of the relationship, with people taking greater risks for those they were closer to, and fewer risks for those they were less close to. We observed an interaction effect between closeness and probability (likelihood of receiving a fine), which showed when the risk of the fine was lower and requests came from a closer social contact, participants were more inclined to take risks, but when the risk of the fine was higher and requests came from a more distant social contact, they were less likely to take risks.

Our results were consistent with those of Foreman et al. (2019) and Strickland et al. (2022) who found risk-taking differed by social proximity. People were more influenced by those closest to them, suggesting that people take risks based on the closeness of the relationship they have with the peer, rather than the type of relationship. Therefore, the wider social network of contacts, including close friends and family should be considered when aiming to reduce an individual's harmful risk-taking behaviour. Furthermore, in a pandemic, it may be useful to emphasise the risks of transmission of a virus between friends and family, rather than strangers in public-health messaging. The results of these studies together illustrate that people are influenced by others, not just friends, and people are more influenced by those with whom they have a closer relationship. The degree of closeness affects the degree of influence of that person within the social environment.

Age

We also examined the effects of age on decision-making within our programme of research. Overall, findings from four of the five studies showed younger people exhibit greater risk-taking, at least in some conditions. The four studies that showed a relationship between age and discounting were Studies 1, 2.1, 2.2, and 3.2. In Study 1, the relationship between age and delay discounting depended on the measure of discounting behaviour. There was a weak relationship between age and AUC values, showing young people exhibited more impulsive behaviour, however no relationship was observed between age and discount rates calculated by Rachlin's (2006) equation. In Study 2.1 (comparing peer absence, peer presence, and negative peer influence), younger age was associated with greater risk-taking across conditions for the food scenario, but the relationship between age and risk-taking was not significant for the other two scenarios. In Study 2.2 (where positive peer influence was included), younger age was associated with greater risk-taking in the majority of conditions and scenarios. The results of Study 3.2 (comparing social influence by closeness) showed younger age was associated with greater risk-taking for closer contacts (e.g., social contacts #1 and #10) across the scenarios, but not more distant social contacts.

Study 3.1 (comparing social influence across relationship type) showed there was no relationship between age and risk-taking. Further to not observing a consistent relationship between age and delay-discounting behaviour, in Study 1, we also examined the relationship between age and self-reported measures of impulsivity and sensation-seeking and found that age was not correlated with scores on the BIS-11 or BSSS, which is also inconsistent with prior research (e.g., Forrest et al., 2019; Roth et al., 2005; Steinberg et al., 2008; Steinberg et al., 2018). However, low variation in age of the participants within the sample may have reduced the correlation coefficient between variables. As previous research has indicated that adolescents are more impulsive than adults (e.g., de Water et al., 2014; Green et al., 1994; Steinberg et al., 2009), perhaps the relationship between age and discounting was inconsistent across measures as participants in our sample were mostly over 18 years old, limiting the range of ages within the study's sample.

Although we observed no relationship between age and impulsivity, we did observe a relationship between age and risk-taking in the studies examining the differences between peer presence and peer influence (Studies 2.1 and 2.2), and social closeness (Study 3.2). In Studies 2.1 and 2.2, risk-taking was compared under different peer conditions (peer absence, peer presence, negative peer influence, and positive peer influence), and in Studies 3.1 and 3.2, all hypothetical risks were taken under the influence of others. Therefore, it is difficult to compare the findings of these conditions with those from previous literature, as there is limited research on age differences in risk-taking under the influence of others.

Examining the relationship between age and discounting in the absence of peers, the results of Study 2.1 showed that younger participants had higher discount rates in the food scenario. There was no relationship between age and discounting for the peer-absent conditions of the meeting and car scenarios. As the findings were inconsistent across the scenarios in Study 2.1, our results were mostly inconsistent with the previous literature indicating younger participants take more risks (de Water et al., 2014; Green et al., 1994; Steinberg et al., 2009). In Study 2.2, discounting in the peer-absent condition was correlated with age for all scenarios, again showing younger participants discounted more steeply, therefore exhibiting greater risk-taking. In Study 2.2, the relationship between the discount rate and age was weaker for peer absence, compared to those in the peer-presence, or positive or negative peer-influence conditions. This finding provides support for age being a contributing factor on the effect of peers on risk-taking, as stronger relationships between age and risk-taking in the peer conditions (peer presence, negative peer influence, and positive peer influence) may mean that younger people are more susceptible to the effects of peers on risk-taking. These findings are consistent with the findings of Gardner and Steinberg (2005), who examined the effects of peer influence on a risk-taking task across adolescents, youths, and adults. They found that adults (24 and over) were less susceptible to peer influence than adolescents (aged 13-16) and youths (aged 18-22; Gardner & Steinberg, 2005). Young people are more sensitive to outcomes and social consequences, and therefore have a greater likelihood of taking risks compared to adults (Gardner & Steinberg, 2005; Shulman et al., 2016; Steinberg & Calkins, 2010; Steinberg & Monahan, 2007).

Studies have shown that older people generally take fewer risks (Defoe et al., 2015; Defoe et al., 2019; Gardner & Steinberg, 2005; Mamerow et al., 2016; Reyna & Farley, 2006). Thus, a surprising finding was that in the medical scenario of Study 3.1, for the parent condition, older participants exhibited greater risk-taking. We theorise that this incongruent finding could be related to the scenario. The scenarios used were based around a viral outbreak, and in the medical scenario and condition, the parent was injured and needed their child to break the lockdown and take them to the medical centre. We overall saw greater risk-taking in the medical scenario compared to the visit or garden scenarios, a finding that may be attributed to higher perceived social consequences; either positive if they do take the risk, or a more severe social consequence if they turn down the request for help. One reason that older people took greater risks in the parent condition could be that their parents are likely to be older, and perhaps the injury was perceived as more serious, or to have more significant detrimental effects to health and wellbeing. Although, we did specify that the parents age was under 60 years, to try to eliminate individual differences in responding to this scenario, we considered if participants still contemplated the age of their parents in the hypothetical scenario. Therefore, as this finding differs to previous research, we question whether the relationship between risk-taking does not decrease with age, or if it does, only under certain circumstances.

Gender

Men report higher levels of impulsivity than women, and are over-represented in statistics for impulsive behaviour such as delinquency, reckless driving, aggression, and substance use (Bener, 2013; Burton et al., 2007; Chen & Jacobson, 2012; Cross, 2010; Cross et al., 2011; Harris et al., 2006; Stoltenberg et al., 2008). Therefore, we expected to find gender differences in impulsivity, risk-taking, and sensation-seeking between men and women. We found risk-taking was more similar between men and women, than different, and so too was susceptibility to the influence of others. Overall, across the five studies, we only found gender differences in two studies.

In the two studies that did show differences in risk-taking between men and women, the differences were not consistent across the scenarios or conditions. In Study 2.2 (where positive peer influence was included), there was a difference in the discount rates of the negative peer-influence condition in just one of the three scenarios. In Study 3.2 (closeness), we found men took more risks for one scenario type (birthday), but not the other two. Even in these two studies, men did not consistently show higher rates of risk-taking compared to women. We found no gender differences in Study 1 (using delay discounting) in discounting behaviour, BSSS total scores, or BIS-11 total scores. We also found no gender differences in Studies 2.1 (comparing peer absence, peer presence and negative peer influence) and 3.1 (comparing social influence across relationship type).

Previous studies examining gender differences in impulsivity have been contradictory (see Cross et al., 2011). Our findings from Study 1 were consistent with past literature that found no differences in men and women on the delay-discounting task (Cross et al., 2011; Reynolds et al., 2004; Weafer & de Wit, 2014). Furthermore, the findings from the self-report measures were consistent with previous literature that found no gender differences on the BIS-11 (J. H. Patton et al., 1995; Reynolds et al., 2006; Vasconcelos et al., 2014), however, these findings are inconsistent with those of Cross et al. (2011), Rosenblitt et al. (2001), and

Stoltenberg et al. (2008), who found higher scores for men for impulsivity and sensation-seeking.

As most of our conditions across our studies involved the presence or influence of peers, and we did not find that the discount rates of men and women differed, our results suggest that men are no more susceptible to the influence of others compared to women. This finding is also inconsistent with previous literature, which indicates that men are more susceptible to peer influence (de Boer et al., 2016; Defoe et al., 2020). The difference between our findings and those of de Boer et al. (2016) and Defoe et al. (2020), may be due to differences in the ages of the samples and the scenarios used in our studies. McCoy et al. (2017) reported that only half of the literature they reviewed showed gender differences in susceptibility to peer influence. We consider whether young men are more susceptible to peer influence than adult men, and whether, because our samples were adults, we did not observe differences in susceptibility between men and women.

As risk-taking was more similar between men and women than different, our results differ from previous literature that has found that men generally take more risks than women (Bener, 2013; de Boer et al., 2016; Dohmen et al., 2011; Gardner & Steinberg, 2005). There is some evidence to suggest that women discount hypothetical outcomes more steeply than real outcomes (see Kirby & Maraković, 1995; Weafer & de Wit, 2014), which may be a factor in our studies, as we used hypothetical outcomes. Differences between gender in risk-taking are perhaps also sensitive to the type of risk-taking measured (McCoy et al., 2017; Morgenroth et al., 2017; Rolison & Shenton, 2020). In Studies 2.1 (comparing peer absence, peer presence, and negative peer influence) and 2.2 (inclusion of positive peer influence), our scenarios were based upon career, health, and recreation. In Studies 3.1 (relationship type) and 3.2 (closeness), our scenarios were based on breaking lockdown in a viral outbreak situation (similar to what people were experiencing with COVID-19), and potentially getting a fine. Therefore, the hypothetical nature of the scenarios, or the content of the scenarios, may explain why men and women discounted similarly in our studies.

Strengths and Weaknesses

Our studies are not without limitations. As previously mentioned, we had a small sample size and men were under-represented in our sample in Study 1, so for subsequent studies we recruited participants using mTurk. Although mTurk is an efficient way to access a willing sample, there have been some concerns regarding using opt-in panels as people may not meet certain eligibility criteria, users may be distracted or dishonest, or not be representative of the general population (Hays et al., 2015; Mellis & Bickel, 2020). However, conventionally collected samples in applied psychology research are also unlikely to represent the general population (see Walter et al., 2019). As we examined how different social influences affected an individual's discounting, and we did not compare the rates of discounting under these conditions to discounting behaviour in the wider population, using an opt-in panel such as mTurk was an appropriate for these studies. We were also reassured that data from our studies followed typical discounting patterns, indicating as the likelihood to receiving the fine increased, the likelihood of taking the risk decreased.

In Studies 3.1 and 3.2, we found that the rates of participants who did not discount was higher than what is commonly seen in delay and probability discounting research (see K. R. Smith et al., 2018). Common practice when analysing discounting data means researchers either ignore non-systematic discounting data (e.g., data that does not show systematic decreases over the changes in the discounting variable), or will apply criteria to identify non-systematic discounting data and potentially remove these individuals from the dataset (K. R. Smith et al., 2018). We applied a less conservative approach than applying Johnson and Bickel (2008)'s algorithm, for identifying non-systematic discounters, and removing the individuals from analyses. We retained all individuals with complete datasets in the analyses, instead changing the *k* values to zero if the participant did not discount the outcome (see methods), an approach used by Sargisson et al. (2021). A meta-analysis conducted by K. R. Smith et al. (2018) found that almost 20% of data could be deemed as non-systematic by using Johnson and Bickel (2008)'s algorithm. However, the percentage of non-systematic discounters in a sample may vary on sample characteristics, such as how and where from the sample was obtained (Neff & Macaskill, 2021). Although identifying non-systematic data is a common practice, the process for dealing with non-systematic data is inconsistent across researchers (K. R. Smith et al., 2018). Furrebøe (2020) examined those who did not discount across two discounting tasks, one for gains and one for losses, and found that rates of discounting were inconsistent across the tasks; some participants who discounted gains, did not discount for losses which indicated that not discounting is a valid response, and that the person is making a conscious choice not to discount under certain circumstances. In our scenarios, we considered choosing not to discount was a valid response. Participants may not want to take the risk, regardless of the likelihood of receiving the fine, or considered other unspecified outcomes such as disease risk, hence we chose to include data from participants who did not discount in our analyses.

Additionally, we used hypothetical scenarios and outcomes, as it would have been unethical to expose participations to harmful outcomes. Previous studies have shown that participants make decisions under hypothetical conditions that are similar to those made for real outcomes (Horn & Freund, 2021; Kühberger et al., 2002; Locey et al., 2011; Madden et al., 2003; Robertson & Rasmussen, 2018). The use of hypothetical outcomes is becoming more popular for decision-making research, where real outcomes may be impractical or unethical (e.g., Berry et al., 2017; Hardisty & Weber, 2009; Kaplan et al., 2014; Sargisson & Schöner, 2020; Weatherly & Ruthig, 2013). As the main aim of these studies was to examine the effect of peers on decision-making, the use of hypothetical scenarios allowed us to describe a hypothetical social environment for decision-making to occur within. The consistency between the findings from Studies 2.1 and 2.2, between the three common conditions (peer absence, peer presence, and negative peer influence), provide support for the reliability of our data.

The use of hypothetical scenarios was also a strength of our research, as the scenarios portrayed real risk-taking experiences that participants may face. Bran and Vaidis (2020) provides a good summary into how risk-taking should be measured in research. Risk-taking measures should be realistic, to capture a more accurate view of projected behaviour in hypothetical choice (Bran & Vaidis, 2020). They also state that the subjectivity of risk-taking should be accounted for in the measurement of risk-taking (Bran & Vaidis, 2020). Across our three scenarios, although the subject matter differed, the scenarios could result in a considerable loss for all our participants. Furthermore, no amount of skill or experience would provide an advantage for making the decision within the scenarios. These two aspects of the scenarios limited the subjectivity of the risk-taking between participants. Our scenarios also measured both active and passive risk-taking, where inaction leads to a riskier choice than action (Bran & Vaidis, 2020). Active risk-taking is more commonly researched than passive risk-taking, as participants are often report either past behaviour, or projected future behaviour in the form of an action (Bran & Vaidis, 2020). For two of the three scenarios (food and car) described in Studies 2.1 and 2.2, the description of the scenario implied that the participant was in a risky situation (having a pizza they were intolerant to and having passed the last gas/petrol station on-route to the concert), and their inaction leaves them vulnerable to the consequences. As many risk-taking measures do not include passive risk-taking, the inclusion of these scenarios was a strength of our research.

Directions for Future Research

The results of Studies 2.1 and 2.2 indicated that the presence of friends affected risk-taking behaviour, therefore, research could be extended by examining whether the presence of other contacts (non-friends) also increase risk-taking. Furthermore, the combination of social and probabilistic discounting methods (Study 3.2) may have wider application in risk-taking for scenarios where social influence is likely to occur, such as risky driving or substance use. In addition, the combination could be used to explore climate-change related decisions based on relationships with current and future family members. Therefore, we suggest future researchers explore whether the finding that people are more influenced by others with whom they have a closer relationship can be generalised to other behaviours. In addition, as the scope of Study 3.2 was limited to negative influence (due to the scenarios), future research also should investigate whether people are more positively influenced by those with whom they have a closer relationship.

Implications for Future Research

The evidence provided from these studies suggest that peer influence needs to be clearly defined in future research. As the effect of peers differs depending on whether the peers are simply present, or provide a risk-promoting or risk-averse opinion, it is important that a clear distinction is made. Furthermore, it should be established that "influence" is not just influence from friends, but more generally "others."

Implications for Risk-taking

As the definition of peers is extended, so should the focus of risk-mitigation strategies. Risk-taking was increased under the influence of partners and parents, so sources of influence that extend beyond friendship should be considered when aiming to reduce harmful risk-taking behaviour in adult populations. Additionally, strategies to reduce harmful risk-taking should incorporate ways to counter passive influence from present others.

The results of these studies collectively lend themselves to understanding how risk-averse social norms may help reduce risk-taking behaviour. Prior research states social norms are more likely to be followed if they are endorsed by a close social contact (Bellato, 2020; Bicchieri et al., 2022; Brechwald & Prinstein, 2011; Tunçgenç et al., 2021; van Bavel et al., 2020), and the results of Study 3.2 showed that risk-taking was greater for those closer social contacts. Therefore, the findings suggest that if the social contact was promoting safer behaviour (such as the positive peer-influence condition described in Study 2.2), risk-averse social contacts may lower risk-taking behaviour beyond baseline (peer absence) rates. Thus it could be useful to encourage present others to promote safer choices, to counter the increased likelihood of risk-taking in their presence or in their absence.

Conclusion

We examined the effects of three factors on decision-making: peers, age, and gender. Our findings illustrate that peers influence risk-taking behaviour, while the effects of age and gender differed across studies. Across the studies presented in this thesis, our findings provided little support that risk-taking was related to age, however, it is possible that younger participants are more affected by the presence and influence of friends. Across our studies, we also found there were more similarities, not differences, in risk-taking between men and women.

These studies increased our understanding of the similarities and differences between peer presence and peer influence. Both peer presence and negative peer influence increased risk-taking, but risk-taking was greater when peers provided direct risk-promoting influence. As risk-promoting peers led to riskier choices being made, peers who provided a risk-averse opinion led to fewer risks, far more than when decisions were made in the absence of peers. Most importantly, peers are broader than just friends; peers also include family and close relations. People are more influenced by people with whom they have a closer relationship. Taken together these findings illustrate that the social environment provides important context that underpins the likelihood of risky choices in decision-making.

References

Ahmed, S., Foulkes, L., Leung, J. T., Griffin, C., Sakhardande, A., Bennett, M., Dunning, D. L., Griffiths, K., Parker, J., Kuyken, W., Williams, J. M. G., Dalgleish, T., & Blakemore, S. J. (2020). Susceptibility to prosocial and antisocial influence in adolescence. *Journal of Adolescence, 84*, 56-68. https://doi.org/10.1016/j.adolescence.2020.07.012

Al-Hasan, A., Yim, D., & Khuntia, J. (2020). Citizens' adherence to COVID-19 mitigation recommendations by the government: A 3-country comparative evaluation using web-based cross-sectional survey data. *Journal of Medical Internet Research*, *22*(8). https://doi.org/10.2196/20634

Albert, D., Chein, J., & Steinberg, L. (2013). The teenage brain: Peer influences on adolescent decision making. *Current Directions in Psychological Science*, *22*(2), 114-120. https://doi.org/10.1177/0963721412471347

Algara, C., Fuller, S., Hare, C., & Kazemian, S. (2021). The interactive effects of scientific knowledge and gender on COVID‐19 social distancing compliance. *Social Science Quarterly*, *102*(1), 7-16. https://doi.org/10.1111/ssqu.12894

Andrews, J. L., Ahmed, S. P., & Blakemore, S. J. (2021). Navigating the social environment in adolescence: The role of social brain development. *Biological Psychiatry*, *89*(2), 109-118. https://doi.org/10.1016/j.biopsych.2020.09.012

Ardern, J. (2020, March 23). *Prime Minister: COVID-19 alert level increased* [Speech]. Beehive.govt.nz. https://www.beehive.govt.nz/speech/prime-minister-covid-19-alert-level-increased

Attema, A. E. (2012). Developments in time preference and their implications for medical decision making. *Journal of the Operational Research Society*, *63*(10), 1388-1399. https://doi.org/10.1057/jors.2011.137

Barr, G. C., Jr., Kane, K. E., Barraco, R. D., Rayburg, T., Demers, L., Kraus, C. K., Greenberg, M. R., Rupp, V. A., Hamilton, K. M., & Kane, B. G. (2015). Gender differences in perceptions and self-reported driving behaviors among teenagers. *Journal of Emergency Medicine*, *48*(3), 366-370 https://doi.org/10.1016/j.jemermed.2014.09.055

Barratt, E. S. (1959). Anxiety and impulsiveness related to psychomotor efficiency. *Perceptual and Motor Skills, 9*, 191–198.

Beck, R. C., & Triplett, M. F. (2009). Test-retest reliability of a group-administered paper-pencil measure of delay discounting. *Experimental and Clinical Psychopharmacology*, *17*(5), 345-355. https://doi.org/10.1037/a0017078

Bellato, A. (2020). Psychological factors underlying adherence to COVID-19 regulations: A commentary on how to promote compliance through mass media and limit the risk of a second wave. *Social Sciences & Humanities Open*, *2*(1). https://doi.org/10.1016/j.ssaho.2020.100062

Bener, A. (2013). The psychological distress and aggressive driving: Age and gender differences in voluntary risk-taking behavior in road traffic crashes. *European Psychiatry*, *28*(S1), 1-1. https://doi.org/10.1016/S0924-9338(13)75901-7

Berry, M., Nickerson, N., & Odum, A. (2017). Delay discounting as an index of sustainable behavior: Devaluation of future air quality and implications for public health. *International Journal of Environmental Research and Public Health*, *14*(9), 997. https://doi.org/10.3390/ijerph14090997

Bicchieri, C., Dimant, E., Gächter, S., & Nosenzo, D. (2022). Social proximity and the erosion of norm compliance. *Games and Economic Behavior*, *132*, 59-72. https://doi.org/10.1016/j.geb.2021.11.012

Bingham, C. R., Simons-Morton, B. G., Pradhan, A. K., Li, K., Almani, F., Falk, E. B., Shope, J. T., Buckley, L., Ouimet, M. C., & Albert, P. S. (2016). Peer passenger norms and pressure: Experimental effects on simulated driving among teenage males. *Transportation Research Part F: Traffic Psychology and Behaviour*, *41*, 124-137. https://doi.org/10.1016/j.trf.2016.06.007

Bixter, M. T., & Rogers, W. A. (2019). Age‐related differences in delay discounting: Immediate reward, reward magnitude, and social influence. *Journal of Behavioral Decision Making*, *32*(4), 471-484. https://doi.org/10.1002/bdm.2124

Blais, A.-R., & Weber, E. U. (2006). A Domain-Specific Risk-Taking (DOSPERT) scale for adult populations. *Judgment and Decision Making*, *1*(1), 33-47.

Blakemore, S.-J. (2018). Avoiding social risk in adolescence. *Current Directions in Psychological Science*, *27*(2), 116-122. https://doi.org/10.1177/0963721417738144

Blauza, S., Heuckmann, B., Kremer, K., & Büssing, A. G. (2021). Psychological distance towards COVID-19: Geographical and hypothetical distance predict attitudes and mediate knowledge. *Current Psychology*, 1-12. https://doi.org/10.1007/s12144-021-02415-x

Bleichrodt, H., Gao, Y., & Rohde, K. I. M. (2016). A measurement of decreasing impatience for health and money. *Journal of Risk and Uncertainty*, *52*(3), 213-231. https://doi.org/10.1007/s11166-016-9240-0

Bonem, E. M., Ellsworth, P. C., & Gonzalez, R. (2015). Age differences in risk: Perceptions, intentions and domains. *Journal of Behavioral Decision Making*, *28*(4), 317-330. https://doi.org/10.1002/bdm.1848

Booth, M. L., Owen, N., Bauman, A., Clavisi, O., & Leslie, E. (2000). Social–cognitive and perceived environment influences associated with physical activity in older Australians. *Preventive Medicine*, *31*(1), 15-22. https://doi.org/10.1006/pmed.2000.0661

Braams, B. R., Davidow, J. Y., & Somerville, L. H. (2019). Developmental patterns of change in the influence of safe and risky peer choices on risky decision-making. *Developmental Science*, *22*(1). https://doi.org/10.1111/desc.12717

Bran, A., & Vaidis, D. C. (2020). Assessing risk-taking: what to measure and how to measure it. *Journal of Risk Research*, *23*(4), 490-503. https://doi.org/10.1080/13669877.2019.1591489

Brechwald, W. A., & Prinstein, M. J. (2011). Beyond homophily: A decade of advances in understanding peer influence processes. *Journal of Research on Adolescence*, *21*(1), 166-179. https://doi.org/10.1111/j.1532-7795.2010.00721.x

Buckley, L., & Foss, M. S. (2012). Protective factors associated with young passenger intervening in risky driving situations. *Journal of Safety Research*, *43*(5-6), 351-356. https://doi.org/10.1016/j.jsr.2012.10.007

Burton, L. A., Hafetz, J., & Henninger, D. (2007). Gender differences in relational and physical aggression. *Social Behavior and Personality*, *35*(1), 41-50. https://doi.org/10.2224/sbp.2007.35.1.41

Byrne, K. A., Six, S. G., Anaraky, R. G., Harris, M. W., & Winterlind, E. L. (2021). Risk-taking unmasked: Using risky choice and temporal discounting to explain COVID-19 preventative behaviors. *PLoS One*, *16*(5), e0251073. https://doi.org/10.1371/journal.pone.0251073

Byrne, K. A., & Worthy, D. A. (2016). Toward a mechanistic account of gender differences in reward-based decision-making. *Journal of Neuroscience, Psychology, and Economics*, *9*(3-4), 157-168. https://doi.org/10.1037/npe0000059

Byrnes, J. P., Miller, D. C., & Schafer, W. D. (1999). Gender differences in risk taking: A meta-analysis. *Psychological Bulletin*, *125*(3), 367-383. https://doi.org/10.1037/0033-2909.125.3.367

Calluso, C., Grande, E., Erario, A., Tosoni, A., & Committeri, G. (2021). Effects of individual discount rate and uncertainty perception on compliance with containment measures during the COVID-19 pandemic. *Brain Sciences*, *11*(10), 1256. https://www.mdpi.com/2076-3425/11/10/1256

Camargo, J., Passarelli, D. A., de Oliveira, M. A., & de Rose, J. C. (2021). Probability discounting and adherence to preventive behaviors during the COVID-19 pandemic. *PsyArXiv*. https://doi.org/10.31234/osf.io/p4a76

Carlucci, L., D'Ambrosio, I., & Balsamo, M. (2020). Demographic and attitudinal factors of adherence to quarantine guidelines during COVID-19: The Italian Model. *Frontiers in Psychology*, *11*(2702). https://doi.org/10.3389/fpsyg.2020.559288

Carter, P. M., Bingham, C. R., Zakrajsek, J. S., Shope, J. T., & Sayer, T. B. (2014). Social norms and risk perception: Predictors of distracted driving behavior among novice adolescent drivers. *Journal of Adolescent Health*, *54*(5, Supplement), S32-S41. https://doi.org/10.1016/j.jadohealth.2014.01.008

Cascio, C. N., Carp, J., O'Donnell, M. B., Tinney, F. J., Bingham, C. R., Shope, J. T., Ouimet, M. C., Pradhan, A. K., Simons-Morton, B. G., & Falk, E. B. (2015). Buffering social influence: Neural correlates of response inhibition predict driving safety in the presence of a peer. *Journal of Cognitive Neuroscience*, *27*(1), 83-95. https://doi.org/10.1162/jocn_a_00693

Casswell, S., Pledger, M., & Pratap, S. (2002). Trajectories of drinking from 18 to 26 years: Identification and prediction. *Addiction*, *97*(11), 1427-1437. https://doi.org/10.1046/j.1360-0443.2002.00220.x

Centola, D. (2011). An experimental study of homophily in the adoption of health behavior. *Science*, *334*(6060), 1269-1272. https://doi.org/10.1126/science.1207055

Chapman, G. B. (1996). Temporal discounting and utility for health and money. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*(3), 771.

Chapman, G. B., & Elstein, A. S. (1995). Valuing the future: Temporal discounting of health and money. *Medical Decision Making*, *15*(4), 373-386. https://doi.org/10.1177/0272989X9501500408

Charlton, S. R., Gossett, B. D., & Charlton, V. A. (2012). Effect of delay and social distance on the perceived value of social interaction. *Behavioural Processes*, *89*(1), 23-26. https://doi.org/10.1016/j.beproc.2011.10.003

Charness, G., & Gneezy, U. (2012). Strong evidence for gender differences in risk taking. *Journal of Economic Behavior and Organization*, *83*(1), 50-58. https://doi.org/10.1016/j.jebo.2011.06.007

Chein, J., Albert, D., O'Brien, L., Uckert, K., & Steinberg, L. (2011). Peers increase adolescent risk taking by enhancing activity in the brain's reward circuitry. *Developmental Science*, *14*(2), F1-F10. https://doi.org/10.1111/j.1467-7687.2010.01035.x

Chen, P., & Jacobson, K. C. (2012). Developmental trajectories of substance use from early adolescence to young adulthood: Gender and racial/ethnic differences. *Journal of Adolescent Health*, *50*(2), 154-163. https://doi.org/10.1016/j.jadohealth.2011.05.013

Choukas-Bradley, S., Giletta, M., Cohen, G. L., & Prinstein, M. J. (2015). Peer influence, peer status, and prosocial behavior: An experimental investigation of peer socialization of adolescents' intentions to volunteer. *Journal of Youth and Adolescence*, *44*(12), 2197-2210. https://doi.org/10.1007/s10964-015-0373-2

Cornwall, A. C., Byrne, K. A., & Worthy, D. A. (2018). Gender differences in preference for reward frequency versus reward magnitude in decision-making under uncertainty. *Personality and Individual Differences*, *135*, 40-44. https://doi.org/10.1016/j.paid.2018.06.031

Coroiu, A., Moran, C., Campbell, T., & Geller, A. C. (2020). Barriers and facilitators of adherence to social distancing recommendations during COVID-19 among a large international sample of adults. *PLoS One*, *15*(10). https://doi.org/10.1371/journal.pone.0239795

Cross, C. P. (2010). Sex differences in same-sex direct aggression and sociosexuality: The role of risky impulsivity. *Evolutionary Psychology*, *8*(4), 779-792.

Cross, C. P., Copping, L. T., & Campbell, A. (2011). Sex differences in impulsivity: A meta-analysis. *Psychological Bulletin*, *137*(1), 97.

Cross, C. P., Cyrenne, D.-L. M., & Brown, G. R. (2013). Sex differences in sensation-seeking: A meta-analysis. *Scientific Reports*, *3*, 2486-2486. https://doi.org/10.1038/srep02486

Cruwys, T., Stevens, M., & Greenaway, K. H. (2020). A social identity perspective on COVID-19: Health risk is affected by shared group membership. *British Journal of Social Psychology*, *59*(3), 584-593. https://doi.org/10.1111/bjso.12391

Cyders, M. A., & Coskunpinar, A. (2011). Measurement of constructs using self-report and behavioral lab tasks: Is there overlap in nomothetic span and construct representation for impulsivity? *Clinical Psychology Review*, *31*(6), 965-982. https://doi.org/10.1016/j.cpr.2011.06.001

de Boer, A., Peeters, M., & Koning, I. (2016). An experimental study of risk taking behavior among adolescents: A closer look at peer and sex influences. *The Journal of Early Adolescence*, *37*(8), 1125-1141. https://doi.org/10.1177/0272431616648453

de Water, E., Cillessen, A. H. N., & Scheres, A. (2014). Distinct age-related differences in temporal discounting and risk taking in adolescents and young adults. *Child Development*, *85*(5), 1881-1897. https://doi.org/10.1111/cdev.12245

DeAngelis, B. N., Ben Salah, A., & al'Absi, M. (2022). Stress and COVID‐19 related behaviours: The mediating role of delay discounting. *Stress and Health*, *38*(1), 140-146. https://doi.org/10.1002/smi.3060

Defoe, I. N., Dubas, J. S., Dalmaijer, E. S., & van Aken, M. A. G. (2020). Is the peer presence effect on heightened adolescent risky decision-making only present in males? *Journal of Youth and Adolescence*, *49*(3), 693-705. https://doi.org/10.1007/s10964-019-01179-9

Defoe, I. N., Dubas, J. S., Figner, B., & van Aken, M. A. (2015). A meta-analysis on age differences in risky decision making: Adolescents versus children and adults. *Psychological Bulletin*, *141*(1), 48-84. https://doi.org/10.1037/a0038088

Defoe, I. N., Dubas, J. S., & Romer, D. (2019). Heightened adolescent risk-taking? Insights from lab studies on age differences in decision-making. *Policy Insights from the Behavioral and Brain Sciences*, *6*(1), 56-63. https://doi.org/10.1177/2372732218801037

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J., & Wagner, G. G. (2011). Individual risk attitudes: Measurement, determinants, and behavioral consequences. *Journal of the European Economic Association*, *9*(3), 522-550. https://doi.org/10.1111/j.1542-4774.2011.01015.x

Donohew, L., Zimmerman, R., Cupp, P. S., Novak, S., Colon, S., & Abell, R. (2000). Sensation seeking, impulsive decision-making, and risky sex: Implications for risk-taking and design of interventions. *Personality and Individual Differences*, *28*(6), 1079-1091. https://doi.org/10.1016/S0191-8869(99)00158-0

Du, W., Green, L., & Myerson, J. (2002). Cross-cultural comparisons of discounting delayed and probabilistic rewards. *The Psychological Record*, *52*(4), 479-492. https://doi.org/10.1007/BF03395199

Duell, N., Steinberg, L., Icenogle, G., Chein, J., Chaudhary, N., Di Giunta, L., Dodge, K. A., Fanti, K. A., Lansford, J. E., Oburu, P., Pastorelli, C., Skinner, A. T., Sorbring, E., Tapanya, S., Uribe Tirado, L. M., Alampay, L. P., Al-Hassan, S. M., Takash, H. M. S., Bacchini, D., & Chang, L. (2018). Age patterns in risk taking across the world. *Journal of Youth and Adolescence*, *47*(5), 1052-1072. https://doi.org/10.1007/s10964-017-0752-y

Ertac, S., & Gurdal, M. Y. (2012). Deciding to decide: Gender, leadership and risk-taking in groups. *Journal of Economic Behavior and Organization*, *83*(1), 24-30. https://doi.org/10.1016/j.jebo.2011.06.009

Estle, S. J., Green, L., Myerson, J., & Holt, D. D. (2006). Differential effects of amount on temporal and probability discounting of gains and losses. *Memory & Cognition*, *34*(4), 914-928. https://doi.org/10.3758/BF03193437

Feldman, D. C. (1984). The development and enforcement of group norms. *The Academy of Management Review*, *9*(1), 47-53. https://doi.org/10.5465/amr.1984.4277934

Feldstein, S. W., & Miller, W. R. (2006). Substance use and risk-taking among adolescents. *Journal of Mental Health*, *15*(6), 633-643. https://doi.org/10.1080/09638230600998896

Flaherty, G. T., Hession, P., Liew, C. H., Lim, B. C. W., Leong, T. K., Lim, V., & Sulaiman, L. H. (2020). COVID-19 in adult patients with pre-existing chronic cardiac, respiratory and metabolic disease: A critical literature review with clinical recommendations. *Tropical Diseases, Travel Medicine and Vaccines*, *6*(1), 16. https://doi.org/10.1186/s40794-020-00118-y

Foreman, A. M., Hayashi, Y., Friedel, J. E., & Wirth, O. (2019). Social distance and texting while driving: A behavioral economic analysis of social discounting. *Traffic Injury Prevention*, *20*(7), 702-707. https://doi.org/10.1080/15389588.2019.1636233

Forrest, W., Hay, C., Widdowson, A. O., & Rocque, M. (2019). Development of impulsivity and risk‐seeking: Implications for the dimensionality and stability of self‐control. *Criminology*, *57*(3), 512-543. https://doi.org/10.1111/1745-9125.12214

Foulkes, L., Leung, J. T., Fuhrmann, D., Knoll, L. J., & Blakemore, S.-J. (2018). Age differences in the prosocial influence effect. *Developmental science*, *21*(6). https://doi.org/10.1111/desc.12666

Francis, K. B., & McNabb, C. B. (2022). Moral decision-making during COVID-19: Moral judgements, moralisation, and everyday behaviour. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.769177

Furrebøe, E. F. (2020). The sign effect, systematic devaluations and zero discounting. *Journal of the Experimental Analysis of Behavior*, *113*(3), 626-643. https://doi.org/10.1002/jeab.598

Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: An experimental study. *Developmental Psychology*, *41*(4), 625-635. https://doi.org/10.1037/0012-1649.41.4.625

Geber, S., Baumann, E., Czerwinski, F., & Klimmt, C. (2019). The effects of social norms among peer groups on risk behavior: A multilevel approach to differentiate perceived and collective norms. *Communication Research*, 0093650218824213. https://doi.org/10.1177/0093650218824213

Gilman, J. M., Curran, M. T., Calderon, V., Stoeckel, L. E., & Evins, A. E. (2014). Impulsive social influence increases impulsive choices on a temporal discounting task in young adults. *PLoS One*, *9*(7). https://doi.org/10.1371/journal.pone.0101570

Gilroy, S. P., Franck, C. T., & Hantula, D. A. (2017). The discounting model selector: Statistical software for delay discounting applications. *Journal of the Experimental Analysis of Behavior*, *107*, 388-401. https://doi.org/10.1002/jeab.257

Green, L., Fry, A. F., & Myerson, J. (1994). Discounting of delayed rewards: A life-span comparison. *Psychological Science*, *5*(1), 33-36. https://doi.org/10.1111/j.1467-9280.1994.tb00610.x

Green, L., & Myerson, J. (1996). Exponential versus hyperbolic discounting of delayed outcomes: Risk and waiting time. *American Zoologist*, *36*(4), 496. https://doi.org/10.1093/icb/36.4.496

Green, L., & Myerson, J. (2004). A discounting framework for choice with delayed and probabilistic rewards. *Psychological Bulletin*, *130*(5), 769-792. https://doi.org/10.1037/0033-2909.130.5.769

Gustafsod, P. E. (1998). Gender differences in risk perception: Theoretical and methodological perspectives. *Risk Analysis*, *18*(6), 805-811. https://doi.org/10.1111/j.1539-6924.1998.tb01123.x

Haddad, A. D. M., Harrison, F., Norman, T., & Lau, J. Y. F. (2014). Adolescent and adult risk-taking in virtual social contexts. *Frontiers in Psychology, 5*. https://doi.org/10.3389/fpsyg.2014.01476

Halilova, J., Fynes-Clinton, S., Green, L., Myerson, J., Wu, J., Ruggeri, K., Addis, D., & Rosenbaum, R. S. (2022). Short-sighted decision-making by those not vaccinated against COVID-19. *PsyArXiv*. https://doi.org/10.31234/osf.io/6uqky

Hardisty, D. J., & Weber, E. U. (2009). Discounting future green: Money versus the environment. *Journal of Experimental Psychology: General*, *138*(3), 329-340. https://doi.org/10.1037/a0016433

Harman, M. J. (2021). The effects of time framing on compliance to hypothetical social-distancing policies related to COVID-19. *Behavior and Social Issues*, *30*(1), 632-647. https://doi.org/10.1007/s42822-020-00041-z

Harris, C. R., Jenkins, M., & Glaser, D. (2006). Gender differences in risk assessment: Why do women take fewer risks than men? *Judgment and Decision Making*, *1*(1), 48-63.

Hasegawa, A., Somatori, K., Nishimura, H., Hattori, Y., & Kunisato, Y. (2019). Associations between self-reported impulsivity and a latent variable of impulsive action constructed from three laboratory tasks. *Journal of Experimental Psychopathology*, *10*(3). https://doi.org/10.1177/2043808719861894

Hayashi, Y., Fessler, H. J., Friedel, J. E., Foreman, A. M., & Wirth, O. (2018). The roles of delay and probability discounting in texting while driving: Toward the development of a translational scientific program. *Journal of the Experimental Analysis of Behavior*, *110*(2), 229-242. https://doi.org/10.1002/jeab.460

Haynie, D. L. (2002). Friendship networks and delinquency: The relative nature of peer delinquency. *Journal of Quantitative Criminology*, *18*(2), 99-134. https://doi.org/10.1023/A:1015227414929

Haynie, D. L., Giordano, P., Manning, W., & Longmore, M. (2005). Adolescent romantic relationships and delinquency involvement. *Criminology*, *43*, 177-210. https://doi.org/10.1111/j.0011-1348.2005.00006.x

Hays, R. D., Liu, H., & Kapteyn, A. (2015). Use of internet panels to conduct surveys. *Behavior Research Methods*, *47*(3), 685-690. https://doi.org/10.3758/s13428-015-0617-9

Holt, D., Green, L., & Myerson, J. (2012). Estimating the subjective value of future rewards: Comparison of adjusting-amount and adjusting-delay procedures. *Behavioural Processes*, *90*, 302-310. https://doi.org/10.1016/j.beproc.2012.03.003

Homish, G. G., & Leonard, K. E. (2008). Spousal influence on general health behaviors in a community sample. *American Journal of Health Behavior, 32*(6), 754-763. https://doi.org/10.5555/ajhb.2008.32.6.754

Homish, G. G., Leonard, K. E., & Cornelius, J. R. (2007). Predictors of marijuana use among married couples: the influence of one's spouse. *Drug and Alcohol Dependence*, *91*(2), 121-128. https://doi.org/10.1016/j.drugalcdep.2007.05.014

Horn, S., & Freund, A. M. (2021). Adult age differences in monetary decisions with real and hypothetical reward. *Journal of Behavioral Decision Making*. https://doi.org/10.1002/bdm.2253

Hoyle, R. H., Stephenson, M. T., Palmgreen, P., Lorch, E. P., & Donohew, R. L. (2002). Reliability and validity of a brief measure of sensation seeking. *Personality and Individual Differences*, *32*(3), 401-414. https://doi.org/10.1016/S0191-8869(01)00032-0

Hudson, A., Hall, P. A., Hitchman, S. C., Meng, G., & Fong, G. T. (2022). Cognitive predictors of vaccine hesitancy and COVID-19 mitigation behaviors in a population representative sample. *medRxiv*, 2022.2001.2002.22268629. https://doi.org/10.1101/2022.01.02.22268629

Hult Khazaie, D., & Khan, S. S. (2020). Shared social identification in mass gatherings lowers health risk perceptions via lowered disgust. *British Journal of Social Psychology*, *59*(4), 839-856. https://doi.org/10.1111/bjso.12362

Iversen, H. (2004). Risk-taking attitudes and risky driving behavior. *Transportation Research Part F: Traffic Psychology and Behaviour*, *7*, 135-150. https://doi.org/10.1016/j.trf.2003.11.003

Jianakoplos, N. A., & Bernasek, A. (1998). Are women more risk averse? *Economic Inquiry*, *36*(4), 620-630. https://doi.org/10.1111/j.1465-7295.1998.tb01740.x

Johnson, M. W., & Bickel, W. K. (2008). An algorithm for identifying nonsystematic delay-discounting data. *Experimental and Clinical Psychopharmacology*, *16*(3), 264-274. https://doi.org/10.1037/1064-1297.16.3.264

Josef, A. K., Richter, D., Samanez-Larkin, G. R., Wagner, G. G., Hertwig, R., & Mata, R. (2016). Stability and change in risk-taking propensity across the adult life span.

Journal of Personality and Social Psychology, *111*(3), 430-450. https://doi.org/10.1037/pspp0000090

Kabamba Nzaji, M., Ngoie Mwamba, G., Mbidi Miema, J., Kilolo Ngoy Umba, E., Kangulu, I. B., Banza Ndala, D. B., Ciamala Mukendi, P., Kabila Mutombo, D., Balela Kabasu, M. C., Kanyki Katala, M., Kabunda Mbala, J., & Luboya Numbi, O. (2020). Predictors of non-adherence to public health instructions during the COVID-19 pandemic in the Democratic Republic of the Congo. *Journnal of Multidisciplinary Healthcare*, *13*, 1215-1221. https://doi.org/10.2147/jmdh.S274944

Kandel, D. B. (1978). Homophily, selection, and socialization in adolescent friendships. *The American Journal of Sociology*, *84*(2), 427-436. https://doi.org/10.1086/226792

Kaplan, B., Reed, D., & McKerchar, T. (2014). Using a visual analogue scale to assess delay, social, and probability discounting of an environmental loss. *The Psychological Record*, *64*(2), 261-269. https://doi.org/10.1007/s40732-014-0041-z

Kessler, L., Hewig, J., Weichold, K., Silbereisen, R. K., & Miltner, W. H. (2017). Feedback negativity and decision‐making behavior in the Balloon Analogue Risk Task (BART) in adolescents is modulated by peer presence. *Psychophysiology*, *54*(2), 260-269. https://doi.org/10.1111/psyp.12783

Kirby, K. N., & Maraković, N. N. (1995). Modeling myopic decisions: Evidence for hyperbolic delay-discounting within subjects and amounts. *Organizational Behavior and Human Decision Processes*, *64*(1), 22-30.

Kirby, K. N., & Maraković, N. N. (1996). Delay-discounting probabilistic rewards: Rates decrease as amounts increase. *Psychonomic Bulletin & Review*, *3*(1), 100-104.

Kiuru, N., Burk, W. J., Laursen, B., Salmela-Aro, K., & Nurmi, J.-E. (2010). Pressure to drink but not to smoke: Disentangling selection and socialization in adolescent peer networks and peer groups. *Journal of Adolescence*, *33*(6), 801-812. https://doi.org/10.1016/j.adolescence.2010.07.006

Knoll, L. J., Magis-Weinberg, L., Speekenbrink, M., & Blakemore, S.-J. (2015). Social influence on risk perception during adolescence. *Psychological science*, *26*(5), 583-592. https://doi.org/10.1177/0956797615569578

Kühberger, A., Schulte-Mecklenbeck, M., & Perner, J. (2002). Framing decisions: Hypothetical and real. *Organizational Behavior and Human Decision Processes*, *89*(2), 1162-1175. https://doi.org/10.1016/S0749-5978(02)00021-3

Lawyer, S. R., & Schoepflin, F. J. (2013). Predicting domain-specific outcomes using delay and probability discounting for sexual versus monetary outcomes. *Behavioural Processes*, *96*, 71-78. https://doi.org/10.1016/j.beproc.2013.03.001

Leonard, K. E., & Mudar, P. (2003). Peer and partner drinking and the transition to marriage: A longitudinal examination of selection and influence processes. *Psychology of Addictive Behaviors*, *17*, 115-125. https://doi.org/10.1037/0893-164X.17.2.115

Leonard, K. E., & Mudar, P. (2004). Husbands' influence on wives' drinking: Testing a relationship motivation model in the early years of marriage. *Psychology of Addictive Behaviors*, *18*(4), 340-349. https://doi.org/10.1037/0893-164X.18.4.340

Leverett, S., Garza, C., & Seaman, K. (2021). The effect of delay duration on delay discounting across adulthood. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*. https://doi.org/10.1093/geronb/gbab198

Litman, L., Robinson, J., & Abberbock, T. (2017). TurkPrime.com: A versatile crowdsourcing data acquisition platform for the behavioral sciences. *Behavior Research Methods*, *49*(2), 433-442. https://doi.org/10.3758/s13428-016-0727-z

Lloyd, A., McKay, R., Hartman, T. K., Vincent, B. T., Murphy, J., Gibson-Miller, J., Levita, L., Bennett, K., McBride, O., Martinez, A. P., Stocks, T. V. A., Vallières, F., Hyland, P., Karatzias, T., Butter, S., Shevlin, M., Bentall, R. P., & Mason, L. (2021). Delay discounting and under-valuing of recent information predict poorer adherence to social distancing measures during the COVID-19 pandemic. *Scientific Reports*, *11*(1). https://doi.org/10.1038/s41598-021-98772-5

Locey, M. L., Jones, B. A., & Rachlin, H. (2011). Real and hypothetical rewards in self-control and social discounting. *Judgment and Decision Making*, *6*(6), 522-564.

Lonardo, R. A., Giordano, P. C., Longmore, M. A., & Manning, W. D. (2008). Parents, friends, and romantic partners: Enmeshment in deviant networks and adolescent delinquency involvement. *Journal of Youth and Adolescence*, *38*(3), 367-383. https://doi.org/10.1007/s10964-008-9333-4

Madden, G. J., Begotka, A. M., Raiff, B. R., & Kastern, L. L. (2003). Delay discounting of real and hypothetical rewards. *Experimental and Clinical Psychopharmacology*, *11*(2), 139-145. https://doi.org/10.1037/1064-1297.11.2.139

Mamerow, L., Frey, R., & Mata, R. (2016). Risk taking across the life span: A comparison of self-report and behavioral measures of risk taking. *Psychology and Aging*, *31*(7), 711-723. https://doi.org/10.1037/pag0000124

Mares, S. H., van der Vorst, H., Engels, R. C., & Lichtwarck-Aschoff, A. (2011). Parental alcohol use, alcohol-related problems, and alcohol-specific attitudes, alcohol-specific communication, and adolescent excessive alcohol use and alcohol-related problems: An indirect path model. *Addictive Behaviors*, *36*(3), 209-216. https://doi.org/10.1016/j.addbeh.2010.10.013

Mata, R., Josef, A. K., & Hertwig, R. (2016). Propensity for risk taking across the life span and around the globe. *Psychological Science 27*(2), 231-243. https://doi.org/10.1177/0956797615617811

Mata, R., Josef, A. K., Samanez-Larkin, G. R., & Hertwig, R. (2011). Age differences in risky choice: A meta-analysis. *Annals of the New York Academy of Sciences*, *1235*, 18-29. https://doi.org/10.1111/j.1749-6632.2011.06200.x

Mazur, J. E. (1987). An adjusting procedure for studying delayed reinforcement. In M. L. Commons, J. E. Mazur, J. A. Nevin, & H. Rachlin (Eds.), *Quantitative analyses of behavior: The effect of delay and of intervening events on reinforcement value.* (Vol. 5, pp. 55-73). Erlbaum.

McCoy, S. S., Dimler, L. M., Samuels, D. V., & Natsuaki, M. N. (2017). Adolescent susceptibility to deviant peer pressure: Does gender matter? *Adolescent Research Review*, *4*(1), 59-71. https://doi.org/10.1007/s40894-017-0071-2

McDonald, R. I., & Crandall, C. S. (2015). Social norms and social influence. *Current Opinion in Behavioral Sciences*, *3*, 147-151. https://doi.org/10.1016/j.cobeha.2015.04.006

McKerchar, T. L., Green, L., Myerson, J., Pickford, T. S., Hill, J. C., & Stout, S. C. (2009). A comparison of four models of delay discounting in humans. *Behavioural Processes*, *81*(2), 256-259. https://doi.org/10.1016/j.beproc.2008.12.017

McKerchar, T. L., & Renda, C. R. (2017). Delay and probability discounting in humans: An overview. *The Psychological Record*, *62*(4), 817-834. https://doi.org/10.1007/BF03395837

Mellis, A. M., & Bickel, W. K. (2020). Mechanical Turk data collection in addiction research: Utility, concerns and best practices. *Addiction*, *115*(10), 1960-1968. https://doi.org/10.1111/add.15032

Mishra, S., Lalumière, M. L., & Williams, R. J. (2010). Gambling as a form of risk-taking: Individual differences in personality, risk-accepting attitudes, and behavioral preferences for risk. *Personality and Individual Differences*, *49*(6), 616-621. https://doi.org/10.1016/j.paid.2010.05.032

Montinari, N., & Rancan, M. (2018). Risk taking on behalf of others: The role of social distance. *Journal of Risk and Uncertainty*, *57*, 81-109.

Moreira, D., & Barbosa, F. (2019). Delay discounting in impulsive behavior: A systematic review. *European Psychologist, 24*(4), 312-321. https://doi.org/10.1027/1016-9040/a000360

Morgenroth, T., Fine, C., Ryan, M. K., & Genat, A. E. (2017). Sex, drugs, and reckless driving: Are measures biased toward identifying risk-taking in men? *Social Psychological and Personality Science*, *9*(6), 744-753. https://doi.org/10.1177/1948550617722833

Myerson, J., & Green, L. (1995). Discounting of delayed rewards: Models of individual choice. *Journal of the Experimental Analysis of Behavior, 64*(3), 263-276.

Myerson, J., Green, L., & Warusawitharana, M. (2001). Area under the curve as a measure of discounting. *Journal of the Experimental Analysis of Behavior*, *76*(2), 235-243. https://doi.org/10.1901/jeab.2001.76-235

Neff, M. B., & Macaskill, A. C. (2021). The effect of “should” and “would” instructions on delay discounting of rewards for self and others. *Journal of Behavioral Decision Making*, *34*(4), 568-580. https://doi.org/10.1002/bdm.2230

Nelson, J. A. (2014). The power of stereotyping and confirmation bias to overwhelm accurate assessment: The case of economics, gender, and risk aversion. *Journal of Economic Methodology*, *21*(3), 211-231. https://doi.org/10.1080/1350178X.2014.939691

Nese, M., Riboli, G., Brighetti, G., Sassi, V., Camela, E., Caselli, G., Sassaroli, S., & Borlimi, R. (2022). Delay discounting of compliance with containment measures during the COVID-19 outbreak: A survey of the Italian population. *Journal of Public Health*, *30*(2), 503-511. https://doi.org/10.1007/s10389-020-01317-9

Nigg, J. T. (2017). Annual Research Review: On the relations among self‐regulation, self‐control, executive functioning, effortful control, cognitive control, impulsivity, risk‐taking, and inhibition for developmental psychopathology. *Journal of Child Psychology and Psychiatry*, *58*(4), 361-383. https://doi.org/10.1111/jcpp.12675

Nivette, A., Ribeaud, D., Murray, A., Steinhoff, A., Bechtiger, L., Hepp, U., Shanahan, L., & Eisner, M. (2021). Non-compliance with COVID-19-related public health measures among young adults in Switzerland: Insights from a longitudinal cohort study. *Social Science & Medicine*, *268*. https://doi.org/10.1016/j.socscimed.2020.113370

O'Brien, L., Albert, D., Chein, J., & Steinberg, L. (2011). Adolescents prefer more immediate rewards when in the presence of their peers. *Journal of Research on Adolescence*, *21*(4), 747-753. https://doi.org/10.1111/j.1532-7795.2011.00738.x

Odum, A. L. (2011a). Delay discounting: I'm a k, you're a k. *Journal of the Experimental Analysis of Behavior*, *96*(3), 427-439. https://doi.org/10.1901/jeab.2011.96-423

Odum, A. L. (2011b). Delay discounting: Trait variable? *Behavioural Processes*, *87*(1), 1-9. https://doi.org/10.1016/j.beproc.2011.02.007

Odum, A. L., & Rainaud, C. P. (2003). Discounting of delayed hypothetical money, alcohol, and food. *Behavioural Processes*, *64*(3), 305-313. https://doi.org/10.1016/S0376-6357(03)00145-1

Ohmura, Y., Takahashi, T., Kitamura, N., & Wehr, P. (2006). Three-month stability of delay and probability discounting measures. *Experimental and Clinical Psychopharmacology 14*(3), 318-328. https://doi.org/10.1037/1064-1297.14.3.318

Oliveira, L. L., & Green, L. (2012). Discounting and impulsivity: Overview and relevance to consumer choice. In V. Wells & G. Foxall (Eds.), *Handbook of developments in consumer behaviour* (pp. 285-322). Edward Elgar Publishing. https://ebookcentral-proquest-com.ezproxy.waikato.ac.nz/lib/waikato/reader.action?docID=950410

Olson, E. A., Hooper, C. J., Collins, P., & Luciana, M. (2007). Adolescents' performance on delay and probability discounting tasks: Contributions of age, intelligence, executive functioning, and self-reported externalizing behavior. *Personality and Individual Differences*, *43*(7), 1886-1897. https://doi.org/10.1016/j.paid.2007.06.016

Osmont, A., Camarda, A., Habib, M., & Cassotti, M. (2021). Peers' choices influence adolescent risk-taking especially when explicit risk information is lacking. *Journal of Research on Adolescence*, *31*(2), 402-416. https://doi.org/10.1111/jora.12611

Padrón, I., Rodrigo, M. J., & De Vega, M. (2016). Feedback on health status and peer popularity influences social risk decision-making processes in adolescents and young adults. *European Journal of Developmental Psychology*, *13*(2), 241-253. https://doi.org/10.1080/17405629.2015.1089769

Patton, G. C., Sawyer, S. M. M. D., Santelli, J. S. M. D., Ross, D. A. P., Afifi, R. P., Allen, N. B. P., Arora, M. P., Azzopardi, P. M., Baldwin, W. P., Bonell, C. P., Kakuma, R. P., Kennedy, E. M. P. H., Mahon, J. P., McGovern, T. J. D., Mokdad, A. H. P., Patel, V. P., Petroni, S. P., Reavley, N. P., Taiwo, K., . . . Viner, R. M. P. (2016). Our future: A Lancet commission on adolescent health and wellbeing. *The Lancet (British Edition)*, *387*(10036), 2423-2478. https://doi.org/10.1016/S0140-6736(16)00579-1

Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the Barratt Impulsiveness Scale. *Journal of Clinical Psychology*, *51*(6), 768-774. https://doi.org/10.1002/1097-4679(199511)51:6<768::AID-JCLP2270510607>3.0.CO

Pollak, Y., Dayan, H., Shoham, R., & Berger, I. (2020). Predictors of non-adherence to public health instructions during the COVID-19 pandemic. *Psychiatry and Clinical Neurosciences*, *74*(11), 602-604. https://doi.org/10.1111/pcn.13122

Prosser, A. M. B., Judge, M., Bolderdijk, J. W., Blackwood, L., & Kurz, T. (2020). 'Distancers' and 'non-distancers'? The potential social psychological impact of moralizing COVID-19 mitigating practices on sustained behaviour change. *British Journal of Social Psychology*, *59*(3), 653-662. https://doi.org/10.1111/bjso.12399

Rachlin, H. (2006). Notes on discounting. *Journal of The Experimental Analysis of Behavior*, *85*(3), 425-435. https://doi.org/10.1901/jeab.2006.85-05

Rachlin, H., & Jones, B. A. (2008). Social discounting and delay discounting. *Journal of Behavioral Decision Making*, *21*(1), 29-43. https://doi.org/10.1002/bdm.567

Rachlin, H., Raineri, A., & Cross, D. (1991). Subjective probability and delay. *Journal of Experimental Analysis of Behavior*, *55*(2), 233-244. https://doi.org/10.1901/jeab.1991.55-233

Read, D., & Read, N. L. (2004). Time discounting over the lifespan. *Organizational behavior and human decision processes*, *94*(1), 22-32.

Reimers, S., Maylor, E. A., Stewart, N., & Chater, N. (2009). Associations between a one-shot delay discounting measure and age, income, education and real-world impulsive behavior. *Personality and Individual Differences*, *47*(8), 973-978. https://doi.org/ 10.1016/j.paid.2009.07.026

Reniers, R. L. E. P., Beavan, A., Keogan, L., Furneaux, A., Mayhew, S., & Wood, S. J. (2017). Is it all in the reward? Peers influence risk-taking behaviour in young adulthood. *British Journal of Psychology*, *108*(2), 276-295. https://doi.org/10.1111/bjop.12195

Reniers, R. L. E. P., Murphy, L., Lin, A. B., SP, & Wood, S. J. (2016). Risk perception and risk-taking behaviour during adolescence: The influence of personality and gender. *PLoS One*, *11*(4). https://doi.org/10.1371/journal.pone.0153842

Reyna, V. F., & Farley, F. (2006). Risk and rationality in adolescent decision making: Implications for theory, practice, and public policy. *Psychological Science in the Public Interest*, *7*(1), 1-44. https://doi.org/10.1111/j.1529-1006.2006.00026.x

Reynolds, B., Ortengren, A., Richards, J. B., & de Wit, H. (2006). Dimensions of impulsive behavior: Personality and behavioral measures. *Personality and Individual Differences*, *40*(2), 305-315. https://doi.org/10.1016/j.paid.2005.03.024

Reynolds, B., Richards, J. B., Horn, K., & Karraker, K. (2004). Delay discounting and probability discounting as related to cigarette smoking status in adults. *Behavioural Processes*, *65*(1), 35-42.

Rice, S., & Winter, S. R. (2019). Do gender and age affect willingness to ride in driverless vehicles: If so, then why? *Technology in Society*, *58*, 101145. https://doi.org/10.1016/j.techsoc.2019.101145

Richter, D., & Mata, R. (2018). Age differences in intertemporal choice: U-shaped associations in a probability sample of German households. *Psychology and Aging*, *33*(5), 782.

Riedijk, L., & Harakeh, Z. (2017). Imitating the risky decision-making of peers: An experimental study among emerging adults. *Emerging Adulthood*, *6*(4), 255-265. https://doi.org/10.1177/2167696817722918

Robertson, S. H., & Rasmussen, E. B. (2018). Comparison of potentially real versus hypothetical food outcomes in delay and probability discounting tasks. *Behavioural Processes*, *149*, 8-15. https://doi.org/10.1016/j.beproc.2018.01.014

Rolison, J. J., Hanoch, Y., Wood, S., & Liu, P. J. (2014). Risk-taking differences across the adult life span: A question of age and domain. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *69*(6), 870-880. https://doi.org/10.1093/geronb/gbt081

Rolison, J. J., & Shenton, J. (2020). How much risk can you stomach? Individual differences in the tolerance of perceived risk across gender and risk domain. *Journal of Behavioral Decision Making*, *33*(1), 63-85. https://doi.org/10.1002/bdm.2144

Romer, D., Reyna, V. F., & Satterthwaite, T. D. (2017). Beyond stereotypes of adolescent risk taking: Placing the adolescent brain in developmental context. *Developmental Cognitive Neuroscience*, *27*, 19-34. https://doi.org/10.1016/j.dcn.2017.07.007

Rosenblitt, J. C., Soler, H., Johnson, S. E., & Quadagno, D. M. (2001). Sensation seeking and hormones in men and women: Exploring the link. *Hormones and Behavior*, *40*(3), 396-402. https://doi.org/10.1006/hbeh.2001.1704

Ross, V., Jongen, E. M. M., Brijs, K., Brijs, T., & Wets, G. (2016). Investigating risky, distracting, and protective peer passenger effects in a dual process framework.

Accident Analysis & Prevention, *93*, 217-225. https://doi.org/10.1016/j.aap.2016.05.007

Roth, M., Schumacher, J., & Brähler, E. (2005). Sensation seeking in the community: Sex, age and sociodemographic comparisons on a representative German population sample. *Personality and Individual Differences*, *39*(7), 1261-1271. https://doi.org/10.1016/j.paid.2005.05.003

Salvy, S.-J., Jarrin, D., Paluch, R., Irfan, N., & Pliner, P. (2007). Effects of social influence on eating in couples, friends and strangers. *Appetite*, *49*(1), 92-99. https://doi.org/10.1016/j.appet.2006.12.004

Sargisson, R. J., Ankoné, B. A. H., Dijkhuis, M., Eilers, H., Moser, E., Philipp, A. J., & Syafika, A. (2021). By-and-Buy: The effect of social influence on discounting of environmental outcomes. *Sustainability and Climate Change*, *14*(4), 217-226. https://doi.org/10.1089/scc.2021.0003

Sargisson, R. J., & Schöner, B. V. (2020). Hyperbolic discounting with environmental outcomes across time, space, and probability. *The Psychological Record*, *70*(3), 515-527. https://doi.org/10.1007/s40732-019-00368-z

Scheres, A., Dijkstra, M., Ainslie, E., Balkan, J., Reynolds, B., Sonuga-Barke, E., & Castellanos, F. X. (2006). Temporal and probabilistic discounting of rewards in children and adolescents: Effects of age and ADHD symptoms. *Neuropsychologia*, *44*(11), 2092-2103.

Schlager, T., & Whillans, A. V. (2022). People underestimate the probability of contracting the coronavirus from friends. *Humanities and Social Sciences Communications*, *9*(1), 59. https://doi.org/10.1057/s41599-022-01052-4

Seaman, K. L., Gorlick, M. A., Vekaria, K. M., Hsu, M., Zald, D. H., & Samanez-Larkin, G. R. (2016). Adult age differences in decision making across domains: Increased discounting of social and health-related rewards. *Psychology and Aging*, *31*(7), 737.

Shulman, E. P., Smith, A. R., Silva, K., Icenogle, G., Duell, N., Chein, J., & Steinberg, L. (2016). The dual systems model: Review, reappraisal, and reaffirmation. *Developmental Cognitive Neuroscience*, *17*, 103-117. https://doi.org/10.1016/j.dcn.2015.12.010

Silva, K., Chein, J., & Steinberg, L. (2016). Adolescents in peer groups make more prudent decisions when a slightly older adult is present. *Psychological Science*, *27*(3), 322-330. https://doi.org/10.1177/0956797615620379

Simons-Morton, B. G., Bingham, C. R., Falk, E. B., Li, K., Pradhan, A. K., Ouimet, M. C., Almani, F., & Shope, J. T. (2014). Experimental effects of injunctive norms on simulated risky driving among teenage males. *Health Psychology*, *33*(7), 616-627. https://doi.org/10.1037/a0034837

Simpson, C., & Vuchinich, R. (2000). Reliability of a measure of temporal discounting. *The Psychological Record*, *50*, 3-16. https://doi.org/10.1007/BF03395339

Smith, A. R., Chein, J., & Steinberg, L. (2014). Peers increase adolescent risk taking even when the probabilities of negative outcomes are known. *Developmental Psychology*, *50*(5), 1564-1568. https://doi.org/10.1037/a0035696

Smith, C., & Hantula, D. (2008). Methodological considerations in the study of delay discounting in intertemporal choice: A comparison of tasks and modes. *Behavior Research Methods*, *40*(4), 940-953. https://doi.org/10.3758/BRM.40.4.940

Smith, K. R., Lawyer, S. R., & Swift, J. K. (2018). A meta-analysis of nonsystematic responding in delay and probability reward discounting. *Experimental and Clinical Psychopharmacology*, *26*(1), 94-107. https://doi.org/10.1037/pha0000167

Smith, L. E., Amlôt, R., Lambert, H., Oliver, I., Robin, C., Yardley, L., & Rubin, G. J. (2020a). Factors associated with adherence to self-isolation and lockdown measures in the UK; a cross-sectional survey. *medRxiv*. https://doi.org/10.1101/2020.06.01.20119040

Smith, L. E., Mottershaw, A. L., Egan, M., Waller, J., Marteau, T. M., & Rubin, G. J. (2020b). The impact of believing you have had COVID-19 on behaviour: Cross-sectional survey. *medRxiv*. https://doi.org/10.1101/2020.04.30.20086223

Somerville, L. H., Haddara, N., Sasse, S. F., Skwara, A. C., Moran, J. M., & Figner, B. (2018). Dissecting "peer presence" and "decisions" to deepen understanding of peer influence on adolescent risky choice. *Child Development*, *90*(6), 2086-2103. https://doi.org/10.1111/cdev.13081

Stanford, M., Mathias, C., Dougherty, D., Lake, S., Anderson, N., & Patton, J. (2009). Fifty years of the Barratt Impulsiveness Scale: An update and review. *Personality and Individual Differences*, *47*, 385-395. https://doi.org/10.1016/j.paid.2009.04.008

Steca, P., Adorni, R., Greco, A., Zanatta, F., Fattirolli, F., Franzelli, C., Giannattasio, C., & D'Addario, M. (2022). Impulsivity assessed ten years earlier and sociodemographic factors predict adherence to COVID-19 related behavioral restrictions in old individuals with hypertension. *BMC Public Health*, *22*(1), 185. https://doi.org/10.1186/s12889-022-12624-z

Steens, A., Freiesleben de Blasio, B., Veneti, L., Gimma, A., Edmunds, W. J., Van Zandvoort, K., Jarvis, C. I., Forland, F., & Robberstad, B. (2020). Poor self-reported adherence to COVID-19-related quarantine/isolation requests, Norway, April to July 2020. *Eurosurveillance*, *25*(37), 2001607. https://doi.org/10.2807/1560-7917.ES.2020.25.37.2001607

Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking. *Developmental Review*, *28*(1), 78-106. https://doi.org/10.1016/j.dr.2007.08.002

Steinberg, L., Albert, D., Cauffman, E., Banich, M., Graham, S., & Woolard, J. (2008). Age differences in sensation seeking and impulsivity as indexed by behavior and self-report: Evidence for a dual systems model. *Developmental Psychology*, *44*(6), 1764-1778. https://doi.org/10.1037/a0012955

Steinberg, L., & Calkins, S. D. (2010). A dual systems model of adolescent risk-taking. *Developmental Psychobiology*, *52*(3), 216-224. https://doi.org/10.1002/dev.20445

Steinberg, L., Graham, S., O'Brien, L., Woolard, J., Cauffman, E., & Banich, M. (2009). Age differences in future orientation and delay discounting. *Child Development*, *80*(1), 28-44. https://doi.org/10.1111/j.1467-8624.2008.01244.x

Steinberg, L., Icenogle, G., Shulman, E. P., Breiner, K., Chein, J., Bacchini, D., Chang, L., Chaudhary, N., Giunta, L. D., Dodge, K. A., Fanti, K. A., Lansford, J. E., Malone, P. S., Oburu, P., Pastorelli, C., Skinner, A. T., Sorbring, E., Tapanya, S., Tirado, L. M. U., . . . Takash, H. M. S. (2018). Around the world, adolescence is a time of heightened sensation seeking and immature self-regulation. *Developmental Science*, *21*(2). https://doi.org/10.1111/desc.12532

Steinberg, L., & Monahan, K. C. (2007). Age differences in resistance to peer influence. *Developmental Psychology*, *43*(6), 1531-1543. https://doi.org/10.1037/0012-1649.43.6.1531

Stephenson, M. T., Velez, L. F., Chalela, P., Ramirez, A., & Hoyle, R. H. (2007). The reliability and validity of the Brief Sensation Seeking Scale (BSSS-8) with young adult Latino workers: implications for tobacco and alcohol disparity research. *Addiction*, *102*(Supplementary 2), 79-91. https://doi.org/10.1111/j.1360-0443.2007.01958.x

Stoltenberg, S. F., Batien, B. D., & Birgenheir, D. G. (2008). Does gender moderate associations among impulsivity and health-risk behaviors? *Addictive Behaviors*, *33*(2), 252-265. https://doi.org/10.1016/j.addbeh.2007.09.004

Stone, E. R., & Allgaier, L. (2008). A social values analysis of self–other differences in decision making involving risk. *Basic and Applied Social Psychology*, *30*(2), 114-129. https://doi.org/10.1080/01973530802208832

Strickland, J. C., Reed, D. D., Hursh, S. R., Schwartz, L. P., Foster, R. N. S., Gelino, B. W., LeComte, R. S., Oda, F. S., Salzer, A. R., Schneider, T. D., Dayton, L., Latkin, C., & Johnson, M. W. (2022). Behavioral economic methods to inform infectious disease response: Prevention, testing, and vaccination in the COVID-19 pandemic. *PLoS One*, *17*(1), e0258828. https://doi.org/10.1371/journal.pone.0258828

Stuifbergen, M. C., & van Delden, J. J. M. (2010). Filial obligations to elderly parents: A duty to care? *Medicine, Health Care and Philosophy*, *14*(1), 63-71. https://doi.org/10.1007/s11019-010-9290-z

Tomova, L., & Pessoa, L. (2018). Information about peer choices shapes human risky decision-making. *Scientific Reports*, *8*(1), 5129. https://doi.org/10.1038/s41598-018-23455-7

Tunçgenç, B., El Zein, M., Sulik, J., Newson, M., Zhao, Y., Dezecache, G., & Deroy, O. (2021). Social influence matters: We follow pandemic guidelines most when our close circle does. *British Journal of Psychology*, *112*(3), 763-780. https://doi.org/10.1111/bjop.12491

van Bavel, J. J., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., Crockett, M. J., Crum, A. J., Douglas, K. M., Druckman, J. N., Drury, J., Dube, O., Ellemers, N., Finkel, E. J., Fowler, J. H., Gelfand, M., Han, S., Haslam, S. A., Jetten, J., . . . Willer, R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*, *4*(5), 460-471. https://doi.org/10.1038/s41562-020-0884-z

van Hoorn, J., Crone, E. A., & Van Leijenhorst, L. (2017). Hanging out with the right crowd: Peer influence on risk-taking behavior in adolescence. *Journal of Research on Adolescence*, *27*(1), 189-200. https://doi.org/10.1111/jora.12265

van Hoorn, J., van Dijk, E., Meuwese, R., Rieffe, C., & Crone, E. A. (2014). Peer influence on prosocial behavior in adolescence. *Journal of Research on Adolescence*, *26*(1), 90-100. https://doi.org/10.1111/jora.12173

van Leijenhorst, L., Westenberg, P. M., & Crone, E. A. (2008). A developmental study of risky decisions on the Cake Gambling Task: Age and gender analyses of probability estimation and reward evaluation. *Developmental Neuropsychology*, *33*(2), 179-196. https://doi.org/10.1080/87565640701884287

Vasconcelos, A. G., Sergeant, J., Corrêa, H., Mattos, P., & Malloy-Diniz, L. (2014). When self-report diverges from performance: The usage of BIS-11 along with neuropsychological tests. *Psychiatry Research*, *218*(1), 236-243. https://doi.org/10.1016/j.psychres.2014.03.002

Walshe, E. A., Winston, F. K., & Romer, D. (2021). Rethinking cell phone use while driving: Isolated risk behavior or a pattern of risk-taking associated with impulsivity in young drivers? *International Journal of Environmental Research and Public Health*, *18*(11), 5640. https://doi.org/10.3390/ijerph18115640

Walter, S. L., Seibert, S. E., Goering, D., & O'Boyle, E. H. (2019). A tale of two sample sources: Do results from online panel data and conventional data converge? *Journal of Business and Psychology*, *34*(4), 425-452. https://doi.org/10.1007/s10869-018-9552-y

Weafer, J., & de Wit, H. (2014). Sex differences in impulsive action and impulsive choice. *Addictive Behaviors*, *39*(11), 1573-1579.

Weatherly, J. N., & Ruthig, J. (2013). Degree of delay discounting as a function of who receives the outcome and the discounter's perceived level of social support. *A Journal for Diverse Perspectives on Diverse Psychological Issues*, *32*(1), 1-17. https://doi.org/10.1007/s12144-012-9160-3

Weatherly, J. N., Terrell, H. K., & Derenne, A. (2010). Delay discounting of different commodities. *The Journal of General Psychology*, *137*(3), 273-286. https://doi.org/10.1080/00221309.2010.484449

Weber, E. U., Blais, A.-R., & Betz, N. E. (2002). A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviors. *Journal of Behavioral Decision Making*, *15*(4), 263-290. https://doi.org/10.1002/bdm.414

Webster, R. K., Brooks, S. K., Smith, L. E., Woodland, L., Wessely, S., & Rubin, G. J. (2020). How to improve adherence with quarantine: Rapid review of the evidence. *Public Health*, *182*, 163-169. https://doi.org/10.1016/j.puhe.2020.03.007

Weigard, A., Chein, J., Albert, D., Smith, A., & Steinberg, L. (2014). Effects of anonymous peer observation on adolescents' preference for immediate rewards. *Developmental Science*, *17*(1), 71-78. https://doi.org/10.1111/desc.12099

Williams, S. N., Armitage, C. J., Tampe, T., & Dienes, K. (2020). Public perceptions and experiences of social distancing and social isolation during the COVID-19 pandemic: A UK-based focus group study. *BMJ Open*, *10*(7), e039334. https://doi.org/10.1136/bmjopen-2020-039334

Willoughby, T., Good, M., Adachi, P. J. C., Hamza, C., & Tavernier, R. (2014). Examining the link between adolescent brain development and risk taking from a social–developmental perspective (reprinted). *Brain and Cognition*, *89*, 70-78. https://doi.org/10.1016/j.bandc.2014.07.006

Willoughby, T., Heffer, T., Good, M., & Magnacca, C. (2021). Is adolescence a time of heightened risk taking? An overview of types of risk-taking behaviors across age groups. *Developmental Review*, *61*. https://doi.org/10.1016/j.dr.2021.100980

Wilson, J. M., Sevi, B., Strough, J., & Shook, N. J. (2021). Age differences in risk taking: Now you see them, now you don't. *Aging, Neuropsychology, and Cognition*, 1-15. https://doi.org/10.1080/13825585.2021.1885608

Windle, M., & Windle, R. C. (2018). A prospective study of mutual influence for substance use among young adult marital dyads. *Psychology of Addictive Behaviors*, *32*(2), 237-243. https://doi.org/10.1037/adb0000329

Wismans, A., Letina, S., Wennberg, K., Thurik, R., Baptista, R., Burke, A., Dejardin, M., Janssen, F., Santarelli, E., Torrès, O., & Franken, I. (2021). The role of impulsivity and delay discounting in student compliance with COVID-19 protective measures. *Personality and Individual Differences*, *179*. https://doi.org/10.1016/j.paid.2021.110925

Wolf, L. J., Haddock, G., Manstead, A. S. R., & Maio, G. R. (2020). The importance of (shared) human values for containing the COVID‐19 pandemic. *British Journal of Social Psychology*, *59*(3), 618-627. https://doi.org/10.1111/bjso.12401

Wood, M. D., Read, J. P., Mitchell, R. E., & Brand, N. H. (2004). Do parents still matter? Parent and peer influences on alcohol involvement among recent high school graduates. *Psychology of Addictive Behaviors*, *18*(1), 19-30. https://doi.org/10.1037/0893-164X.18.1.19

World Health Organization. (2020a). *Modes of transmission of virus causing COVID-19: Implications for IPC precaution recommendations: Scientific brief, 29 March 2020.* https://apps.who.int/iris/handle/10665/331616

World Health Organization. (2020b, March 11). *WHO Director-General's opening remarks at the media briefing on COVID-19 – 11 March 2020* [Press Release]. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

Yurasek, A. M., Brick, L., Nestor, B., Hernandez, L., Graves, H., & Spirito, A. (2018). The effects of parent, sibling and peer substance use on adolescent drinking behaviors. *Journal of Child and Family Studies*, *28*(1), 73-83. https://doi.org/10.1007/s10826-018-1251-9

Ziegler, F. V., & Tunney, R. J. (2012). Decisions for others become less impulsive the further away they are on the family tree. *PLoS One*, *7*(11). https://doi.org/10.1371/journal.pone.0049479

Appendix A

Supplementary Tables Study 2.1

Table A.1

Median k Values for Men and Women in Study 2.1

		Men	Women
Meeting	*Peer Absence*	0.12	0.21
	Peer Presence	0.24	0.28
	Negative Influence	0.32	0.45
Food	*Peer Absence*	0.12	0.20
	Peer Presence	0.12	0.21
	Negative Influence	0.20	0.24
Car	*Peer Absence*	0.05	0.08
	Peer Presence	0.06	0.10
	Negative Influence	0.12	0.15

Table A.2

Mann-Whitney U Analyses Comparing Risk-Taking Between Men and Women for Study 2.1

	Meeting		
	Peer Absence	***Peer Presence***	***Negative Influence***
Z	-0.91	-0.34	-1.81
Sig.	.36	.74	.07
N	320	323	323
r	-0.05	-0.02	-0.10
	Food		
Z	-0.83	-0.9	-0.14
Sig.	.41	.37	.89
N	321	325	322
r	-0.05	-0.05	-0.01
	Car		
Z	-0.99	-0.72	-0.32
Sig.	.32	.47	.75
N	320	320	319
r	-0.06	-0.04	-0.02

Table A.3

Spearman's rho Correlation Coefficients Between Age and k Values for Study 2.1

		Correlation Coefficient (r_s)	**Sig. (2-tailed)**	***N***
Meeting	*Absent*	-0.00	.97	321
	Present	-0.01	.87	324
	Negative	-0.01	.80	324
Food	*Absent*	-0.13	**.01**	322
	Present	-0.09	.10	326
	Negative	-0.14	**.01**	323
Car	*Absent*	-0.05	.40	321
	Present	-0.04	.49	321
	Negative	-0.01	.92	320

Appendix B

Supplementary Tables Study 2.2

Table B.1

Median k Values for Men and Women in Study 2.2

		Men	Women
Meeting	*Peer Absence*	0.12	0.23
	Peer Presence	0.20	0.35
	Negative Influence	0.27	0.46
	Positive Influence	0.08	0.16
Food	*Peer Absence*	0.08	0.21
	Peer Presence	0.10	0.23
	Negative Influence	0.10	0.34
	Positive Influence	0.04	0.14
Car	*Peer Absence*	0.11	0.09
	Peer Presence	0.09	0.12
	Negative Influence	0.12	0.25
	Positive Influence	0.04	0.05

Table B.2

Mann-Whitney U Analyses Comparing Risk-Taking Between Men and Women for Study 2.2

	Peer Absence	***Peer Presence***	***Negative Influence***	***Positive influence***
Meeting				
Z	-0.93	-1.58	-1.46	-1.34
Sig.	.35	.11	.14	.18
N	390	391	389	391
r	-0.05	-0.08	-0.07	-0.07
Food				
Z	-1.48	-1.60	-2.46	-1.86
Sig.	.14	.11	**.01**	.06
N	383	388	386	388
r	-0.08	-0.08	-0.12	-0.09
Car				
Z	-1.01	-0.14	-0.61	-0.99
Sig.	.31	.89	.54	.32
N	385	389	385	384
r	-0.05	-0.01	-0.03	-0.05

Table B.3

Median s Values by Scenario and Condition for Study 2.2

	Absent	*Present*	*Negative Influence*	*Positive Influence*
Meeting	0.66	0.65	0.67	0.63
Food	0.63	0.58	0.63	0.52
Car	0.73	0.75	0.76	0.61

Appendix C

Supplementary Tables Study 3.1

Table C.1

Median s Values by Scenario and Condition for Study 3.1

	Friend	***Parent***	***Partner***
Visit	0.00	0.09	0.24
Garden	0.05	0.19	0.22
Medical	0.18	0.06	0.15

Table C.2

Wilcoxon Signed-Rank Post-Hoc Analyses of s Values for Study 3.1

	Friend		
	Visit - Garden	***Visit - Medical***	***Garden - Medical***
Z	-1.78	-0.02	-0.97
Sig.	.08	.99	.33
N	226	229	225
r	-0.12	0.00	-0.06
	Parent		
Z	-0.99	-2.02	-3.09
Sig.	.32	.04	**.002**
N	230	225	230
r	-0.07	-0.13	-0.20
	Partner		
Z	-0.68	-3.35	-2.91
Sig.	.50	**.001**	**.004**
N	229	228	225
r	-0.04	-0.22	-0.19

Note. Bonferroni correction applied resulting in a critical p value of $p < .017$.

Appendix D

Supplementary Tables Study 3.2

Table D.1

Median k Values Across Probability

	95%	90%	50%	30%	10%	5%
Birthday	0.00	0.00	0.00	0.03	0.04	0.03
Garden	0.00	0.00	0.07	0.12	0.05	0.01
Medical	0.01	0.01	0.01	0.01	0.00	0.00

Table D.2

Median s Values by Scenario and Condition for Study 3.2

	#1	#10	#25	#50	#100
Birthday	0.28	0.08	-0.01	-0.01	-0.01
Garden	0.35	0.39	0.21	0.00	-0.01
Medical	0.02	0.41	0.36	0.28	0.02

Table D.3

Wilcoxon Signed-Rank Post-Hoc Analyses of s Values for Study 3.2

	Garden - Birthday	*Medical - Birthday*	*Medical - Garden*
		#1	
Z	-0.15	-3.67	-3.46
Sig.	.88	**<.001**	**<.001**
N	222	222	224
r	-0.01	-0.25	-0.23
		#10	
Z	-4.21	-3.2	-0.7
Sig.	**<.001**	**.001**	.48
N	225	217	217
r	-0.28	-0.22	-0.05
		#25	
Z	-2.74	-3.1	-0.24
Sig.	**.006**	**.002**	.81
N	226	219	218
r	-0.18	-0.21	-0.02
		#50	
Z	-3.36	-4.86	-0.81
Sig.	**<.001**	**<.001**	.42
N	226	218	216
r	-0.22	-0.33	-0.05
		#100	
Z	-2.2	-4.86	-2.5
Sig.	0.28	**<.001**	**.012**
N	223	216	211
r	-0.15	-0.33	-0.17

Note. Bonferroni correction applied resulting in a critical p value of $p < .017$.

Table D.4

Median k Values for Men and Women in Study 3.2

		Men	Women
Birthday	*#1*	0.15	0.00
	#10	0.05	0.00
	#25	0.00	0.00
	#50	0.00	0.00
	#100	0.00	0.00
Garden	*#1*	0.10	0.03
	#10	0.12	0.03
	#25	0.03	0.01
	#50	0.01	0.00
	#100	0.00	0.00
Medical	*#1*	0.00	0.00
	#10	0.39	0.46
	#25	0.18	0.15
	#50	0.07	0.06
	#100	0.00	0.00