Exploring the influence of nature exposure on decision-making

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Chapter 1: Introduction

Overview

Presently, more than 50% of the world's population lives in urban cities, an increase from 15% in 1950 (Annez & Buckley, 2009). The causes of increasing urbanization include changes in lifestyle, a transition to greater economic productivity, and space pressures. Many modern cities are dominated with impervious, inorganic, resilient structures and arranged to facilitate personal vehicles. An example of such a city is New York, which is dominated by the built environment. Consequently, these cities' biodiversity is negatively affected, and residents have difficulty accessing natural areas.

Studies suggest it is important to consider the role of design in urbanization as it can influence human health (Jackson, 2003). For example, views of wooded areas have been associated with increased speed of recovery from surgery (Ulrich, 1984). Exposure to nature is not only restorative in terms of physical recovery, but also exhibits salutogenic properties in support of emotional and mental health outcomes (Kaplan, 1995). Access to green space for leisure is related to positive mental health outcomes (Jackson, 2003). Nature also promotes positive mood, according to Kaplan's Attention Restoration Theory (ART) (1995). Supporting ART, the Biophilia hypotheses states nature contact is essential to humans' emotional well-being (Wilson, 1984).

Research supports that humans use emotions in our decision-making processes when outcomes are uncertain (Cassotti et al., 2012). Cassotti et al. found that when they exposed participants to images of positive facial expressions, this induced a decrease in the presence of the framing bias. The researchers concluded improving positive affect among participants lowered the incidence of the framing bias. This is evidence that emotions impact decision-making.

Thus, given the evidence that contact with nature is an important determinant of emotional health, and that the potential for human contact with nature is challenged with increasing urbanization, the importance of understanding how our living spaces impact our cognition is paramount. Recent

evidence that mood impacts decision-making contributes to this research projects' foundation. My research project aims to contribute to the evolving body of literature on nature in urban design by investigating whether nature exposure influences the decision-making process.

Background

A dominant theory in cognition is that human decision-making arises as a result of two cognitive processes: System 1 (intuitive) and System 2 (analytic/executive) thinking (Cassotti et al., 2012). System 1 or intuitive decisions occur when people involve their emotions while making decisions. Intuitive thinking is used for daily decisions that do not take much thought, and where choices can be made quickly. Intuitive thinking is thus used for risk-based questions, and is in contrast to System 2 (analytic/executive) thinking which is more deliberate and is less susceptible to emotional influence.

System 1 and System 2 thinking comprise much of our cognitive process in decision-making (Cassotti et al., 2012; Evans, 2008). If people rely on their emotions to make these types of decisions (i.e., primarily use of System 1 thinking) what is known as "the framing bias" can occur (Cassotti et al., 2012). The framing bias occurs when people are faced with equal outcome questions that are worded (or framed) as gains or losses (Cassotti et al., 2012). The framing bias is defined as inconsistent decision-making for equal outcome questions and arises with risk-based questions, where outcomes are uncertain at the time of decision-making (Kahneman & Tversky, 1984). For example, consider the following two questions developed by Kahneman and Tversky (1984):

> 1) Would you accept a gamble that offers a 10% chance to win $95 and a 90% chance to lose $5?
> 2) Would you pay $5 to participate in a lottery that offers a 10% chance to win $100 and a 90% chance to win nothing?

The above two questions have the same expected outcome, however in problem 1 the question is framed as a loss, and in problem 2 the question is framed as a cost. Kahneman and Tversky (1984) found that 55 of 132 undergraduate students agreed to one gamble, but not the other, despite the same expected outcome. This illustrates the framing bias influenced decisions for nearly half of the participants. With the presence of the framing bias, there is a preference for risk taking with losses

(Cassotti et al., 2012; Kahneman & Tversky, 1984). Thus, a perceptual illusion (false understanding) is formed from people's emotions that result in a preference of one outcome over another in two equal outcome gambles (Kahneman & Tversky, 1984). Again, this is an example of how intuitive thinking (which factors emotions into decision-making) creates a framing bias. Positive emotional context is associated with less risk taking in the losses realm, which is known as loss aversion (Cassotti et al., 2012; Kahneman & Tversky, 1984). Thus, risk-taking behaviour is influenced by emotions.

There is evidence that two-dimensional (i.e., images and sounds) nature exposure has cognitive and emotional healing properties according to Kaplan's ART (1995). Nature exposure in this paper is classified as two-dimensional. ART suggests nature exposure promotes a positive mood (Kaplan, 1995). In light of these findings, it is prudent to evaluate nature's cognitive impact on humans, and whether this impact creates differences in decision-making outcomes via an emotional pathway. Understanding nature's cognitive impact on humans is important since many people work and make decisions in office environments that have limited access to nature. This includes decision-makers who create and implement policy, marketers interested in selling products, and consumers' spending decisions. For example, support for a public service program may change depending on how the project benefits and costs are presented to the decision-maker. This research has many applications in understanding the human process of decision-making.

Summary of Literature

Literature in economics has explored the decision-making processes and flaws among decision makers (Kahneman & Tversky, 1984). Kahneman & Tversky's research found that people violate the rational assumption of invariance (i.e., holding two options as equivalent despite their differences in wording) when they are faced with probability-based questions (1984). This is known as the framing bias, with evidence that it is influenced by emotions and has consequences on choices (Kahneman & Tversky, 1984; Cassotti et al., 2012). Furthermore, research indicates people are known to make greater risks with gambles in the losses realm relative to risks with gambles in the gains realm (Kahneman & Tversky,

1984). An example of this is the results from a question posed by Kahneman and Tversky to study participants:

> Imagine that you face the following pair of concurrent decisions. First examine both decisions, then indicate the options you prefer.
>
> Decision 1) Choose between:
> A. a sure gain of $240
> B. 25% chance to gain $1000 and 75% chance to gain nothing
>
> Decision 2) Choose between:
> C. a sure loss of $750
> D. 75% chance to lose $1000 and 25% chance to lose nothing

For Decision 1, 84% of respondents chose A, and for Decision 2, 87% of respondents chose D. This result shows that the majority of participants preferred a sure gain (with a smaller expected value), but also prefer gambling with the possibility of a greater loss to avoid a smaller, but certain, loss.

In the field of psychology, research has investigated the influence of positive emotional contexts on decision makers by showing them pictures of varying facial expressions (Cassotti et al., 2012). Cassotti et al.'s study found a positive link between exposing participants to positive facial expressions and a positive emotional environment (i.e., a positive mood), and that this eliminated the framing bias, and significantly reduced risk seeking in the losses realm. Cassotti et al's study formed a basis of evidence of the impact of positive emotions on decision-making for this study.

Turning now to literature in environmental science, the ART suggests that nature has restorative benefits (Kaplan, 1995). Other research has supported ART, finding that natural environments promote positive moods, while urban environments with a low presence of nature increase stress (Velarde, Fry & Tveit, 2007). There is evidence that positive emotions have an influence on decision-making, and that natural and urban environments promote different cognitive/emotional states (Cassotti et al., 2012; Velarde, Fry & Tveit, 2007). There has been no published work to date connecting the influence of nature exposure on decision-making.

Study Introduction

The objective of this study is to determine if exposure to images and sounds of nature influences risk-based decision-making. Specifically, this study will examine whether exposure to 2 dimensional nature creates a positive mood among participants, measured by the elimination of the framing bias and increased loss aversion. The effects of nature exposure are being examined because there is an opportunity to incorporate exposure into indoor workspaces. Furthermore, nature exposure can be easily regulated and controlled for variability among study participants (i.e., the exposures are identical).

Primary research question:

1) *Does two-dimensional nature exposure influence decision-making?* Where "influence" is measured as changes to loss aversion and the framing bias.

Summary of Approach

My study is limited to registered part- or full-time students at Dalhousie University, Halifax, Nova Scotia. Participants will sign up through an optional course credit point online system (SONA) offered through Dalhousie University. SONA gives credit points for students in psychology classes so that student participants will be limited to those enrolled in a psychology course. This study is experimental in design and employs a pre- and post-measure design among three conditions. One hundred and twenty participants were recruited over two months which provided an adequate sample size to power the analysis.

Valid and reliable measures were used to assess baseline and post-exposure mood, nature relatedness, and risk-taking preferences. The analysis was divided into three research questions that sought to answer the primary research question. These subsidiary research questions were:

1) *Is there a difference between this study's decision-making question results and Kahneman and Tversky's 1984 study results?* These results provided insight as to whether exposure had an impact on decision-making.

2) *Is there a difference in decision-making between this study's three conditions?* This examined whether condition type varied results between the study conditions.
3) *Is there a difference in mood across conditions?* This highlighted whether condition influenced positive and/or negative affect.

SPSS Statistics was used to run all statistical tests. Kahneman & Tversky's (1984) study provides an explanation for each question as to what it is measuring, along with an explanation of what the participant responses indicate.

Chapter 2: Literature Review

This literature review explores the need for and reasoning behind studying whether nature exposure influences decision-making for risk-based questions. Relevant fields for this study include environmental science, economics, and psychology. Most research articles collected for this literature review were found through Web of Science and other multidisciplinary databases available through Dalhousie University Libraries. Search terms included, but were not limited to: nature, urbanization, nature relatedness, dual process theory, attention restoration theory, nature exposure, risk, and decision-making. References to associated literature were reviewed to find related studies and expand the literature search. Please note that for repetition's sake, for the remainder of this paper "Kahneman & Tversky's research" refers to their 1984 publication (please see References).

The world is urbanizing, with more than 50% of the world's population now living in cities, compared to 15% in 1950 (Annez & Buckley, 2009). Urbanization is defined as the movement of people to urban cities, where city growth rates are an indicator of the rate of urbanization (Annez & Buckley, 2009). A consequence of urbanization is the decline in natural landscapes as a proportion of all land uses, particularly in urban and sub-urban areas. Since there is evidence that nature exposure increases an individual's capacity for voluntary attention, a decrease in exposure to natural landscapes is likely to

negatively affect attention and stress (Kaplan, 1995). Thus there is a need to explore how reductions in exposure to natural landscapes influence decision-making.

Mental and emotional responses to urban and natural environments can be positive or negative depending on the type of exposure. Urban parks have comparatively lower restorative benefits when compared with coastal views, woodlands, forests, hills, moorland, and mountains (White, Pahl, Ashbullby, Hebert & Depledge, 2013). White et al. defined restorative benefits in their study as feelings of calm, relaxation, revitalization, and refreshment. In cities, increased biodiversity is positively associated with increased (self-reported) restorative benefits among humans (Carrus et al., 2015). Carrus et al. used the Perceived Restorativeness Scale which measured participants psychological and physical benefits to nature exposure. There is also evidence that natural environments decrease stress and promote sustained attention. Viewing nature reduces anger and anxiety, and helps sustain attention (St. Leger, 2003). Furthermore, research shows that people living in urban cities who spend a few days in a natural environment have a reduction in mental fatigue and improved critical thinking (St Leger, 2003). These results suggest that exposure to different environments illicit varying degrees of positive or negative emotions.

Mood can influence our decision-making processes for everyday decisions where, often, the outcomes lack certainty (Kahneman, 2003; Cassotti et al., 2012; Habib et al., 2015). Before understanding how this influence happens, we will first explore what risk-based (or risky) questions are. Risky questions are defined as having unexpected outcomes at the time of decision-making (Kahneman & Tverksy, 1984). Decision-makers are typically risk averse, with risk aversion being inversely associated with wealth (Kahneman & Tverksy, 1984). When decision makers are faced with risky questions, they are usually risk averse, particularly when a certain gain versus a larger, but uncertain gain are the two outcomes (Kahneman & Tverksy, 1984). This relationship can be seen in Figure 1.

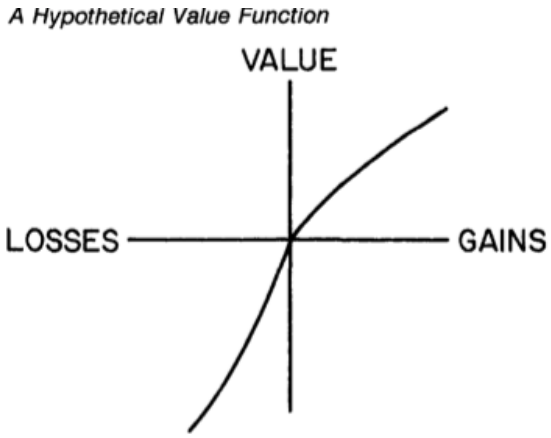


Figure 1 A (hypothetical) value function. This graph represents a decision maker's perceived value of a gain with decreasing marginal returns to value as the amount of the gain increases (top right quadrant). This explains why decision-makers must have a relatively stronger alternate choice to gamble with gains. In the losses quadrant (bottom left quadrant), small losses have a steeper slope of value that begins to flatten out more as losses become greater. Image source: Kahneman & Tversky, 1984.

Rational choice theory is a classic economic theory for decision-making that does not factor in the influence of emotions (Kahneman & Tverksy, 1984). Theoretically, a person using rational choice to make decisions will evaluate their options by calculating expected outcome. Expected outcomes for risk-based questions can be calculated by multiplying the percentage probability of option A with the monetary outcome of option A, and adding this to the other options (i.e. [probability A*value A] + [probability B*value B] +… = expected monetary outcome).

Rational choice theory requires dominance and invariance to hold (Kahneman & Tversky, 1984). Dominance implies that the option with the best-expected outcome is preferred (Kahneman & Tversky, 1984). Invariance means that preferences for decision outcomes should not be based on the way they are phrased/framed (Kahneman & Tversky, 1984). Thus, rational choice theory purports that decision processes are inherently objective. However, this does not mean people can easily conform to this process, due to emotional influences such as the framing bias (Habib, Cassotti, Moutier, Houdé, & Borst, 2015).

A framing bias is formed when decision-makers make inconsistent decisions for equal expected outcome questions that are phrased (i.e. "framed") differently (Kahneman & Frederick, 2007). Question

framing causes a form of bias that introduces subjectivity to the process of making rational decisions, usually through the careful selection of specific words or phrases. The words “keep” and “lose”, for example, promote emotional responses when deciding to accept or reject a gamble. Thus phrases and terms used when asking a risk-based question are influential. For example, consider a decision-maker deciding whether the benefits outweigh the costs associated with a carbon tax program. The terms/framing used to present the costs to the decision maker will influence their decision, despite the objective information regarding the costs and benefits.

The framing bias is influenced from emotions and has the potential to influence decisions regarding risky questions that are inconsistent with rational choice theory. Participants that are less susceptible to the framing effect (i.e. framing an equivalent outcome as a gain or loss) are considered more rational, and there is a fair degree of variation in rationality among decision makers (Kahneman & Frederick, 2007). People’s ability to control their System 1 intuitive thinking influences whether they experience the framing bias (Cassotti et al., 2012). For example, someone who used emotions to come to decisions with uncertain outcomes (i.e. System 1 intuitive thinking) experiences a greater presence of the framing bias compared to those that can constrain System 1 processing. While it is unclear to what degree the world’s population can control the framing bias susceptibility, Habib et al. agree from their findings that the framing effect is common among decision-makers regarding risky decisions (Habib et al., 2015). Knowing that people are influenced by emotions in the decision-making process, it is critical to review measures to assess if and to what extent people experience this influence. These measures are loss aversion and the framing bias.

Loss aversion, or the degree to which people are averse to a loss (Kahneman & Tversky, 1984), is a measure that can be used to determine the influence of emotion on decision-making. Sure gains are very attractive, whereas sure losses are very unattractive when compared with probable losses (Kahneman & Frederick, 2007). Thus, greater loss aversion with gambles in the gains realm is expected in comparison with less loss aversion (i.e. risk seeking) for gambles in the losses realm (Kahneman & Tversky,

1984). The above paragraphs have outlined different theories explaining how decision-making processes are formed when people encounter decision-making choices. This literature review will now review how emotions influence the framing bias and loss aversion.

According to work in the economics field, emotions influence the decision-making process via the reflection effect through altering loss aversion and the framing bias. Positive emotional contexts (achieved by showing participants positive emotional images) reduces loss aversion and eliminates the framing bias (Cassotti et al., 2012). Furthermore, fear and anger induce more or less risk-taking respectively in the gains realm (Habib et al., 2015). Therefore, intuitive judgment is very accessible and is used quickly to arrive at responses. When used in the decision-making process, it can trigger the framing bias (Kahneman, 2003).

Mood also influences the decision-making process through altering loss aversion and the framing bias. The somatic marker hypothesis and System 1 intuitive thinking process support this idea. The somatic marker hypothesis states that emotions influence everyday, rational decision-making through marker signals that arise during bioregulatory processes in the brain (Bechara & Damasio, 2005). This means that emotions trigger a physical change via activation of certain brain regions. The preference for equivalent outcome choices framed as gains (Kahneman & Tversky, 1984) supports the use of System 1 thinking (Kahneman, & Frederick, 2007). A foundation has been laid for understanding how people involve emotions while making choices. This literature review will now seek to explain how our environments, specifically natural environments, influence our emotions.

The Attention Restoration Theory (ART) states that nature supports restoration from mental fatigue (Kaplan, 1995). The Biophilia hypotheses states humans have an inherent need for a physical, emotional, and spiritual connection with nature (Wilson, 1984). ART and the Biophilia hypotheses have been supported through subsequent research that suggests nature exposure lowers mental fatigue, improves critical thinking, and reduces anger and anxiety (St Leger, 2003; Velarde, Fry & Tveit, 2007). Exposure to natural landscapes have also been associated with short-term recovery from stress and/or

mental fatigue (Velarde et al., 2007). Ecospychology is the relationship between ecology and psychology to study humans' cognitive interactions with nature (Conn, 1998). According to ecopsychology, the disconnect of humans with their natural world via urbanization has caused negative mental and emotional consequences for humans (Conn, 1998). For example, the joy and happiness of human interaction with nature has diminished with humans' diminishing opportunities to immerse themselves in nature (Conn, 1998). This evidence suggests nature exposure improves (and is necessary for) mental and emotional health. Understanding that nature exposure influences emotions has implications for decision-making since negative and positive emotions can be measured and compared with decisions.

Images of nature are effective in eliciting similar emotional and mental benefits as exposure to real natural environments. Students ranked images of natural settings over images of urban settings when asked to classify images based on their restorative properties (Herzog, Black, Fountaine & Knotts, 1997). In another study, participants described pictures of rural scenes as peaceful, in contrast to pictures of urban settings that were not perceived as peaceful (Kim et al., 2010). In other research, females experienced less stress and anger while exposed to paintings of plants in an office setting compared to abstract paintings and no paintings (Kweon, Ulrich, Walker & Tassinary, 2008).

There is also evidence that urban exposure impacts mood. In a study by Lederbogen et al., urban dwellers experience negative impacts to their social evaluative stress processing abilities (2011). This results in high reported levels of stress and other mental health disorders (Lederbogen et al., 2011). Furthermore, Nutsford et al. found that increased observable and active access to green spaces for urban dwellers was correlated with improved mental health (Nutsford et al., 2013). The preceding evidence indicates that nature and urban environments impact positive and negative emotions, particularly those related to stress.

This research is innovative and will contribute to a gap in the literature around decision-making and nature exposure. No studies have appeared in the literature that have the same research design and

goals as this study. There is a gap in the literature linking nature exposure, positive emotional affect, and emotion's influence on decision-making. There is, however, support in all these areas- it is the connection between them that is missing. Understanding whether nature and urban exposure impacts decision-making has applications for urban design. It may support the integration of green spaces in urban environments, and the benefits of reducing noise pollution in cities to lessen negative mood. These changes could be achieved on a small scale through individual choices (i.e. decorating a home or office), or on a large scale through city design (i.e. policy makers enforcing the development of green spaces).

Chapter 3: Methods

The methods employed in this study were designed to explore the influence of three 2 dimensional exposures on positive/negative affect, and rationality in the decision-making process.

Study sample

The study employed a non-probabilistic convenience sampling approach, drawing from students enrolled in psychology course(s) at Dalhousie University. Recruitment occurred through the Department of Psychology and Neuroscience SONA system which allowed students to sign up for psychology-affiliated studies. This study offered 0.5 credit points towards a student's psychology class in exchange for their participation. Students were given the option for their data to be used or not used for analysis (i.e., participant or observer) with no penalty associated with choice. Dalhousie's research ethics and SONA review boards approved this study.

Research tools

Research tools include mood and nature affiliation scales, as well as a series of risk-based questions adapted from Kahneman and Tversky's study. The PANAS (Positive and Negative Affect Schedule) assessed self-reported mood using a 20-item scale (see Appendix 2 for PANAS scale). Participant mood was measured at baseline and following a five-minute exposure to one of three conditions. Pre- and post-

exposure measurement of mood is necessary to evaluate the influence of experimental condition on mood. Positive affect was calculated by summing values for items 1, 3, 5, 9, 10, 12, 14, 16, 17 and 19 (Watson, Clark & Tellegan, 1988). Negative affect was calculated by summing the values for items 2, 4, 6, 7, 8, 11, 13, 15, and 18. Scores ranged from 10-50, with higher scores indicating greater positive/negative mood.

The Nature Relatedness (NR) scale includes seven items and requires respondents to reflect on their relationship with, and dependence on nature (see Appendix 2 for the NR scale). During the development of the short form NR scale (NR-6), Nisbet & Zelenski found there was no statistically significant difference in reliability or validity found between the NR-6 and long form scales (2013). NR scores are calculated by summing item scores, where the totals indicate the strength of an individual's nature connectedness (Nisbet & Zelenski, 2009). The NR scale is an important measure to include as it reveals participants' existing connections with the natural environment, thus acting as a control for individuals' varying connections with nature. This is important to control for because participants with higher NR scores may be more positively affected by the nature exposure than participants with lower NR scores.

Decision questions adapted from Kahneman and Tversky's study were employed to evaluate the influence of experimental condition on decision-making. The decision questions were originally designed to test for the presence of the framing bias and loss aversion in the decision-making process. Table 1 provides a list of questions used for this study along with an explanation of what each question is attempting to measure.

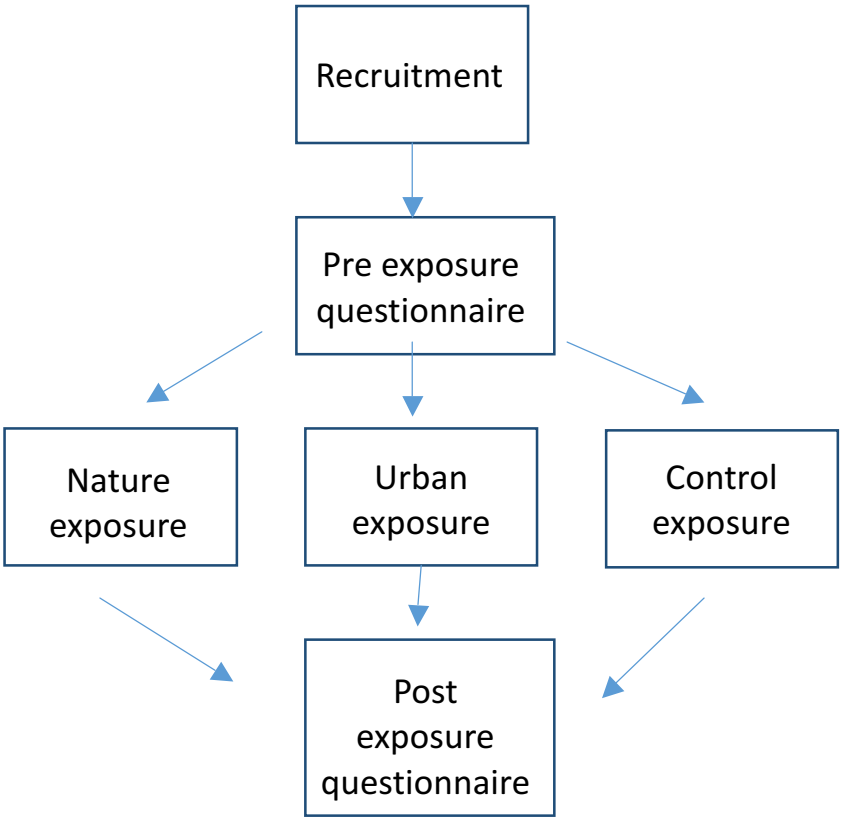
Table 1. Risk questions in the post-exposure questionnaire and their measures. All questions are from Kahneman & Tversky's 1984 study.

Question	Measure
1. Choose between: A. 25% chance to win $240 and 75% chance to lose $760 B. 25% chance to win $250 and 75% chance to lose $750	Analysis 1: % of study respondents answering A versus B. Analysis 2: Comparing % of respondents answering A versus B within each group. (test for rational decision-making)
2. Imagine that you face the following pair of concurrent decisions. First examine both decisions, then indicate the options you prefer. Decision (i) Choose between: A. a sure gain of $240 B. 25% chance to gain $1000 and 75% chance to gain nothing Decision (ii) Choose between: C. a sure loss of $750 D. 75% chance to lose $1000 and 25% chance to lose nothing	Analysis 1: % of study respondents answering A for Decision (i) & D for Decision (ii). Analysis 2: comparing the frequency of A & D responses between groups. (test for preference of a sure gain and preference for a gamble with a loss (loss aversion expressed in the gains realm))
3. Would you pay $5 to participate in a lottery that offers a 10% chance to win $100 and a 90% chance to win nothing? A. Yes B. No 7. Would you accept a gamble that offers a 10% chance to win $95 and a 90% chance to lose $5? A. Yes B. No	**Q. 3 must be compared with Q. 7 to test for the presence of the framing bias. Analysis 1: % of A for Q.3 & A for Q.7 **and** B for Q.3 & B for Q. 7. Analysis 2: comparing the frequency of responses (as described in Analysis 1 above) between the three groups. (test for no presence of framing bias)
4. Consider the following two-stage game. In the first stage, there is a 75% chance to end the game without winning anything and a 25% chance to move into the second stage. If you reach the second stage you have a choice between: A. a sure win of $30 B. 80% chance to win $45 Your choice must be made before the game starts, i.e., before the outcome of the first stage is known. Please indicate the option you prefer. 5. Which of the following options do you prefer? A. 25% chance to win $30 B. 20% chance to win $45	**Q. 4 must be compared with Q. 5 to test for the presence of the framing bias. Analysis 1: % of A for Q.4 & A for Q.5 and B for Q.4 & B for Q.5 overall. Analysis 2: comparing the frequency of responses (as described in Analysis 1 above) between the three groups. (test for framing bias: A & A and B & B have equivalent expected outcomes (choice influenced by the two stages of the game- the weight of the potential winnings in second stage for Q.4 is compounded))
6. Imagine that you have decided to see a play where admission is $10 per ticket. As you enter the theater, you discover that you have lost a $10 bill. Would you still pay $10 for a ticket for the play? A. Yes B. No 8. Imagine that you have decided to see a play and paid the admission price of $10 per ticket. As you enter the theater, you discover that you have lost the ticket. The seat was not marked, and the ticket cannot be recovered. Would you pay $10 for another ticket? A. Yes B. No	**Q. 6 must be compared with Q. 8 to test for the presence of the framing bias. Analysis 1: % of A & A and B & B within overall. Analysis 2: comparing the frequency of responses (as described in Analysis 1 above) between the three groups. (test for invariance between the two options)

Study procedure

A Protocol Manual was developed and provides a detailed overview of the study protocol (Appendix 2). An overview of the study procedure is shown in Figure 2.

Figure 2 Study procedure



The five-minute exposure consisted of a PowerPoint presentation shown on a desktop monitor that included twenty unique images and sounds developed for each of the three condition groups (i.e., nature, urban, and control). The nature exposure group slides included images of natural landscapes, the majority of which were terrestrial (see Appendix 2)). The images were selected based on their restorative properties (Velarde et al., 2007).

The urban exposure group slides included images of typical urban environments and were absent of vegetation or other natural features. The control group viewed slides of random images with no

natural or urban environments. Individual slides for all conditions were shown for 15 seconds resulting in a five-minute exposure time for each participant.

Data analysis

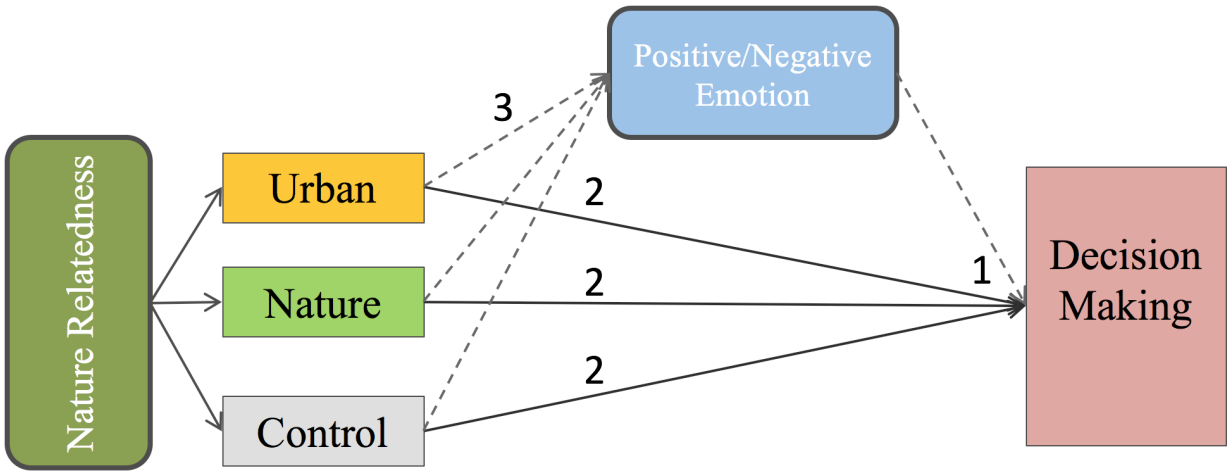
Data were recorded on paper and then manually entered in an Excel spreadsheet for import into software for statistical analysis (SPSS, 2012). A formative analysis was completed after 60 participants to ensure the appropriateness of statistical procedures for the data under collection, and to evaluate emerging patterns.

Data were grouped according to exposure condition and descriptive statistics were calculated to evaluate age and sex characteristics as well as NR scores for each condition. The key variables of interest for data analysis were the presence and frequency of framing bias among participants within each condition, and indications of loss aversion captured from participant responses to decision making questions.

Data were analyzed in three separate stages:

1) **Analysis 1** assessed whether there were differences in the risk-based decision question responses between this study and Kahneman & Tversky's study. For comparison, data were combined for all three experimental conditions.
2) **Analysis 2** evaluated whether responses to decision making questions were statistically different among the three experimental conditions.
3) **Analysis 3** investigated if PANAS scores varied significantly among experimental condition groups to see if participant mood was influenced by condition exposure.

Figure 3 Analytic pathways investigated through this research. The first path (1) investigates the direct association between exposure to any condition and decision-making. The second path (2) examined differences in decision-making responses among the three experimental groups. The third path (3) quantified the relationship between exposure condition and mood.



See Figure 3 above for a visual representation of the research pathways of this study. For Analysis 1, the chi-square statistic was employed to test for equality of calculated proportions between grouped responses (all three conditions) and responses published in Kahneman & Tversky's study. Significance was calculated using a z-score calculator for two independent samples with different sample sizes (Stangroom, 2016). The chi-square test was also employed in Analysis 2 to evaluate equality of the proportion of responses for decision-making questions amongst the three experimental conditions.

In Analysis 3, chi square tests were used to compare proportions. One-way ANOVAs were also employed to identify the source of variations in mood between experimental conditions. Univariate ANCOVAs were also used to identify the variable(s) causing differences in mood among experimental conditions. Condition and changes to positive and negative pre- and post-exposure affect scores were used as the measures of comparison.

Chapter 4: Results

Demographics

Females dominated the sample (82%, n=94). All three conditions had a majority of females (Table 2). Participant age ranged between 18 and 44 years, and the majority of participants were between the age of 18-22 years (92%, n=105). The mean age was 20.3 years (SD=3.4 years). The majority of participants (39%, n=45) were studying psychology, with students in neuroscience (12%, n=14) and medical sciences (11%, n=13) being the second and third most common major, respectively.

No significant differences in nature relatedness (NR) scores were found across the three conditions (nature: μ=3.1, SD=0.8; urban: μ=3.2, SD=0.9; and control: μ=3.3, SD=0.6; $F_{(2, 113)}$ =.738, p= .480)). The overall mean NR score was μ=3.2 (SD=0.8). The lack of variation in NR scores across conditions removes NR as a factor in explanations of differences in decision making responses and mood outcomes.

Table 2. Distribution of sex by condition.

Sex	**All (n=114)**	**Nature (n=41)**	**Urban (n=37)**	**Control (n=36)**
Female	82% (n=94)	93% (n=37)	70% (n=26)	86% (n=31)
Male	18% (n=20)	7% (n=4)	30% (n=11)	14% (n=5)

Analysis 1: Comparison of this study's results to Kahneman and Tversky's results

The aim of Analysis 1 was to compare the results from this study to Kahneman and Tversky's study.

Hypotheses for each of the eight risk based questions are below:

H_0: There is no significant difference between the responses from Kahneman and Tversky's 1984 study and this study.

H_1: There is a significant difference between the responses from Kahneman and Tversky's 1984 study and this study.

Note: Due to missing data, (i.e., participants did not respond to all questions) the sample size was not always n=114.

When compared to Kahneman and Tversky (1984), participants answered four of the eight questions differently (Table 3). For example, Question 2 results in Kahneman and Tversky's study showed that 84% (n=126) of participants preferred option 1 for decision I, and 87% (n=131) preferred option 2 for decision II, which is significantly different than the results of this study (73% and 79%, respectively). Further analysis highlighted that the control and nature groups were the source of the significant differences for Question 2 comparisons. A significant difference also appeared for Question 4. In Kahneman and Tversky's study, 74% (n=63) of participants answered yes to Question 4, whereas 59% (n=66) of participants in this study answered yes. These significant differences were found in the urban and control groups. Finally, Question 8 responses varied significantly for the overall group and each condition, when compared to Kahneman and Tversky's results. Kahneman and Tversky had 46% (n=92) respond yes to Question 8, whereas a comparatively higher percentage responded yes in this study overall and for each condition.

Kahneman and Tversky's 1984 paper reported results for Questions 3 and 7 as the percentage and number of participants that expressed opposite answers to these two equivalent outcome questions. Therefore, in Table 3, question 3 and 7 for this study's results were reported as R3_Recode (a recoded format) for ease of comparison to Kahneman and Tversky's results (1984). See Table 4 for a description of the recoded questions.

Table 3. Decision-making responses compared by study condition.

Risk question	All (N=114)	Nature (n=41)	Urban (n=37)	Control (n=36)
Question 2, Decision I	Option 1 (A): 73% (n=82)* Option 2 (B): 27% (n=30)	Option 1 (A): 78% (n=31) Option 2 (B): 28% (n=9)	Option 1 (A): 73% (n=27) Option 2 (B): 27% (n=10)	Option 1 (A): 69% (n=24)* Option 2 (B): 31% (n=11)
Question 2, Decision II	Option 1 (A): 21% (n=23) Option 2 (B): 79% (n=89)*	Option 1 (A): 29% (n=12) Option 2 (B): 71% (n=29)*	Option 1 (A): 11% (n=4) Option 2 (B): 89% (n=33)	Option 1 (A): 20% (n=7) Option 2 (B): 80% (n=28)
Question 3	Yes (A): 37% (n=42) No (B): 63% (n=72)	Yes (A): 37%(n=15) No (B): 63% (n=26)	Yes (A): 32% (n=12) No (B): 68% (n=25)	Yes (A): 42% (n=15) No (B): 58% (n=21)
Question 7	Yes (A): 49% (n=56) No (B): 51% (n=58)	Yes (A): 49% (n=20) No (B): 51% (n=21)	Yes (A): 46% (n=17) No (B): 54% (n=20)	Yes (A): 53% (n=19) No (B): 47% (n=17)
R3_Recode	Yes/Yes or No/No: 65% (n=74) Yes/No, No/Yes: 35% (n=40)	Yes/Yes or No/No: 68% (n=28) Yes/No, No/Yes: 32% (n=13)	Yes/Yes or No/No: 59% (n=22) Yes/No, No/Yes: 41% (n=15)	Yes/Yes or No/No: 67% (n=24) Yes/No, No/Yes: 33% (n=12)
Question 4	Yes (A): 59%(n=66)* No (B): 41% (n=46)	Yes (A): 62% (n=24) No (B): 38% (n=15)	Yes (A): 57%(n=21)* No (B): 43% (n=16)	Yes (A): 58% (n=21)* No (B): 42% (n=15)
Question 5	Yes (A): 45% (n=51) No (B): 55% (n=63)	Yes (A): 44% (n=18) No (B): 56% (n=23)	Yes (A): 46% (n=17) No (B): 54% (n=20)	Yes (A): 44% (n=16) No (B): 56% (n=20)
Question 6	Yes (A): 90%(n=103) No (B): 10% (n=11)	Yes (A): 95% (n=39) No (B): 5% (n=2)	Yes (A): 86% (n=32) No (B): 14% (n=5)	Yes (A): 89% (n=32) No (B): 11% (n=4)
Question 8	Yes (A): 67% (n=76)* No (B): 33% (n=38)	Yes (A): 68% (n=28)* No (B): 22% (n=13)	Yes (A): 68%(n=25)* No (B): 22% (n=12)	Yes (A): 64% (n=23)* No (B): 36% (n=13)

*Significant when $p<0.05$ for a one-tailed z score.
** Significant differences when compared with Kahneman and Tversky's results (1984) are denoted with an asterisk.
***Note: Sample size varied (+/- 2) for groups because of incomplete questionnaires during data collection.
****See Appendix 2, Post Exposure Questionnaire to see the full questions.

Analysis 2: Comparison of risk-based question responses between conditions

The aim of Analysis 2 was to compare the eight risk-based question responses between the study's three conditions. The hypotheses are below:

H_0: There is no significant difference in the proportion of question responses between conditions.

H_1: There is a significant difference in the proportion of question responses for one or more of the conditions.

For Analysis 2, the original questions were recoded to compare rational versus irrational question responses between conditions. The recoding provided an opportunity to investigate the proportion of participants who made consistent choices. For example, Question 3 and 7 have equivalent outcomes, (i.e., have equal expected outcomes for losses and gains; see Table 1). Therefore, recoding Question 3 and 7 to R3_Recode allowed for a binary analysis of consistent and non consistent decision-making. Recoded question statistics thus identified the framing bias and changes to loss aversion, depending on the question comparison. See Table 4 for the recodes of the decision-making questions.

The measure "typical characteristics of decision making" was used to compare the proportion of respondents within each condition that were averse to risk in the gains realm, and sought risk in the losses realm (Table 5). This measure highlighted differences in decision making among conditions. There were no significant differences for R2_Recode responses between conditions (Table 5). The other questions used the "framing bias" as a measure to determine if the frequency of inconsistent decision-making varied between conditions. There was non significant variation of the presence of the framing bias between each condition (Table 5).

Table 4. Recodes for risk-based questions.

Original Label	**Recoded Label**
Question 2, Decision I and Question 2, Decision II	**R2_Recode**: if Decision I=A and Decision II=D are chosen
Question 3 and Question 7	**R3_Recode**: if Question 3=A and Question 7=A OR Question 3=B and Question 7=B are chosen
Question 4 and Question 5	**R4_Recode**: if Question 4=A and Question 5=A OR Question 4=B and Question 5=B are chosen
Question 6 and Question 8	**R6_Recode**: if Question 6=A and Question 8=A OR Question 6=B and Question 8=B are chosen

Table 5. Recoded risk questions with a description of measures used to derive response values.

Recoded Question	Measure	Response			
		All (n=114)	*Nature* (n= 41)	*Urban* (n=36)	*Control* (n=36)
R2_Recode	Loss aversion in gains, risk seeking in losses realm (**typical characteristics of decision makers**)	Typical: 58% (n=65) Atypical: 42% (n=47)	Typical: 51% (n=21) Atypical: 49% (n=20)	Typical: 66% (n=24) Atypical: 33% (n=12)	Typical: 57% (n=20) Atypical: 43% (n=15)
R3_Recode	Presence of the **framing bias** measured by lack of invariance between question responses (i.e. inconsistent choices for equal outcome questions).	No framing bias: 65% (n=73) Framing bias: 35% (n=39)	No framing bias: 66% (n=27) Framing bias: 34% (n=14)	No framing bias: 61% (n=22) Framing bias: 39% (n=14)	No framing bias: 69% (n=24) Framing bias: 31% (n=11)
R4_Recode	Presence of the **framing bias** measured by lack of invariance between question responses	No framing bias: 49.6% (n=56) Framing bias: 50.4% (n=57)	No framing bias: 49% (n=20) Framing bias: 51% (n=21)	No framing bias: 47% (n=17) Framing bias: 53% (n=19)	No framing bias: 53% (n=19) Framing bias: 47% (n=17)
R6_Recode	Presence of the **framing bias** measured by lack of invariance between question responses	No framing bias: 71% (n=81) Framing bias: 29% (n=33)	No framing bias: 68% (n=28) Framing bias: 32% (n=13)	No framing bias: 78% (n=28) Framing bias: 22% (n=9)	No framing bias: 69% (n=25) Framing bias: 31% (n=11)

*A between-subject effect test showed sex significantly influenced R2_Recode responses ($F_{(2, 111)}$ =5.394, p= .02). Age and Condition did not have significant between-subject effects on the Recode responses.

Analysis 3: Condition exposure and mood

The aim of Analysis 3 was to investigate if there was a relationship between condition exposure (i.e. nature, urban, or control) and PANAS mood scores. The hypotheses are below:

H_0: There is no significant difference between condition exposure and PANAS mood scores.

H_1: There is a significant difference between one or more conditions and PANAS mood scores.

When mood scores were compared between conditions, the negative affect scores were significantly different for post-exposure PANAS ($F_{(2,112)}$ =11.15, $p < 0.01$). A Post-Hoc Multiple Comparisons Bonferroni test was run with the negative scale for post-exposure mood score as the dependent variable, and condition as the factor. The nature and urban conditions had significantly different post-exposure mood score means (nature μ=11.5, SD=2.6; urban μ=16.1, SD=5.1). The mean difference of nature and urban post-exposure PANAS scores was 4.54, ±0.97, p <0 .01). The urban and control condition (μ=13.2, SD=4.4) also had significantly different means (μ difference=2.80, ±1.00, p=0.018).

PANAS results for the positive affect scale were not significant, meaning there were no differences between the three conditions ($F_{(2, 112)}$=0 .55, p =0 .58). Nonetheless, the conditions' positive affect mean scores indicate that only the nature condition had a (not significant) positive increase between pre- and post-exposure scores. The pre-exposure nature condition had a mean of 23.4, SD=5.8, and the post-exposure nature condition had a mean of 25.1, SD=6.8 (see Table 6).

Table 6. Pre- and post-exposure PANAS scores for each study condition.

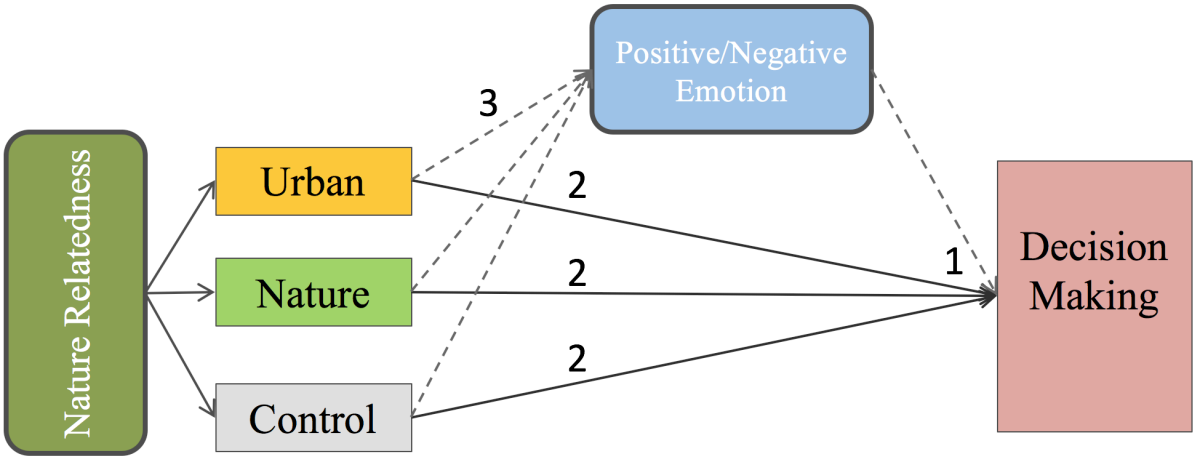
Measure	**All (n=114)**	**Nature (n=41)**	**Urban (n=37)**	**Control (n=36)**
Pre-exposure positive affect	μ=25.2 SD=6.3	μ=23.4 SD=5.8	μ=25.8 SD=6.0	μ=26.5 SD=6.8
Post-exposure positive affect	μ=24.2 SD=7.4	μ=25.1 SD=6.8	μ=23.3 SD=8.2	μ=24.1 SD=7.4
Pre-exposure negative affect	μ=13.9 SD=4.6	μ=13.6 SD=5.0	μ=14.5 SD=5.2	μ=13.7 SD=3.2
Post-exposure negative affect	μ=13.5 SD=4.6	μ=11.5 SD=2.6	μ=16.1* SD=5.4	μ=13.3 SD=4.4

*Significant difference of scores are denoted with an asterisk.
**Note: Sample size varied (+/- 1) for groups because of incomplete questionnaires during data collection.

Chapter 5: Discussion

This study investigated the impact of nature and urban exposure on risk-based decision-making, and condition's impact on mood. See Figure 3 for a visual explanation of the research pathways explored in this study. This figure situates the results from this study. The results suggest there is no relationship between nature exposure and decision-making (pathway 1, Figure 3). Furthermore, there is no difference between exposure type and decision-making (pathway 2, Figure 3). However, there is a relationship between exposure type and negative affect (pathway 3, Figure 3), which is consistent with previous research (see Chapter 2). Specifically, urban exposure is associated with a greater impact on negative affect post exposure PANAS scores.

Figure 3 Analytic pathways investigated through this research. The first path (1) investigates the direct association between exposure to any condition and decision-making. The second path (2) examined differences in decision-making responses among the three experimental groups. The third path (3) quantified the relationship between exposure condition and mood.



Interpretation of results

Analysis 1

The results for risk-based decision-making between this study and Kahneman and Tversky's study (1984) were significantly different for four of the eight questions. This indicates there were varying levels of the framing bias and loss aversion among the questions between the two studies. This means the degree to which people are making inconsistent decisions are different for these studies. Below is a discussion of the significant results and potential reasons for these results.

For question 2, the majority of respondents preferred option A for decision i, and option D for decision ii.

> Question 2. Imagine that you face the following pair of concurrent decisions. First examine both decisions, then indicate the options you prefer.
> Decision (i) Choose between:
> A. a sure gain of $240
> B. 25% chance to gain $1000 and 75% chance to gain nothing
> Decision (ii) Choose between:
> C. a sure loss of $750
> D. 75% chance to lose $1000 and 25% chance to lose nothing

The results reinforce that people are risk averse for gambles in the gains realm (i.e., prefer a sure gain), but are risk seeking in the losses realm (i.e., prefer to gamble to avoid a sure loss) (Kahneman & Tversky, 1984). However, a lower percentage of participants from this study showed the aforementioned preference in comparison to Kahneman and Tverksy's results (1984). This suggests that more people from Kahneman & Tversky's study exhibited risk seeking behaviour for potential losses than this study (1984). The difference for decision i was found in the control group, whereas the difference for decision ii was found in the urban group (see Table 3, Chapter 4). These results suggest less people from the nature condition were willing to gamble and preferred the sure loss when compared with Kahneman and Tversky's results. This finding is important as it suggests people surrounded by nature gamble less with decisions than people in urban environments. This may be because people exposed to nature act in accordance with their typical risk aversion tendencies (see Figure 1) more so than those exposed to urban environments. This is supported by ART, whereby nature improves cognition through mental restoration (Kaplan, 1995). Therefore, growing urbanization may be promoting riskier decision-making.

Question 4 results are significantly different than question 5 results between this study and Kahneman and Tversky's study.

> Question 4. Consider the following two-stage game. In the first stage, there is a 75% chance to end the game without winning anything and a 25% chance to move into the second stage. If you reach the second stage you have a choice between:
> A. a sure win of $30
> B. 80% chance to win $45
> Your choice must be made before the game starts, i.e., before the outcome of the first stage is known. Please indicate the option you prefer.
>
> Question 5. Which of the following options do you prefer?
> A. 25% chance to win $30
> B. 20% chance to win $45

For question 4, there was a significantly lower proportion of respondents that preferred option A compared with Kahneman and Tversky's respondents, although there was no significant difference in responses for question 5. Since questions 4 and 5 are analyzed together to test for the presence of the framing bias, (because the questions have equivalent outcomes) the results show there was a lower

incidence of the framing bias for this study. Interestingly, the urban and control conditions had a lower occurrence of the framing bias than the nature condition. Kahneman and Tversky did not evaluate mood in decision making in their paper. However, this study's finding is counter to findings in more recent literature that indicate nature exposure promotes positive affect (Velarde, Fry & Tveit, 2007), and that an increase in positive affect reduces the presence of the framing bias in decision-making (Cassotti et al., 2012). This study's results suggest either that nature exposure promotes the framing bias, or that urban exposure reduces the framing bias in decision-making, which are both contrary to this study's hypothesis. A possible explanation is that the urban exposure may not have affected participants' decision-making because the participants have been desensitized to urban exposure through their previous experiences.

Results for questions 6 and 8 indicate a significantly smaller presence of the framing bias when compared with Kahneman and Tversky's study.

> Question 6. Imagine that you have decided to see a play where admission is $10 per ticket. As you enter the theater, you discover that you have lost a $10 bill.
> Would you still pay $10 for a ticket for the play?
> A. Yes
> B. No

> Question 8. Imagine that you have decided to see a play and paid the admission price of $10 per ticket. As you enter the theater, you discover that you have lost the ticket. The seat was not marked, and the ticket cannot be recovered.
> Would you pay $10 for another ticket?
> A. Yes
> B. No

This study's participants had a lower frequency of the framing bias since question 6 had non-significant differences, and question 8 had greater "yes" responses in comparison with Kahneman and Tversky's study. Significant differences for question 8 were found across all three conditions and supports the alternative hypothesis. This suggests that either the differences are due to differences in the population the study was drawn from, or that all types of exposure reduce the framing bias in comparison with no exposure. Perhaps all five-minute exposures promoted mental restoration, in accordance with the ART theory (Kaplan, 1995). This result is contrary to evidence from the literature

that suggests nature exposure and urban exposure would have opposite impacts on the framing bias due to their different impacts on positive and negative affect (Velarde, Fry & Tveit, 2007).

Analysis 2

The null hypothesis was supported by this study's results (i.e., no difference between each condition's question responses). These results imply that the type of exposure had no impact on risk-based decision-making. This could be due to several reasons. First, the five-minute exposures may not be long enough to elicit a change in decision-making. The literature recommends a five to ten-minute exposure length (Berto, 2005); however, five minute exposures may be insufficient to elicit a change in mood. Further research should lengthen the exposure time to determine if this changes decision-making by deepening immersion. This experiment could also be repeated with exposure to real nature or urban environments. This may elicit greater mood changes through more sensory stimuli, which could impact decision-making. Second, the two-dimensional exposures may not have created as great an effect as real exposures would (i.e., immersion in real nature or urban environments). Although the 2 dimensional exposures included a sound track for participants to listen to, the visual and auditory stimuli may not have provided an immersive environment similar to that of exposure to actual nature/urban environments. Other factors such as smell and feeling were missing from the 2 dimensional exposure that could have elicited differences in decision-making between groups. There is no known previous research investigating the relationship between nature and/or urban exposure and decision-making.

Analysis 3

The Chi-Squared results between the urban condition and pre- and post-PANAS scores indicate that the 5-minute urban exposure resulted in a significant increase in negative affect (NA). This result suggests urban surroundings impact negative affect differently than natural surroundings. Wilson's Biophilia hypotheses (1984) is supported by the finding that urban exposure creates the greatest change in post exposure NA. The Biophilia hypotheses states that humans have an innate need for and connection with

the natural world (1984). In an increasingly urbanized world (Annez & Buckley, 2009), human's connections to nature are disrupted, despite their need for nature contact. This provides an explanation for the increase in negative affect among urban exposure participants.

While post-exposure positive affect (PA) was not statistically different between groups, the change in pre- versus post-exposure PA was greatest for the nature group. Previous literature suggests two-dimensional nature exposure increases positive affect (Herzog et al., 1997; Kim et al., 2010; Kweon et al., 2008). Thus, this study hypothesized that the nature exposure would significantly increase pre- versus post-exposure PA scores. Since the nature group's pre- versus post-exposure PA scores were not significantly different, this result is not in line with the aforementioned literature.

Previous work suggests an individual's mood can impact decision-making (Cassotti et al., 2012; Habib et al., 2015). Perhaps the results from this study differ from what is reported in the literature because of the means by which changes to mood were induced. Cassotti et al. (2012) flashed pictures of facial expressions to influence the positive/negative affect of participants. This study used a comparatively indirect method of inducing emotions among participants (i.e. exposure to images and sounds). This study's results encourage further investigation into the impacts of mood on decision-making.

According to ecopsychology, a concern with the rapid rate of urbanization is that humans are becoming physically detached from nature, thus immersion in natural environments will not improve positive affect (Conn, 1998). This study found there was no significant increase in the nature group's pre- and post-exposure PA scores, which supports the ecopsychology theory. While this research is not enough to discern a definitive pattern, the results suggest the nature group is desensitized to natural environments.

Study applications

As previously suggested by Kahneman and Tversky, the consequences of inconsistent decision making is unsettling because decision-makers across professions, sex, and age are unaware of the

influence of the framing bias in their decision-making process (1984). This study supports the need for procedures to be put in place for decision makers to make consistent choices. The first suggestion by Kahneman and Tversky on how to achieve this is to transform equivalent outcome questions to use the same framing (i.e. word choices such as "loss" or "cost"). Secondly, decision makers should weigh their options based on their actual expected outcomes, and be cognizant of the role mood plays in decision-making.

Understanding that urban exposure impacts mood negatively has applications for urban design. This study's results support the mood benefits of incorporating green spaces into urban environments and reducing noise pollution. These changes could be achieved on a small scale through individual choices (i.e. decorating a home or office), or on a large scale through city design planning (i.e. policy makers investing in the development of green spaces).

Suggestions for future studies

Suggestions for future studies include repeating this study with a more balanced proportion of sexes, and a wider range of age, education, and professions. This study was dominated by female participants and psychology students. Since the results indicate a significant relationship between Sex and R2_Recode (which measured the degree of loss aversion in the gains versus losses realms), further studies with a greater balance and number of male and female participants would be beneficial to add to the robustness of this finding.

This study could also be expanded upon by analyzing the relationship between mood and decision-making. Due to time constraints, this analysis could not be completed for the study. Instead, it was assumed that since exposure did not impact decision-making, but that exposure influenced negative affect, that mood did not influence decision-making. The mood and decision-making relationship could be studied by statistically investigating the relationship between post-exposure PA and NA scores and the presence of the framing bias in the decision-making questions.

Limitations and delimitations

A study limitation is that this study's sample was dominated by females. Kahneman and Tversky's study had more diverse and varying sample sizes, (i.e. students, professionals, people with varying experiences, etc.). This study could be improved by recruiting a larger sample size with a balance of male-female participants. While there is not literature indicating males and females (in general) have varying levels of the framing bias, this would still be useful in identifying any emerging patterns. Furthermore, the study would be improved by expanding the collection timeline to increase sample size among the three conditions, and expand recruitment methods to sample the wider community (i.e. not limiting the sample to students at Dalhousie University).

A second limitation was that two researchers were used to lead participants through this study. Although the lead researcher trained and watched the assistant researcher conduct the experiment several times, there may have been subtleties in differing executions of the experiment which may have influenced results.

A delimitation of this study is that only Dalhousie students in a psychology class could participate since recruitment was done through the SONA system at Dalhousie University. This means that results could not be generalized to the greater student population and beyond.

Conclusion

Increasing urbanization prompts the urgency of researching how varying environments impact humans' decision-making. This study sought to examine the relationship between two-dimensional nature and urban exposure, and decision-making. When compared to Kahneman and Tversky's results, half of the eight risk-based questions had significantly different results, suggesting differences in decision-making between populations (analysis 1). This study also found there was no difference in decision-making between the three exposure groups (analysis 2). This is contrary to other literature, but may be because the length of exposure or visual and auditory stimuli were insufficient in eliciting changes in decision-

making. Finally, this study found urban exposure participants had significantly greater increases in negative affect when compared with the other exposure groups (analysis 3).

This research has important implications for decision-makers. Professionals making policy decisions should be aware of how their environments and the framing of questions can impact their decision choices. Without being aware of this, as this study's results suggest, decision-makers may express inconsistent policy preferences and thus make ill-informed choices. Furthermore, this research supports previous literature that suggests urban environments increase negative affect, which has important implications for mood and psychological well-being in the face of increasing urbanization.

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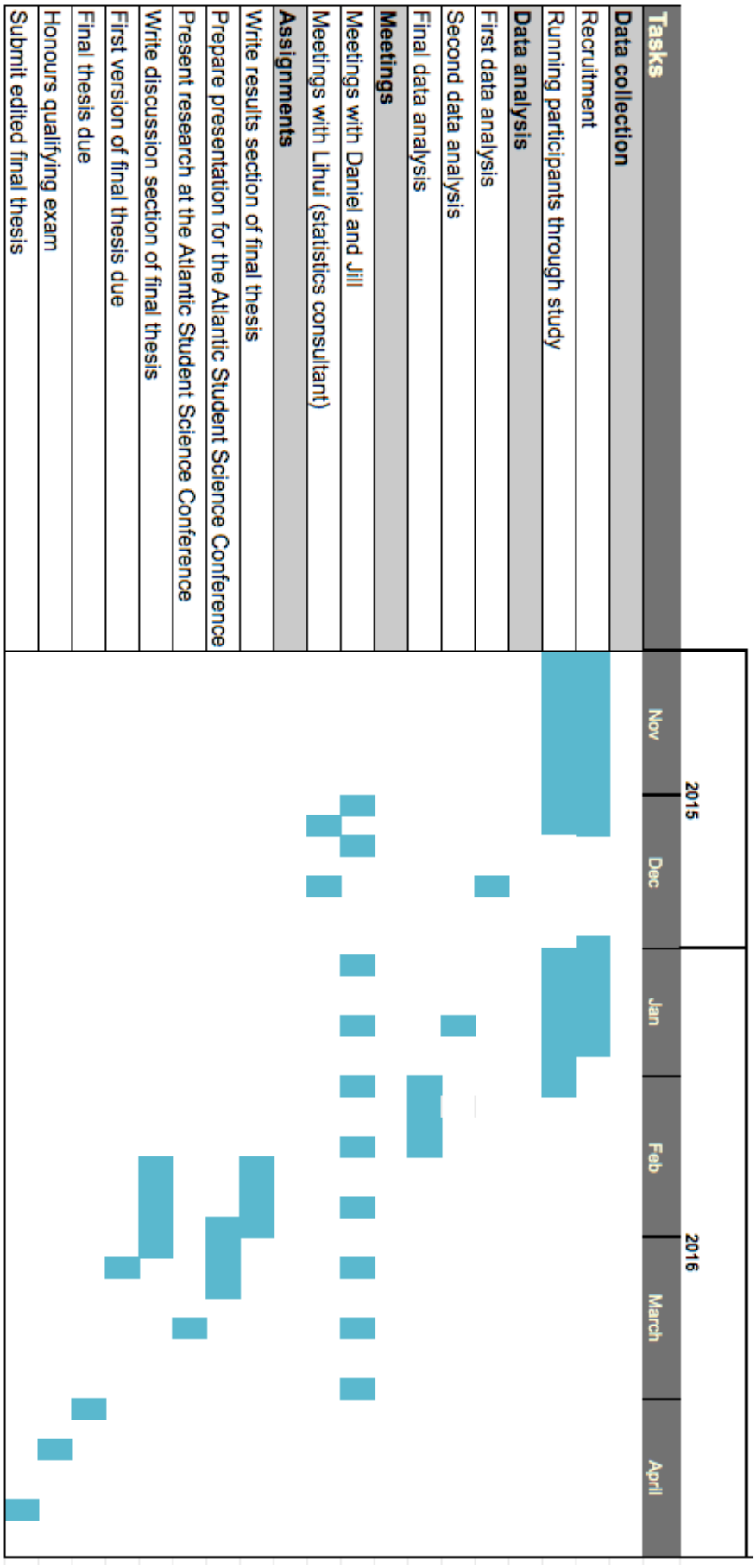
Appendix 1: Timeline



Appendix 2: Study Tools

Consent Form

CONSENT FORM

Project Title: Exploring the influence of nature exposure in risk-oriented decision making

Lead researcher: Rachel Shin
BSc Combined Honours, Environmental Science and Economics
Dalhousie University
rachel.shin@dal.ca

Other researchers: Jill McSweeney, Ph.D(c)
IDPhD Program, Faculty of Graduate Studies
Dalhousie University
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Dr. Daniel Rainham, Ph.D
Environmental Science
Dalhousie University
daniel.rainham@dal.ca

Dr. Shannon Johnson, Ph.D
Psychology
Dalhousie University
shannon.johnson@dal.ca

Project Introduction

We invite you to take part in a research study being conducted by Rachel Shin, who is a student at Dalhousie University, as part of her BSc Combined Honours in Environmental Science and Economics. Taking part in this research is your decision. You can leave the study at any time without negative implications to you if you decide not to participate. The following information tells you about what you will be asked to do and about any potential benefit, risk, or discomfort that you may experience. You should discuss any questions you have about this study with Rachel Shin.

Purpose and Outline of the Research Study

This research project is looking at the emotional and cognitive influence of environmental factors on decision-making when faced with risk-based problems.

Who Can Participate in the Research Study

You may participate in this study if you are a student at Dalhousie University.

What You Will Be Asked to Do

To help us understand the influence of environmental factors on decision making, we will ask you to complete a variety of questionnaires, including a decision making exercise, an assessment of your mood, and your thoughts regarding nature.

Before the study begins, the researcher will review this consent form with you, and outline what you will be asked to do during your participation in the study, and potential benefits and risks you will be exposed to. You will have the opportunity to ask any questions, and will then be asked to give your signed consent agreeing to participate. The researcher will remain in the study room, and will prompt you to begin the study. If at any time during your participation you have questions or concerns, please notify the researcher. You may stop your participation in the study at any time.

You will be directed to complete a series of questionnaires and a task that include information about your mood, nature connectedness, personal demographics, and risk taking problems. After you have answered all the study questions, the researcher will inform you that your participation has ended. After a short debrief by the researcher, the study will be concluded. The study should take no longer than 30 minutes of your time.

Possible Benefits, Risks and Discomforts

The risks associated with this study are minimal. Participating in this research may make you feel fatigued. To ensure you feel comfortable with your participation, you will be offered breaks between activities to reduce these risks. There is the potential risk to participants of feeling stressed during the decision-making process of this study. Finally, there is a potential risk of an emotional response of participants while responding to questions indicating the participant's mood. If you feel at any point during the study that you would like to withdraw your participation you will be free to do so. Direct benefits to participants may include personal reflection on their critical thinking and decision making/ reasoning processes. Anticipated indirect benefits of the study are a contribution to the knowledge of how people make decisions when primed with exposure to nature.

Compensation / Reimbursement

To thank you for your time, we will provide you with a 0.5 SONA credit towards a psychology class at Dalhousie of your choice.

Privacy and Confidentiality

Confidentiality of the data collected will be assured by maintaining all collected data in the SILK Lab at Dalhousie, where it will only be accessible to members of the research team. All electronic records will be kept secure in a password-protected, encrypted file on a Dalhousie University secure server. We will use a participant number (not name) in our computerized records so that the data we collect contains no identifying information. All identifying information (i.e., consent form signatures) will be kept in a locked filing cabinet. No individual data will be reported. You will not be identified in any reports or publications. The research team will store data in a designated locked area within the SILK Lab for five years following publication of the results, and then destroy the data.

If You Decide to Stop Participating

You are free to leave the study at any time. If you decide to stop participating at any point in the study, you can also decide whether you want any of the information that you have contributed up to that point to be removed or if you will allow us to use that information. If you decide to leave the study, you will still be awarded a 0.5 credit point via SONA.

How to Obtain Results

We will provide you with a short description of group results when the study is finished via email should you desire. No individual results will be provided. You can obtain these results by including your contact information at the end of the signature page. Results will be emailed to you by April 2016.

Questions

We are happy to talk with you about any questions or concerns you may have about your participation in this research study. Please contact Rachel Shin (at rachel.shin@dal.ca), Jill McSweeney (at jmmcswee@dal.ca), or Daniel Rainham (at daniel.rainham@dal.ca) at any time with questions, comments, or concerns about the research study. We will also tell you if any new information arises that could affect your decision to participate.

If you have any ethical concerns about your participation in this research, you may also contact Catherine Connors, Director, Research Ethics, Dalhousie University at (902) 494-1462, or email: ethics@dal.ca.

Project Title:

Exploring the influence of nature exposure in risk-oriented decision-making.

I have read the explanation about this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I agree to take part in this study. However, I realize that my participation is voluntary and that I am free to withdraw from the study at any time.

Please be aware that you have the choice to be a study participant or an observer. As a participant, you give the research team permission to use your data from the study. As an observer, the study's data will be destroyed upon study completion and will not be used by the research team.

_____ I hereby consent that I will be a participant in this study, where my collected data will be used (please use a checkmark to indicate your participation).

_____ I would like to be an observer, and not have my collected data used for the study.

_ _
Name of Participant (Please Print)

_ _
Participant's Signature

_ _
Date

STATEMENT BY PERSON PROVIDING INFORMATION ON STUDY
I have explained the nature and demands of the research study and judge that the participant named above understands the nature and demands of the study.

Name (Print): _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Position _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Signature: _ Date: _ _ _ _ _ _ _ _ _ _ Time: _ _ _

COMMUNICATION OF RESULTS
If you would like to receive a summary of the results of this study, please provide your email address.

Contact Person: _

Email Address: _

SIGNATURE PAGE

(this page must be printed on a separate sheet)

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Science

- **Subjects Must Read And Sign This Form To Confirm That They Understand And Accept Conditions Before Experiment Can Begin**
- **Subjects Must Be Given A Copy Of This Form For Their Information And Records**

Feel free to address any questions you may have about the study to the Principal Investigator either now, or after you have participated.

Study Title Exploring the influence of nature exposure on risk-oriented decision-making

Name of Principal Investigator Rachel Shin

Research Supervisor Jill McSweeney, Dr. Daniel Rainham

Contact Person (if different from PI)

Address Rm 805, LSC, Dalhousie University

Telephone 902-471-5686

Email rachel.shin@dal.ca

Psychology Department Subject Pool Policy

Individuals with specific ethical concerns should contact either the Research Supervisor or a member of the Human Research Participants & Ethics Committee of the Department of Psychology, Tel: 494.1580, email psych.ethics@dal.ca.

Please sign below to confirm that you have had your questions answered to your satisfaction, that you are aware that all records are entirely confidential and that you may discontinue participation at any point in the study.

If you anticipate receiving educational credit points for assisting in this research, you may choose to do so as either a **Research Participant** or as an **Observer**.

If you choose to be a Research Participant, the researcher will keep your data and use it in the research project.

If you choose to be an Observer, the researcher will destroy any data that you may have provided, after you complete the study.

Please check one box below to indicate whether you choose to be a Research Participant or an Observer.

☐ **Research Participant (Use my data)**

☐ **Observer (Destroy my data)**

Participant's Signature: Date:

Principal Investigator's Signature: Date:

Study Debrief

Project Title: Exploring the influence of nature exposure in risk-oriented decision-making

The purpose of this research is to determine whether two-dimensional nature exposure (i.e., images and sounds of landscapes and seascapes) impact an individual's behaviour while making decisions regarding risk-oriented questions. Previous research has shown that images of nature have a positive impact on a person's mood, reduces their stress, and reduces mental fatigue important for critical thinking (Felsten, 2009). Furthermore, other research has indicated environmental exposure can create a positive emotional context (Hartig et. al, 1996). Emotions have an influence on System 1 (Intuitive) thinking, which is commonly used in daily decision-making (Cassotti et al., 2012).

Based on the above literature, this research project is seeking to understand whether nature exposure alters decision making by eliminating the framing bias and increasing loss aversion by creating a positive emotional environment, and thus altering System 1 thinking among decision makers. Framing biases are defined as how questions are asked, i.e. the question and probabilities are the same, yet are worded either as a gain or loss (Kahneman and Tversky, 1984). We are also looking to see if the experimental condition increases loss aversion. Both of the potential effects on the framing bias and loss aversion contribute to the decision-making process and outcome.

In this study you were randomly assigned to one of three groups: an experimental condition that exposed participants to five minutes of nature exposure (images and sounds), an experimental condition that exposed participants to five minutes of urban exposure (images and sounds), or a control condition with no exposure. If you were in the first experimental condition, we exposed you to nature images and sounds in an effort to induce a positive emotional context for participants. We also wanted to determine whether urban exposure created or did not create a negative emotional context for those participants randomly assigned to the second experimental condition.

We prompted you to complete the Nature Relatedness questions to determine whether those participants with higher Nature Relatedness were more responsive (i.e. in creating a positive emotional context) by nature and/or urban exposure than those participants with lower Nature Relatedness scores. Nature Relatedness refers to the physical and spiritual connection of humans towards the natural world. We also may have prompted you to complete a mood questionnaire before and after the exposure to assess whether the nature and/or urban exposure had an impact on changes to your mood.

If you are interested in this area of research, the following sources are available via the library:

- Aïte, A., Cassotti, M., Habib, M., Houdé, O., Moutier, S. & Poirel, N. (2012). Positive emotional context eliminates the framing effect in decision-making. *Emotion, 12*(5), 926-931. doi: 10.1037/a0026788

- Felsten, G. (2009). Where to take a study break on the college campus; An attention restoration theory perspective. Journal of Environmental Psychology, 29, 160-167.

- Habib, M., Cassotti, M., Moutier, S., Houdé, O. & Borst, G. (2015). Fear and anger have opposite effects on risk seeking in the gain frame. Frontiers in Psychology, 6(253). doi: 10.3389/fpsyg.2015.00253

- Kahneman, D. & Tversky, A. (1984). Choices, values, and frames. *American Psychologist, 39*(4), 341-350.

- Nisbet, E. K., Zelenski, J. M., Murphy, S. A. (2009). The nature relatedness scale. Environ. Behav. 41, 715-740.

- St Leger, L. (2003). Health and nature- New challenges for health promotion. *Health Promotion International, 18*(3), 173-175.

If you have any complaints, concerns, or questions about this research, please feel free to contact Rachel Shin (rachel.shin@dal.ca), Jill McSweeney (jmmcswee@dal.ca), or Dr. Daniel Rainham, Ph.D Assistant Professor of the Department of Environmental Science (daniel.rainham@dal.ca), or the Director of Research Ethics at Dalhousie University (ethics@dal.ca, P: 902.494.1462).

Finally, thank you again for helping us with this research.

Pre Exposure Questionnaire

Participant #:

Date:

Instruction: Please rate the extent to which you agree with each statement, using the scale from 1 to 5 as shown below. Please respond as you really feel, rather than how you think "most people" feel.

1	2	3	4	5
Disagree strongly	Disagree a little	Neither agree or disagree	Agree a little	Agree strongly

1. My ideal vacation spot would be a remote, wilderness area. _____
2. I always think about how my actions affect the environment. _____
3. My connection to nature and the environment is part of my spirituality. _____
4. I take notice of wildlife wherever I am. _____
5. My relationship to nature is an important part of who I am. _____
6. I feel very connected to all living things and the earth. _____

7. Please share any comments you may have on the questions, what they prompted you to think about or your thoughts about nature.

Instruction: We are interested in your current mood. Below are words to describe mood. For each word select one of the five options that best describes your mood.

1	2	3	4	5
Very Slightly or Not at All	A little	Moderately	Quite a Bit	Extremely

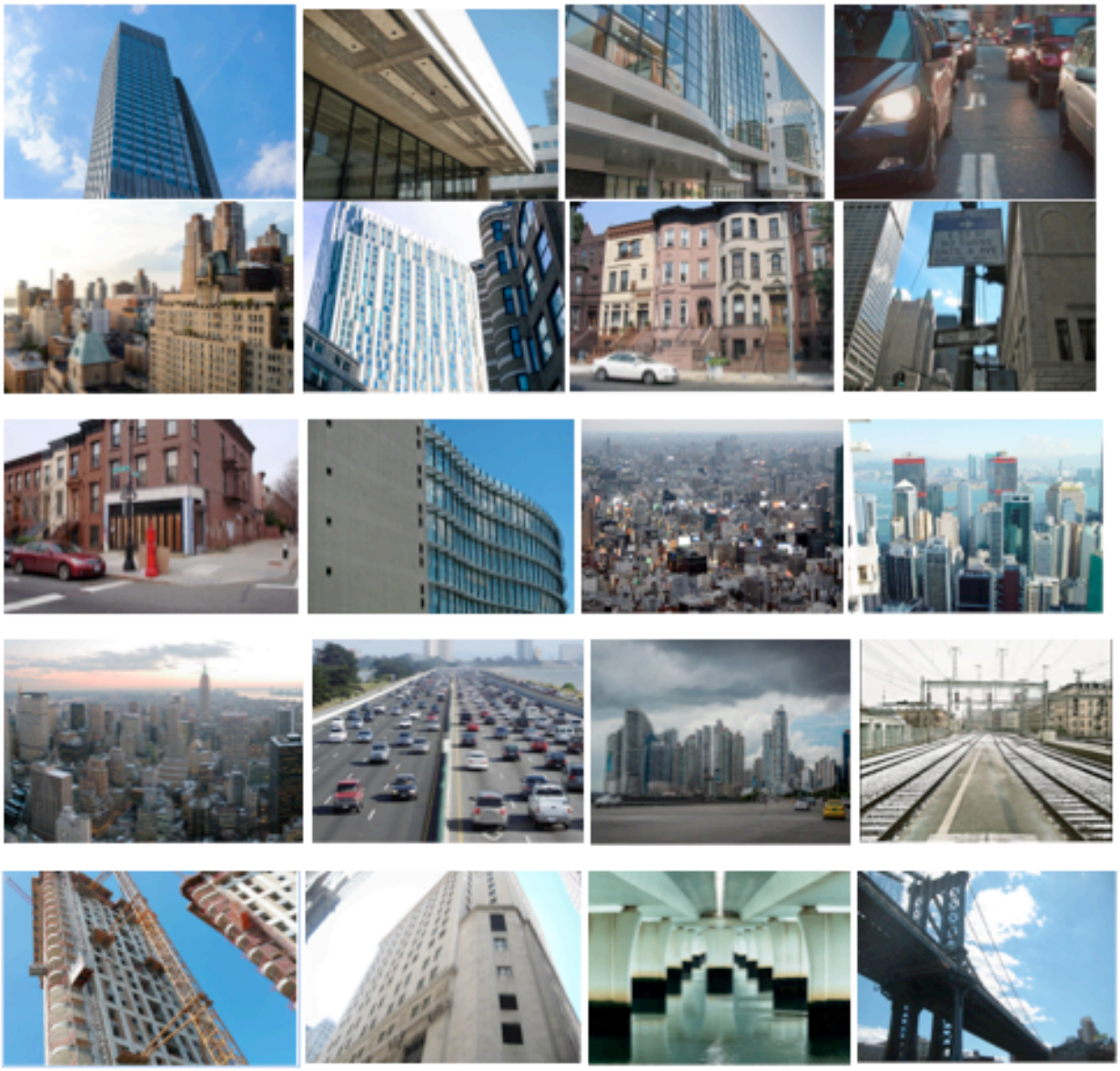
_____	1. Interested	_____	11. Irritable
_____	2. Distressed	_____	12. Alert
_____	3. Excited	_____	13. Ashamed
_____	4. Upset	_____	14. Inspired
_____	5. Strong	_____	15. Nervous
_____	6. Guilty	_____	16. Determined
_____	7. Scared	_____	17. Attentive
_____	8. Hostile	_____	18. Jittery
_____	9. Enthusiastic	_____	19. Active
_____	10. Proud	_____	20. Afraid

Five-Minute Exposure Slides

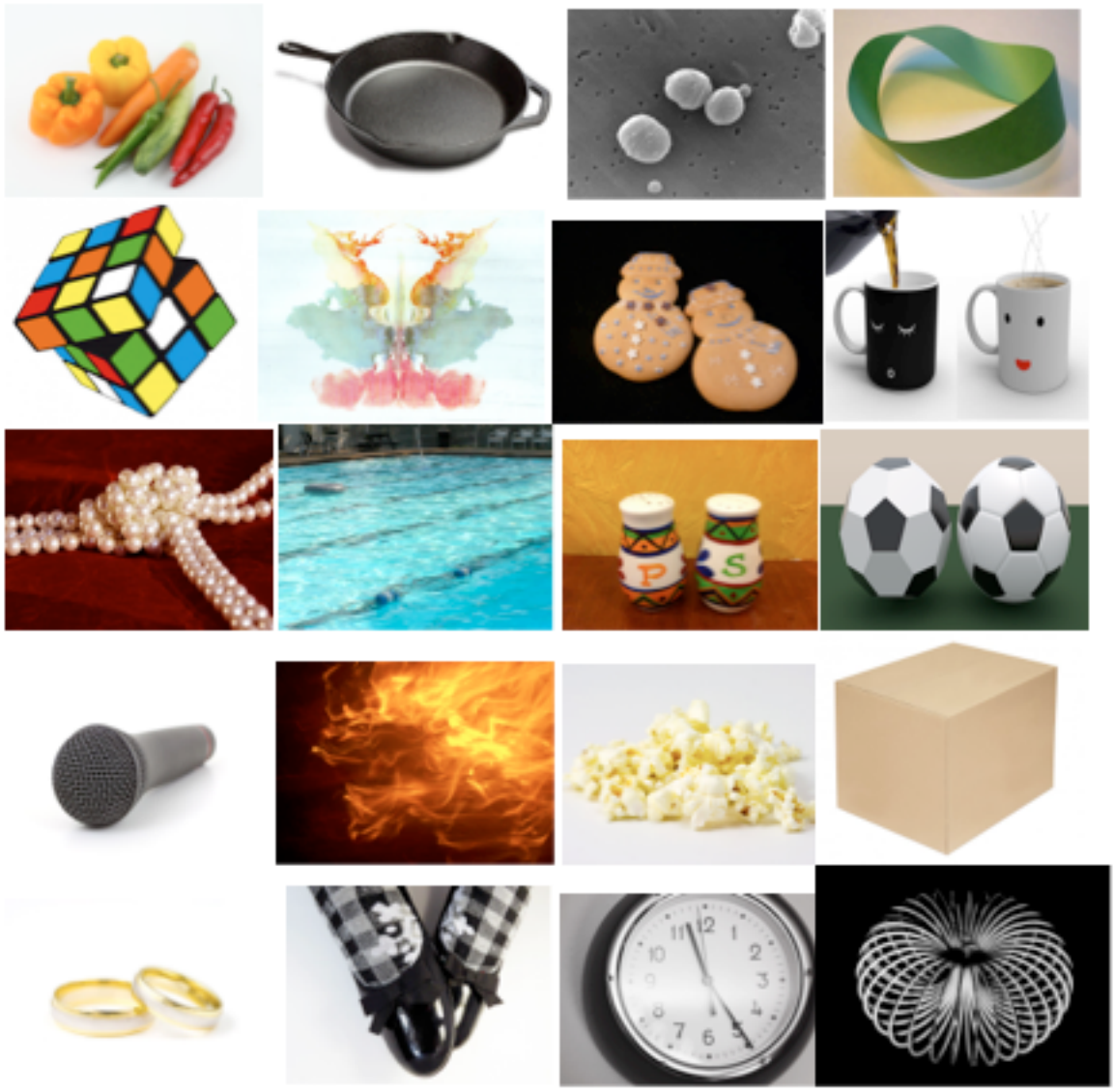
Slide images are a mix of public commons images, and Rachel Shin's. The slides are organized in descending order by row (i.e. first row, left to right, are slides 1-3; second row, left to right, are slides 4-6; etc.).

Nature Exposure Slides

Urban Exposure Slides



Control Slides



Post Exposure Questionnaire

Participant #:

Date:

Instruction: We are interested in your current mood. Below are words to describe mood. For each word select one of the five options that best describes your mood.

1	2	3	4	5
Very Slightly or Not at All	A little	Moderately	Quite a Bit	Extremely

_____	1. Interested	_____	11. Irritable
_____	2. Distressed	_____	12. Alert
_____	3. Excited	_____	13. Ashamed
_____	4. Upset	_____	14. Inspired
_____	5. Strong	_____	15. Nervous
_____	6. Guilty	_____	16. Determined
_____	7. Scared	_____	17. Attentive
_____	8. Hostile	_____	18. Jittery
_____	9. Enthusiastic	_____	19. Active
_____	10. Proud	_____	20. Afraid

Instruction: Please carefully read and choose between the options presented in the following questions. Please put a circle around your response.

1. Choose between:

A. 25% chance to win $240 and 75% chance to lose $760

B. 25% chance to win $250 and 75% chance to lose $750

2. Imagine that you face the following pair of concurrent decisions. First examine both decisions, then indicate the options you prefer.

Decision (i) Choose between:

A. a sure gain of $240

B. 25% chance to gain $1000 and 75% chance to gain nothing

Decision (ii) Choose between:

C. a sure loss of $750

D. 75% chance to lose $1000 and 25% chance to lose nothing

3. Would you pay $5 to participate in a lottery that offers a 10% chance to win $100 and a 90% chance to win nothing?

A. Yes

B. No

4. Consider the following two-stage game. In the first stage, there is a 75% chance to end the game without winning anything and a 25% chance to move into the second stage. If you reach the second stage you have a choice between:

A. a sure win of $30

B. 80% chance to win $45

Your choice must be made before the game starts, i.e., before the outcome of the first stage is known. Please indicate the option you prefer.

5. Which of the following options do you prefer?

A. 25% chance to win $30

B. 20% chance to win $45

6. Imagine that you have decided to see a play where admission is $10 per ticket. As you enter the theater, you discover that you have lost a $10 bill.

Would you still pay $10 for a ticket for the play?

A. Yes

B. No

7. Would you accept a gamble that offers a 10% chance to win $95 and a 90% chance to lose $5?

A. Yes

B. No

8. Imagine that you have decided to see a play and paid the admission price of $10 per ticket. As you enter the theater, you discover that you have lost the ticket. The seat was not marked, and the ticket cannot be recovered.

Would you pay $10 for another ticket?

A. Yes

B. No

Demographic Information

Sex (please circle one): M, F, Other

Age: _____

What is the postal code of your permanent/family's home address? _____

Current Year of Study: _____

What is the degree you are working towards? _____

Protocol Manual

Exploring the influence of nature exposure on risk-oriented decision-making

Lead Investigator: Rachel Shin
Supervisors: Jill McSweeney, Daniel Rainham, and Shannon Johnson

Assignment to Condition

The lead investigator is responsible for all the administrative work (assignment to condition, confirmation of participation, reminder email, and debrief email).

Once the participant has indicated they would like to participate in the study (via SONA), they will be given an ID # ranging from 1-120. Each ID # will be linked to a condition using Research Randomizer (https://www.randomizer.org/) and will determine whether or not the participant will be in the experimental 1 (nature), experimental 2 (urban), or control condition.

Participant number and assigned conditions will be saved in a file "Admin.xls". A separate (and password protected) file will be used to identify participant number and participant identity.

Confirmation of Participation

To be sent 24 hours within signing up for the study via SONA

RE: Confirmation of Exploring the influence of nature exposure on risk-based decision-making study participation

Hello,

Thank you for signing up for my study. This email is to confirm your sign up date and time. You will also receive a reminder email 24 hours before you participate in the study. The reminder email will provide you with directions to the study area (LSC 3rd floor Psychology Lounge Area), and the consent form that you should review before your participation.

Thanks again, and please email me back if you have any questions.

All the best,

-Lead Investigator

Reminder Email

To be sent 24 hours in advance of scheduled participation time via SONA

RE: Reminder: Exploring the influence of nature exposure on risk-based decision-making participation

Hello,

(Attach consent form and SONA consent form)

This email is a reminder that your study participation is scheduled for tomorrow. We will be meeting at the LSC 3rd floor Psychology Lounge Area.

To get to the Lounge area during regular hours (9-5pm), enter the LSC from the Henry Hicks entrance doors, turn left, and continue down the hall through a set of doors. You will then see a lounge area with multiple chairs and sofas. There should also be a sign indicating this is the Psychology Lounge Area. Please wait for me here, and I will come out to get you at your study time.

To get to the Lounge area after regular hours (past 5pm or on weekends), enter the LSC from the new Wallace McCain Learning Commons. An outdoor entrance is at the end of Lord Dalhousie Drive (the entrance faces King's College University). Head up to the 3rd floor, and continue to the Psychology and Neuroscience Wing. You will then see a lounge area with multiple chairs and sofas. There should also be a sign indicating this is the Psychology Lounge Area. Please wait for me here, and I will come out to get you at your study time.

Please also find attached the consent form I will be reviewing with you and asking you to sign at the beginning of the study. This will provide you with more detail of the study and what you will be asked to do. The study will take no longer than 30 minutes, and you will be given the opportunity to complete a form to gain a 0.5 credit for a psychology class of your choice for your participation. I will answer any questions you have about the study during your participation.

Thank you, and please email me back if you have any questions.

All the best,

-Lead Investigator

Debrief Email

RE: Follow up email to Exploring the influence of nature exposure on risk-based decision-making study participation

Hello,

(Attach debrief form)

Thank you for participating in my study. Please find attached a document that explains more about the study's design and provides related literature if you are interested in learning more.

I've also assigned you the 0.5 credit point on SONA.

If you indicated you would like to receive the study results, you can expect these by April 2016.

Thanks again, and please let me know if you have any questions.

All the best,

-Lead Investigator

Setup

Open up “Admin.xls”, check participant number and condition (i.e. Exposure 1, Exposure 2, or Control).

Record participant ID # on

- Pre-exposure survey
- Post-exposure survey

After the study participation, place consent forms and SONA consent forms in “Consent Form” folder; pre-exposure questionnaire in “Pre-Exposure Questionnaire” folder; and post-exposure questionnaire in “Post-Exposure Questionnaire” folder. Lock filing cabinet with these folders.

Setup Condition

The room will look identical for Experimental Condition 1, Experimental Condition 2, and the Control Condition. The room is small, windowless, has neutral-colour paint, has a round desk with two chairs and a desktop computer at a rectangular deck facing the far wall of the study room.

The same procedure will be followed for all three groups:

1) Have the appropriate PowerPoint ready on the computer screen, but minimized (so it cannot be seen until the exposure part of the study).
2) Have a consent form and SONA consent form, pre-exposure questionnaire, and post-exposure questionnaire forms at the participant’s work desk.

Welcome and Consenting Participants

Greet participant at study room.

Hello (participant name), my name is Rachel/Marcel. We've been in contact via email about participating in this research study.

Before we begin the experiment, I will go over a few key points to make sure you understand what you'll be required to do during your participation in the study, any risks that you might encounter, and your rights as a study participant.

This is an honour's undergraduate research study that is being conducted at Dalhousie University. I greatly appreciate your participation, and would like to reinforce that your continual participation is voluntary, so you may choose to leave the study at any time, for any reason.

Very briefly, this study is looking at whether nature exposure influences stress and behaviours. You will be asked to complete a variety of surveys and exercises during the next 20-30 minutes. If at any time you feel uncomfortable and would like to stop, please let me know.

It is important that you know of any possible risks and/or conflicts of interests for this study. The potential risks that you might incur are (1) you might feel uncomfortable answering one of the survey questions. If this happens, please let me know. As your participation is voluntary, you can stop and withdraw your participation without any consequences. (2) You may be exposed to sounds and visual stimuli that might bother you. If you feel uncomfortable at anytime, please let me know immediately. We will leave the room and stop your participation. Do you have any questions about potential risks to you?

I want to let you know that all collected data will remain securely locked in our lab, and only accessible by my supervisor and I. All data will remain anonymous, so no identifying information will be released.

At the end of the study you will receive a 0.5 course credit point towards a psychology course of your choice.

Do you have any questions or concerns about the study and your participation?

Give participant a copy of the consent form, and ask them to read through it.

Pre-exposure questionnaire

To be handed out after consenting process is completed.

Thank you for reading through and signing the consent form and SONA consent form. I will now ask you to complete this first package of questionnaires. The instructions are inside, but please let me know if you have any questions while completing the questionnaires.

Exposure

To be done after the pre exposure questionnaire is completed.

Experimental 1

Thank you for completing the questionnaire. Please now turn your attention to the computer monitor at your work station and watch the screen. Please remain watching the screen until I provide you with further instruction.

Pull up tab for Experimental 1 exposure (Nature) PowerPoint and begin playing slideshow.

Experimental 2

Thank you for completing the questionnaire. Please now put on these headphones and turn your attention to the computer monitor at your work station and watch the screen. Please remain watching the screen until I provide you with further instruction.

Pull up tab for Experimental 2 exposure (Urban) PowerPoint and begin playing slideshow.

Control

Thank you for completing the questionnaire. Please now turn your attention to the computer monitor at your work station and watch the screen. Please remain watching the screen until I provide you with further instruction.

Pull up tab for Experimental 2 exposure (Urban) PowerPoint and begin playing slideshow.

Post-exposure questionnaire

To be handed out after the exposure.

You may now remove your headphones. **Minimize slideshow.** *Thank you for watching the slideshow. I will now ask you to complete this package of questionnaires. The instructions are inside, but please let me know if you have any questions while completing the questionnaires.*

Study Conclusion

We are now finished the study. I will be sending you a written debrief via email within the next 24 hours to provide further information regarding the study and its purpose. At that time, if you have any questions and/or concerns about your participation, please contact me to arrange a time we can discuss your questions. You will also receive the 0.5 psychology course credit within the next 24 hours. Do you have any questions before you leave?

Thank you for your participation in the study!

Debrief Email

Send the debrief email (see script above in Appendix 2) to participants within 24hrs of their study completion. Include "Debrief Email" (see form above in Appendix 2) as an attachment to this email. Be sure to Bcc so participants' identities remain anonymous.

Assign the SONA credit point within 24 hours to the student through Dalhousie University's SONA system online.