The Impact of Socio-Environmental Cues of Harshness on Risk-Taking Using Virtual Reality

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Abstract

There is much variation between people when it comes to risky behaviour. Identifying factors that account for these individual differences within people's risk-taking willingness is an important aspect when informing intervention design to reduce risk-taking behaviour. One possible approach is offered by evolutionary psychology, which suggests that higher risk-taking can be seen as a behavioural tendency that is adaptive when being in a harsh environment, in terms of fitness. The present study aimed to investigate the influence of cues of harshness on risk-taking behaviour. Thereby influences during early childhood as well as situational cues were taken into account. It was hypothesized that immediate cues of harshness lead to increased risk-taking behaviour. Moreover, it was hypothesized that exposure to cues of harshness during early childhood positively affects the influence of situational cues on risk-taking behaviour. A between-subject experimental design was used to test these hypotheses. The sample consisted of 38 participants, who were exposed to one of two Virtual Reality scenes displaying different kinds of neighbourhoods (deprived vs. control). Risk-taking behaviour was measured by the Balloon Analogue Risk Task. Resource availability during childhood was measured using retrospective self-report in the form of a questionnaire. No significant results were obtained and both hypotheses had to be rejected. This indicates that situational cues of harshness and exposure to harshness during the early years of childhood do not have a significant effect on risk-taking behaviour.

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People constantly face the decision to what extent they are willing to take risks. This can range from deciding whether to smoke cigarettes, over making risky financial investments, up to engaging in violent crimes. In Germany, during the years 2008 until 2011, 29.7% of all people from 18- 79 years frequently smoked cigarettes (Lampert et al., 2013), although the possible severe health impact of smoking is known. People vary strongly in the extent to which they are willing to take such risks. This study aims to identify the impact of socio environmental cues in the form of harshness on risk-taking behaviour as one factor that is responsible for this variation.

This introduction first outlines the concepts of decision-making and risk-taking behaviour and gives an overview of the main assumptions of an evolutionary psychology perspective. Subsequently, it explains the concept of phenotypic plasticity and what added value it can have in understanding individual differences in risk-taking behaviour. In connection with that, the role of harshness and early childhood adversity on phenotypic plasticity in explaining risk behaviour is discussed. In this context, the operationalization of the dependent variable risk-taking, the Balloon Analogue Risk Task, is introduced. In the next section, research is presented that indicates that this discussed influence of harshness on risk-taking behaviour also occurs through situational cues in the immediate environment. In the last section, the current study is introduced, and the research questions and hypotheses are stated. Subsequently, the benefit of Virtual Reality technologies for the current study is discussed.

Risk-Taking Behaviour and Decision Making

Risk-taking behaviour can have many forms and has a wide range of possible severe consequences. Some of the most prominent risky behaviours that are discussed in literature are unprotected sexual activity, illegal drug use, alcohol consumption, gambling, crime and violence (Curry & Youngblade, 2006). Over the past decades, a considerable amount of research discussed the aetiology of risk-taking behaviour. There is evidence that personality factors, gender, or emotions influence the decision-making process involved in risk taking (Curry & Youngblade, 2006, Cooper et al., 2003). However, various models in the field of decision-making sciences agree that some form of outcome evaluation is an essential part of the decision-making process. Optimal decision-making can be defined as choosing the option that is most advantageous to the individual, taking short-term as well as long-term consequences into account (Bechara, 2005).

The existence of different goal-directed systems, which assess the expected reward of an action, has been suggested (Rangel et al., 2008). Verdejo-Garcia et al. (2018) defined preference formation as one of the main stages of decision making, in which the individual forms a preference for one of the possible decisions. This is done by weighing the values of the different options and selecting the one with the biggest subjective value, which leads to the question what the difference in value assessment results from. Why are some people more willing to take risks than others and e.g. favour short-term benefits over long-term benefits? Different fields of psychology use different approaches to answer this question. This study uses a perspective that is informed by evolutionary psychology.

Risk-Taking from the Perspective of Evolutionary Psychology

The goal of evolutionary psychology is defined as "to study human behavior as the product of evolved psychological mechanisms that depend on internal and environmental input for their development, activation, and expression in manifest behavior*"* (Confer et al., 2010, p.110). Evolutionary psychology is based on Darwin's theory of natural selection, which can be defined as a "process that results in the adaptation of an organism to its environment by means of selectively reproducing changes in its genotype, or genetic constitution" (The Editors of Encyclopaedia Britannica, 2020). Traits that are beneficial for an organism's survival will be transmitted to offspring at a higher rate than traits that hinder the chances of survival. This leads to adaptations of the organism to its environment.

Natural selection is closely connected to the concept of reproductive fitness. Evolutionary psychology views individuals as purpose driven with the ultimate goal of producing offspring and therefore increasing their fitness (individual reproductive success) (Neuberg et al., 2010). All behaviours, and psychological mechanisms that produce behaviour, are ultimately driven by the goal of reproduction. Taking into consideration the literature about decision-making processes, evolutionary psychology argues that the behavioural option which poses the highest benefit for reproduction will be assigned the highest value (Neuberg et al., 2010). Regarding risk-taking behaviour, this implies that people's willingness to take risks depends on their assessment of the impact this decision will have on their fitness. However, this does not mean that the goal to reproduce is consciously present and that all behaviour is directly related to it. The behaviour can also serve this purpose through indirect pathways e.g. improving health or social status (Neuberg et al., 2010).

Given the fact that people differ in their risk-taking willingness while assuming that all decision-making ultimately serves the goal of reproduction, the question arises, what accounts

for these differences in the assessment of risk-taking behaviour. In the following section, the role of phenotypic plasticity on individual differences in risk-taking behaviour is discussed.

Phenotypic Plasticity

Natural selection does not only happen when certain genes are passed on to the offspring. Evolved traits do not necessarily have to be present at birth, and adaptation to the environment can also happen during the life span of an organism. Neuberg et al. (2010) describe the principle of adaptive phenotypic plasticity. The adaptive phenotypic plasticity principle states that the way the genotype is translated into the phenotype is not set in stone and physical and social cues, during the life span of an organism, play a role in the tailoring of the phenotype to its environment. Thus, a single genotype can be expressed in more than one form and this expression depends on environmental cues (Neuberg et al., 2010). This shows that development plays a role in shaping the phenotype of an organism. Importantly, Acasuso-Rivero et al. (2019) found that phenotypic plasticity does not only apply to traits that are directly related to reproductive fitness and that trait plasticity is not dependent on proximity to fitness. How closely risk-taking is related to fitness depends on the context. Risk-taking, e.g. in the form of gambling, could be seen as not directly linked to reproductive success. Nevertheless, based on the findings of Acasuso-Rivero et al. (2019), all forms of risk-taking behaviour can potentially be affected by phenotypic plasticity.

This could partially answer the question why people differ in their assessment of risks. In how far the processes of phenotypic plasticity are adaptive in terms of fitness and what influence this has on risk-taking behaviour will be discussed in the context of early childhood adversity, taking into account the environmental dimension of harshness.

Harshness

According to Ellis et al. (2009) and Frankenhuis et al. (2016), harshness is an important environmental factor when examining the impact of phenotypic plasticity on individual development. Harshness can be defined as “the rates of mortality and morbidity caused by factors an individual cannot control” (Frankenhuis et al., 2016, p. 76), meaning conditions that are relatively insensitive to the behaviour of the organism and cause disability and death. Overall, such environments increase the likelihood of dying or being seriously injured before being able to reproduce (Ellis et al., 2009). They, for example, include e.g. resource-scarce environments, environments where people are violent, and surroundings with increased exposure to pathogens (Ellis et al., 2009; Griskevicius et al., 2013).

Early Childhood Adversity

The plasticity of a phenotype varies across the course of development and early childhood is one phase in which the organism is particularly sensitive to environmental circumstances (Boivin et al., 2012; Fawcett & Frankenhuis, 2015; Penhune, 2011). Thus, early childhood adversity plays an important role in shaping the phenotype. Adverse childhood experiences are "stressful and/ or traumatic events that may include abuse, neglect, household dysfunction, and exposure to violence and crime" (Brown & Shillington, 2017, p. 1). All of the named circumstances can be sources of extrinsic mortality and morbidity and are therefore possible cues of harshness.

There is plenty of research that indicates that adverse experiences during early childhood can have a profound impact on psychological, emotional, and behavioural outcomes later in life (Brown & Shillington, 2017; Shonkoff, et al., 2012; Boivin et al., 2012). One aspect of the above mentioned impact is an increased tendency towards risk-taking and impulsive behaviour like substance use, delinquency and spending money even though resources are scarce (Griskevicius et al., 2013). There is a growing body of empirical and theoretical research that represents the view that at least some of these outcomes are not per se dysfunctional but rather adaptive strategies in the context of the adverse environment (Ellis & Del Giudice, 2019; Frankenhuis et al., 2016; Fenneman & Frankenhuis, 2020). In other words, experiences during early childhood lead to a development of the phenotype that is adjusted to the perceived environmental circumstances, in this case, adverse circumstances. During the first years in a person's life schemas are created that influence how the world is perceived later in life (Wuth et al., 2021). Thus, the strategies to improve fitness are based on the view of the world that the environmental cues during childhood conveyed.

Conditional Adaptation in the Context of Harshness

It is suggested that people who have grown up in harsh environments have developed behavioural tendencies that are adaptive, in terms of fitness, when being faced with harshness (Ellis et al., 2020). A harsh environment suggests a low life expectancy. When having a shorter reproductive life span, there is uncertainty about how long an organism will have time to reproduce. Consequently, it seems more adaptive to invest in short-term rewards than long-term rewards to reach the goal of reproduction sooner. People become present-oriented and adopt a "here-and-now-preference" since a focus on the uncertain future seems less valuable (Frankenhuis et al., 2016). Frankenhuis et al., (2016) argue that such an orientation can manifest in higher motivation to capture immediate rewards. People might be more willing to take risks, if those increase the chance of immediate or soon benefits. As an example, they describe

different sources that indicate that violent offenders act more impulsively and have an increased risk for sexually transmitted diseases and early death, but in general, they also produce more offspring (i.a. Nagin & Pogarsky, 2004; Yao et al., 2014, as cited in Frankenhuis et al., 2016). Therefore, from an evolutionary perspective, their orientation towards the present is adaptive (Frankenhuis et al., 2016). Such a tendency can be investigated by using the Balloon Analogue Risk Task.

Balloon Analogue Risk Task

The Balloon Analogue Risk Task (BART) is a measure of risk-taking behaviour. It is described as a "computerized, laboratory-based measure that involves actual risky behavior for which, similar to real-world situations, riskiness is rewarded up until a point at which further riskiness results in poorer outcomes" (Lejuez et al., 2002, p. 75-76). Participants have to inflate balloons. The more air they pump into the balloon, the more money they earn. At some point, the balloon explodes, and no reward is received. The maximum inflation point of each balloon is unknown to the participant and varies between different kinds of balloons (there is no difference visible for the participant). The principle of rewarding riskiness up to a certain point and providing a high uncertainty at what point riskiness is no longer rewarded resembles real-world risk behaviours like e.g. gambling and risky money investment. Risk behaviour is operationalized as the average number of pumps per trial. Since risk taking can encompass a wide range of behaviours, there is no single established definition in literature. Trimpop (1994, p. 9) defines risk-taking behaviour as "any consciously or non-consciously controlled behavior with a perceived uncertainty about its outcome, and/or about its possible benefits or costs for the physical, economic or psycho-social well-being of oneself or others". In the context of the BART, people have to decide between a smaller, but relatively certain reward and a bigger but more uncertain reward.

Research suggests that reward sensitivity is one construct through which risk-taking behaviour can be assessed. The BART is widely used in neuroimaging studies which show a correlation between BART scores and reward sensitivity whereby higher reward sensitivity is generally associated with more risk-taking behaviour (Qu et al., 2015; Yarosh et al., 2014).
Reward sensitivity can be defined as a construct that "encompasses individual differences in the tendency to detect, pursue, learn from, and derive pleasure from positive stimuli" (Goodnight, 2018, para. 1) or "the processing and responding to pleasurable and/or reinforcing stimuli" (Tenenbaum et al., 2017, p. 966). This means that people respond differently to rewards and experience greater positive emotions as a result of reward stimuli. At the same time, it can lead to insensitivity to loss (Kim et al., 2015). Therefore, it might be possible that people who

experience harshness are more sensitive to rewards and show increased risky behaviour on the BART. There is already some evidence that points in this direction. A study by Gonzalez et al. (2016) found that people who grew up in a harsh neighbourhood show increased levels of neural reward sensitivity.

As mentioned before, in the context of the BART people face the trade-off between a small reward that is relatively certain and a bigger reward that is more uncertain. The unconscious belief that they cannot count on rewards in the future leads to more sensitivity to immediately available rewards. People are very uncertain about the future and how much time they have left to pursue rewards and reproduce. It appears to be unlikely that there is enough time left to pursue many small rewards. Therefore, in harsh environments, it seems more adaptive to opt for the riskier strategy and thereby heightening the chances of getting the bigger reward now. Moreover, the insensitivity to losses is a second factor that favours the decision towards the riskier option because less importance is placed on the fact that this option is more uncertain and brings a higher possibility of not having any reward in the end compared to the other option. Thus, it is more adaptive to explore risky, but potentially more profitable alternatives. In the context of the BART, that means tending to pump more air into the balloon. The possibility to get a higher reward is valued more than the possible risk of losing the money that is earned from one balloon.

Impact of Situational Environmental Cues on Cognition and Behaviour

There is a growing body of research indicating that also current environmental cues of harshness can influence the decision-making process and therefore risk-taking behaviour. First of all, there is much evidence that situational circumstances and stressors, in general, can have an impact on risk-taking (Johnson et al., 2012; Starcke et al., 2008; Schepis et al., 2011). A study by Nettle et al. (2014) showed that even brief exposure to a certain environment, in this case, a neighbourhood, can cause a temporary change in attitudes. Participants who visited a deprived neighbourhood for up to 45 minutes, reported general lower social trust and greater paranoia afterwards, compared to participants who visited an affluent neighbourhood. Furthermore, there is research that focuses specifically on cues of harshness in this context. One study showed that exposing participants to pictures of either a resource scarce or a resource rich environment influenced their alcohol consumption, suggesting a direct connection between immediate cues of harshness and real-world risk behaviour (Harrison et al., 2019). Griskevicius et al. (2011) found that the influence of situational harshness on risk taking is influenced by childhood experiences. Their outcomes suggest that people who had a low socioeconomic status growing up, show increased risk behaviour when facing acute cues of harshness and vice versa.

Harshness was manipulated by showing fictitious newspaper articles dealing with "recent trends toward violence and death in the United States" (Griskevicius et al., 2011, p. 1018). Participants who grew up in relatively resource scarce environments favoured higher, but uncertain financial gains over lower but certain financial gains. This resembles risk behaviour as operationalized by the BART. Griskevicius et al. (2011) assume that this effect is due to the adoption of a strategy that is driven by the unconscious belief that there is not much time left for reproduction, as described earlier. However, Pepper et al. (2017) could not replicate these findings in a similar study.

The named evidence shows that even brief exposures to certain stimuli can affect our cognition concerning how the world is perceived and that there is an influence of situational cues of harshness on risk-taking behaviour. This hints towards an influence of immediate cues of harshness on risky behaviour that is comparable to the influence of childhood cues and follows a similar rationale.

The Current Study

There is much theoretical and empirical research that suggests an influence of experienced harshness during childhood on risk-taking behaviour later in life. Some research also hints towards a role of immediately perceived harshness in this context. However, there is not much research that focuses directly on the role of immediate cues of harshness on risk-taking behaviour.

This study aims to fill this gap by conducting an experiment in which perceived harshness is manipulated by using Virtual Reality (VR). People will be exposed either to a neighbourhood that is high in cues of harshness or one that is low in cues of harshness and serves as a control condition. In this study, harshness during early childhood will be operationalized as socioeconomic status, since it is an indicator of resource availability in most countries and has already been used in previous research (Griskevicius et al., 2013; Belsky et al., 2012). To examine the influence of childhood experiences, a questionnaire about socioeconomic status during early childhood (until the age of five) is used as a measure. As mentioned before, risk-taking behaviour will be operationalized by the BART. Thereby, this study aims to investigate both, the impact of socio environmental cues in the past as well as in the immediate present, on risk-taking behaviour. More precisely, the focus lies on the question to what extent cues of harshness affect risk-taking behaviour in the present measured by people's performance on the BART. The aim is to get a more complete picture of how harshness influences risk-taking behaviour.

The first research question is “What is the impact of situational environmental cues of harshness on risk-taking behaviour?”. Based on the presented evidence, it is hypothesized that immediate cues of harshness lead to increased risk-taking behaviour as measured by the BART. The second research question is “Does exposure to cues of harshness during early childhood moderate the effect of situational cues of harshness on risk-taking behaviour on the BART?” It is expected that exposure to cues of harshness during early childhood positively affects the influence of situational cues on risk-taking behaviour as measured by the BART.

The Added Benefit of Virtual Reality

Griskevicius et al. (2011) manipulated harshness by showing newspaper articles that predict a harsh future. Their study could not be replicated. Harrison et al. (2019) manipulated harshness by showing pictures that included cues of mortality and morbidity. They found that exposure to these pictures influenced alcohol consumption. However, they could not find this effect for risk behaviour on the BART. It could be asked whether these shortcomings are the result of a weak manipulation of the independent variable. Both, the article and the pictures do not characterize the immediate environment itself as harsh, but rather show or foreshadow environments that are harsh (but are not necessarily related to the participant’s personal immediate environment). The use of VR has the potential to improve manipulation. In this study, VR is used to manipulate situational cues of harshness by displaying different kinds of neighbourhoods. The use of such technology has different potential benefits in contrast to conventional methods like e.g. presenting texts. When presenting information in written form, it cannot be assured that the given text creates the same imagery in all participants. By using VR, it can be controlled what participants actually see and perceive as their environment at the given moment. Thus, variability in how the presented stimuli are experienced can be minimized. Moreover, VR can create an immersive experience. It may be argued that this immersive experience creates a stronger effect than being presented with information through traditional mediums and thus, is closer to encountering harshness in the real world.

Relevance of this Study

Risk behaviour is the cause of many premature deaths. Investigating what increases the willingness to take risks is necessary to inform intervention design to reduce risk-taking behaviour. One potential benefit of this study is that VR is used as a tool for manipulation. This can be beneficial, in the ways described above, compared to research that uses traditional mediums. Moreover, both immediate experience in the form of situational cues of harshness, and childhood experience, in the form of resource scarcity are examined. Until now, there is little research that has focused on both aspects.

Method

Design

The study makes use of a between-subjects experimental design as each participant was only exposed to one of the experimental conditions. The independent variable is "situational harshness". This variable has two conditions (low and high) which were operationalized by the VR scenes that the participants were exposed to. The dependent variable is "risk taking behaviour", which is operationalized by the score on the BART (indicated by the average number of pumps). Moreover, the total number of explosions per participant is used as a second score on the BART to test the first hypothesis. Further, the variable "resource scarcity during early childhood" (low vs. moderate vs. high) was measured in a survey and examined as a moderator of the relationship between the independent variable situational harshness and the dependent variable risk taking behaviour.

Participants

This research has been approved by the ethics committee of the University of Twente. Participants were recruited via the Twente student research participation system (SONA) and could earn 1,5 SONA points by participating. Additionally, wider recruitment strategies via social media were used and the link to the study was sent in university-related WhatsApp and Facebook groups. Moreover, printed posters were hung up at different places around the campus and the nearby city (Appendix A). Therefore, convenience sampling was applied. Participants who did not apply through SONA received a 5€ VVV-Voucher. All participants had the chance to win one out of five 20€ BoL -Vouchers.

In total, 39 participants were recruited. 20 were female, 18 were male and one participant selected "other". Regarding nationality, 28 (71.8%) participants were German, 6 (15.4%) were Dutch and five participants (12.8%) were from another country. The mean age of participants was 21.35 (SD = 1.9).

Materials and Procedure

Questionnaire 1

First, participants were informed about the procedure of the experiment. They were seated at a table with a screen and keyboard. Then, they filled in the first questionnaire, in which they received general information about the study, i.e. people involved, risks, reward and data security and answered questions about their demographic data (Appendix B). Also, they gave their informed consent (Appendix C) and read some general information about the following VR procedure (Appendix D).

VR Neighbourhood Scenes

After that, participants were introduced to the VR equipment. The independent variable "situational harshness" was manipulated by exposure to VR environments. Three different virtual environments (including the practice scene) were developed and coded by the head researcher using the program "Unity 2020.3.2". The "Oculus Rift S" VR headset and the corresponding "Touch controllers" were used for the VR implementation.

First, participants spent some time in a practice scene to become familiar with how the controllers work and how to move inside the VR scene. To influence the participants' perception as little as possible a simple environment was chosen. It consisted of a meadow with a blue sky. Big, colourful objects, like e.g. cube were placed on the meadow for participants to walk around (Appendix E). In all scenes, black circles and arrows were drawn on the floor to indicate where participants were supposed to go. Participants were told that they were supposed to follow the arrows and pause at the circles to become aware of the environment. They were encouraged to ask questions while being in the practice scene since interaction in the experimental VR environment was to be avoided. After approximately a few minutes (when they indicated that they felt confident with using the controllers and moving in the virtual environment), the scene was stopped. Next, participants got the information that they will stay seven minutes in the experimental environment. After that, the VR simulation was started. Participants were not randomly assigned to each condition. Due to technical reasons, the first 20 participants were assigned to the experimental condition and the last 19 participants were assigned to the control condition. However, researchers had no control over at which time a participant signed up. Therefore, there was some random variation in the assignment.

Each of the two scenes shows a different neighbourhood. The geographical location of the two neighbourhoods was not precisely specified. However, due to their general appearance, they can be assigned to being in a Western society. Moreover, the English language in which the animated characters speak suggests that the neighbourhood is located in an area with English as the primary language, e.g. the United Kingdom, the United States, Australia or Canada. Both neighbourhoods had similar layouts. There was a basketball court in the centre, which is surrounded by a street. Houses were placed along the street.

The experimental condition displayed a deprived neighbourhood environment. The environment contains cues of different aspects that characterize a neighbourhood in which people with a lower socioeconomic status live. Features were designed to convey the feeling that this neighbourhood is characterized by the lack of intact infrastructure and public services, a high crime rate and low value of property. Trash on the ground indicates that there is not much

public spending. This is also emphasized by the streets having potholes. A bus stop with a broken window suggests that there are few possibilities of public transportation. Regarding sound effects, participants could hear police sirens that seem to be only a few streets away. The sirens, as well as the damaged bus stop, connote high crime rates. Moreover, participants could hear two people fight from within one of the houses, which represents household conflicts. The unkempt look of the houses (e.g. broken windows and graffiti) conveys bad maintenance of private property which indicates the low value of the property. This leads to the perception of the neighbourhood as an area in which predominantly people with a lower socioeconomic status live. An example picture of this environment can be found in Appendix F.

The control condition displayed a neighbourhood which gives the impression that its local residents are of middle socioeconomic status. There were no hints of the features of categories that were described above. The environment is clean, and the look of the buildings conveys regular maintenance. Participants could hear birds and a conversation between two people about going on a camping trip. The layout is approximately the same as for the experimental condition. An example picture of this environment can be found (Appendix G). After seven minutes the participants were asked to take off the VR glasses and the scene was stopped.

Balloon Analogue Risk Task

Subsequently, the participants played three games in Open Sesame. All three games were measures of decision-making. However, only one of the games, the BART, is relevant for this study and will be discussed. The other games (Information Sampling Task and Monetary Delay Discounting Task) were used as dependent measures in different papers. The BART was either the first or the second game that participants played. The order of the BART and the Information Sampling Task was randomized, while Monetary Delay Discounting was always the last game to be played. The BART is a laboratory-based measure of risk-taking behaviour which was developed by Lejuez et al. in 2002. The BART has acceptable test-retest-reliability (White et al., 2008). This indicates that the performance of a person on one occasion is representative of performance on other occasions. Moreover, performance on the BART has shown to be related to self-reported real world risk behaviours (Lejuez et al., 2003). However, it has to be taken into consideration that the named evidence is based on studies in which participants were exposed to a greater number of balloons compared with the current study. It cannot be ruled out that the comparatively low number of trials has an effect on retest reliability and validity.

The BART is a game in which the participant has to decide how much air is pumped into a balloon. One click on the space bar equals one pump of air. With each pump, money is earned. If a balloon explodes, all money that is earned on that balloon is lost. Participants see one balloon at a time and have to inflate this balloon by pressing the spacebar. With each inflation, they earn points, which are credited to their account displayed on the right upper corner of the screen. Each balloon has a maximum inflation level that is unknown to the participant. If a balloon is inflated too much and explodes, the money that has been earned from this specific balloon is lost. Example pictures of the game can be found in Appendix H.

For this study, the game was programmed by the head researcher using the software "Open Sesame", version 3.3.8. A random seed probability for explosion was set for each balloon. With every pump, the probability of explosion increases by five per cent. In the first practice trial, the balloon always exploded after the second pump. In the second practice trial, the balloon exploded after the maximum number of pumps possible, which is 15. First, the game instructions were shown on the screen (Appendix I). There were two practice trials (meaning two balloons) whose outcomes were not counted. After that, the game was played on five balloons.

Between the end of the VR simulation and the start of the games, the researchers had as little interaction with the participant as possible. Participants were asked to put on headphones and to inform the researcher when they were finished with both the game as well as the second questionnaire. After starting the game, the researcher left the room.

Questionnaire 2

After the game was finished, the second questionnaire automatically opened and was filled in. The second questionnaire included nine questions of a manipulation check for the VR conditions, a naivety check, and 20 questions about early childhood, i.e. resource availability, parental investment, neighbourhood quality and perceived unpredictability. Example questions can be found in Appendix J. The retrospectively self-reported socioeconomic status during childhood, which is used as a measure for resource scarcity during early childhood, was assessed using the following three questions that were part of the second questionnaire. 1) "My family usually had enough money for things." 2) "I grew up in a relatively wealthy neighbourhood." 3) "I felt relatively well-off compared to other children in my nursery, kindergarten or school". Participants were asked to indicate their agreement with these statements on a scale from 1 to 10, with 1 indicating strong disagreement and 10 strong agreement. Both questionnaires were created in the program Qualtrics. Due to the

Covid-19 situation during the time that the experiment was conducted, hygiene measures of the University of Twente were adhered to.

Data Analysis

Data Preparation

Of the 39 participants who completed the study, data from 38 participants remained for analysis. Due to technical problems, data from one participant had to be excluded because data on the dependent variable (BART) was missing. This was probably due to a mistake that happened when the relevant file was copied onto the hard drive. After the data exclusion, 20 participants were exposed to the experimental condition and 18 were exposed to the control condition

A common measure of the BART is to use the average number of adjusted pumps, which only takes into consideration pumps of balloons that did not explode. This can be of benefit because the number of pumps on balloons that explode is necessarily constrained. This is not possible with the current data. Due to the small number of trials per participant (five), there were two cases in which all five balloons exploded and several cases in which four balloons exploded. Since this means that a certain amount of data would not have been taken into account during analyses, it was decided to include data of all balloons (regardless of whether they exploded or not). Therefore, the average number of pumps is used to assess performance on the BART. However, in order to test if the assigned condition affects the number of explosions, a second analysis will be conducted to take this into account.

Data was uploaded into the program SPSS to be analysed. From the data that was collected from the BART, two variables were created. The first one is the average number of pumps for each participant. This variable is based on five variables, from which each represents one trial and indicates the number of pumps each participant performed on that trial. To create the new variable “average number of pumps” (mPumps), the mean of these five variables was computed. The second variable that was created is based on five variables that indicate whether a balloon exploded or not, with every variable showing the data for one trial. These variables were added up to create the new variable “total number of explosions” (tExplosions). The three measures of resource availability during childhood were recoded into the single variable “resource availability during childhood” by computing the mean of all three. The variable was recoded into a categorical one to prepare the data for the planned statistical analysis. It shows an ordinal measurement whereby three groups were created. This was done based on percentiles. The three groups were coded as low perceived resource availability (0 - 6), moderate perceived resource availability (6.1- 7.67) and high perceived resource availability

(7.67-9). SPSS syntax can be found in Appendix K. The experimental condition (deprived neighbourhood scene) will be in the following referred to as “deprived condition”.

Analysis Plan

1. Hypothesis.

To test the first hypothesis the effect of the independent variable “situational harshness” on the dependent variable “risk-taking behaviour” is tested. Therefore, an independent sample t-test was chosen to compare the effect of the VR condition on mPumps. Due to violations of the normality assumption, it was planned to use non-parametric statistics to examine the influence of the VR condition on tExplosions. Therefore, a Mann-Whitney U test was chosen.

2. Hypothesis.

To test the second hypothesis, the interaction effect of “resource scarcity during early childhood” and “situational harshness” on “risk taking behaviour” is tested. A two-way ANOVA was chosen to test whether there is an interaction effect between VR condition and resource availability during childhood on mPumps.

Results

Descriptive Statistics

For mPumps, participants who were exposed to the deprived condition showed a mean of 4.18 pumps with a Standard Deviation of 1.16. Participants who were exposed to the control condition showed a mean of 4.84 with a Standard Deviation of 1.08. For the number of tExplosions, participants in the deprived condition showed a mean of 2.3 with a Standard Deviation of 1.08. Participants who were exposed to the control condition showed a mean of 2.67 with a Standard Deviation of 1.19 (see Table 1). For the perceived resource availability during childhood, 14 participants are in the group “low” (38.8 %), 12 participants in the group “moderate” (31.6 %), and 12 in the group “high” (31.6%).

Table 1

Mean and Standard Deviation of BART measures in Deprived (n=20) and Control Condition (n=18)

Measure	Deprived Condition		Control Condition		Whole Sample	
	M	SD	M	SD	M	SD
mPumps	4.18	1.16	4.84	1.08	4.49	1.16
tExplosions	2.3	1.08	2.67	1.19	2.47	1.13

Inferential Statistics

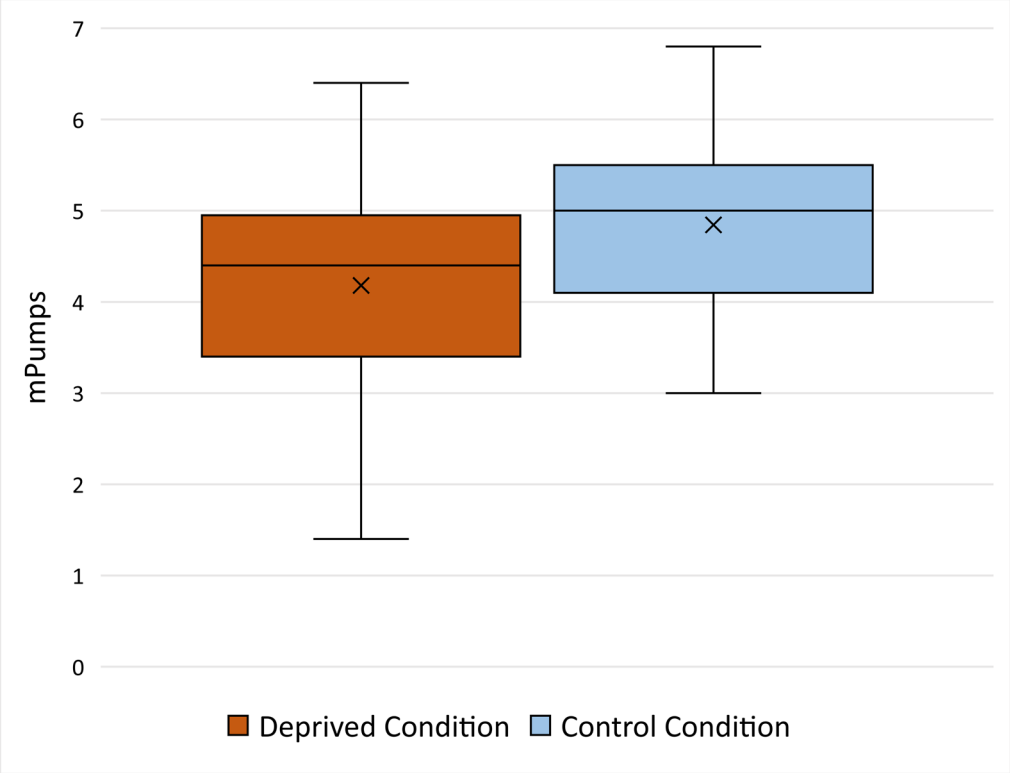
Hypothesis 1.

The average number of pumps per participant is approximately normally distributed and showed a Skewness of - .3 and a Kurtosis of .34. Moreover, the Kolmogorov-Smirnov test indicated a normal distribution of data for the deprived condition, D (20) = .14, p = .2) as well as the control condition, D (18) = .11, p = .2). This assumption was also supported by the Shapiro Wilk test for the experimental, W (20) = 0.97, p= 0.85 and the control condition, W (18) = .9, p = .81.

An independent sample t-test was conducted to compare the number of average pumps in the deprived and control condition. The results of Levene's test of Equality of variances, F (36) = .009, p = .93, indicate that the variance of the two populations is assumed to be approximately equal, thus the standard t-test results were used. The result of the independent t-test was not significant, t (36) = -1.82, p = .08, indicating that there is no significant difference between the scores of participants who were exposed to the deprived condition (M = 4.18, SD = 1.16) and participants who were exposed to the control condition (M = 4.84, SD = 1.08) (Figure 1). These results suggest that exposure to situational cues of harshness does not have a significant effect on the number of pumps in the BART, which means that situational harshness does not have an effect on risk taking behaviour and thus, the null had to be retained.

Figure 1

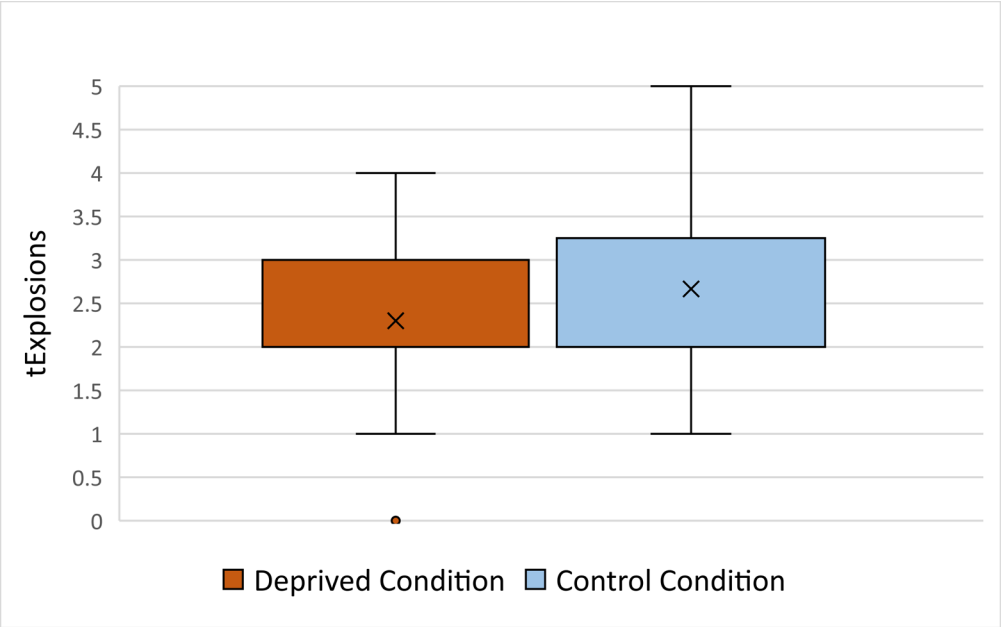
The Average Number of Pumps per Participant in the Deprived (n=20) and Control (n=18) Condition



For number of explosions, the Kolmogorov-Smirnov test indicated that data in the deprived condition, D (20) = .21, p= .02, and in the control condition, D (18) = .27, p = .001, significantly deviate from a normal distribution. Therefore, a Mann-Whitney-U test was calculated. The test revealed that there is no significant difference in the total number of exploded balloons per participant between participants who were exposed to the deprived condition and participants who were exposed to the control condition, U= 156.00, Z = -.74, p = .46 (Figure 2).

Figure 2

Number of Explosions per Participant in the Deprived (n=20) and Control Condition (n=18)



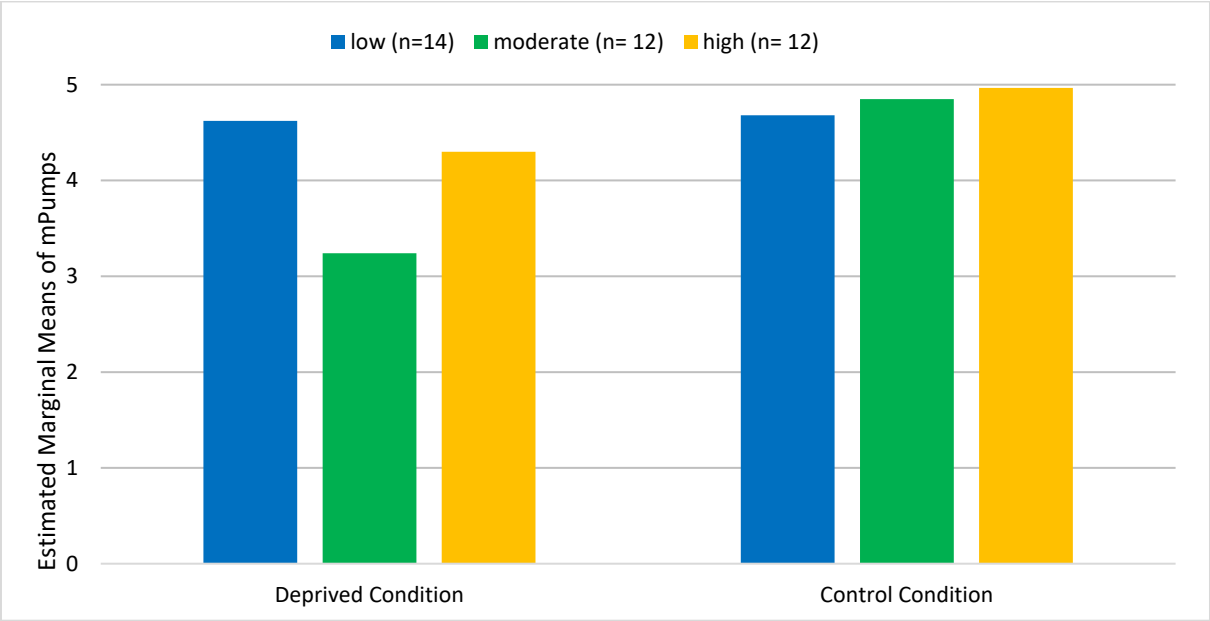
Hypothesis 2.

A two-way ANOVA was conducted to test the hypothesis that exposure to cues of harshness during early childhood positively affects the influence of situational cues on risk-taking behaviour as measured by the BART. The test revealed that resource availability had no significant main effect on mPumps [F (2) = 1.16, p = .33].

Moreover, there was no statistically significant interaction between the effects of VR condition and resource availability on mPumps [F (2) = 1.55, p = .23] (Figure 3). Therefore, resource scarcity during childhood does not have a moderating effect on the relationship between situational cues of harshness on risk-taking behaviour and thus, the null had to be retained.

Figure 3

Number of Pumps on the BART based on Condition and Resource Availability During Childhood



Discussion

This study aimed to gain a better understanding of the influence of exposure to cues of harshness on risk taking behaviour. Thereby, situational cues of harshness, as well as harshness during the early years of childhood, were taken into account.

Specifically, two hypotheses were tested. 1) "Immediate cues of harshness lead to increased risk-taking behaviour on the BART" and 2) "Exposure to cues of harshness during early childhood has a positive effect on the influence of situational cues of harshness on risk-taking behaviour on the BART". The results of the present study indicate that situational cues of harshness do not have an effect on risk taking behaviour. Moreover, exposure to cues of harshness during the early years of childhood did not have an effect on risk taking behaviour and did not moderate the effect of situational cues of harshness on risk taking behaviour. This means that no influence of harshness on risk taking behaviour could be observed. Therefore, both null hypotheses could not be rejected.

These results are inconsistent with the position of the majority of researchers in the scientific field of evolutionary psychology. Many of them take the view that harshness during childhood leads to increased risk taking later in life, due to the development of behavioural

tendencies that are adaptive in terms of fitness and increase survival (Frankenhuis et al., 2016; Ellis et al., 2020). It is assumed that a harsh environment suggests a lower life expectancy and therefore a shorter reproductive life span. This leads to more risk-taking behaviour in order to increase the chances of sooner reproduction. While there has been much research on the effect of harshness during the early years of life, the impact of immediate situational cues of harshness has been examined less. Griskevicius et al. (2011) tested a similar hypothesis and found that people who had a low socioeconomic status when growing up show more risk-taking behaviour when being faced with acute stressors. However, Pepper et al. (2017) could, similar to this study, not find an effect of situational harshness on risk-taking behaviour.

When looking at the results concerning the number of pumps, the mean of the control group was higher than the mean of the experimental group. Although no statistically significant difference was observed, it is interesting to see that the group who was exposed to the experimental condition showed slightly less risk-taking behaviour. Not only does this not support the hypothesis, but it even points in the opposite direction. It was assumed that the influence of situational cues of harshness on risk taking follows the same underlying mechanism that is thought to account for the influence of childhood exposure to harshness on risk taking. It can be asked whether this assumption is correct or if the influence of situational cues on risk taking follows a different rationale. However, when looking at the results of the present study, the relatively small sample size has to be considered.

Limitations

Although the results of the present study do speak against the named literature, it is appropriate to take into consideration aspects that can limit the meaningfulness of the results. First, the most common measure to assess performance on the BART is the average number of adjusted pumps. This measure takes only those balloons into consideration on which participants ended the blow-up procedure themselves, meaning balloons that did not burst. This proceeding is possible if each participant is exposed to a higher number of trials and there is still a reasonable amount of data left after balloons that did burst have been excluded. In this study however, only five balloons were shown to each participant. The decision to reduce the number of trials was made in order to keep the experiment at a reasonable length, since it also included two other decision-making tasks, as well as approximately 10 minutes of exposure to VR environments. Taking into consideration data from all balloons might lead to data that does not correctly represent the risk-taking willingness of participants. If a balloon bursts at some point it is not clear how much the participant was willing to pump up this balloon. This means

that the number of pumps on a balloon that burst is necessarily restrained, and there is a chance of a person's risk-taking willingness being higher than reflected by the data.

Second, the lack of variation in the sample might be another limitation. Evolutionary psychology focuses on universal characteristics that have developed through evolution. Therefore, it has been suggested that research in this field of psychology has a particular need for diverse samples (Henry, 2008; Nielsen et al., 2017; Henrich et al., 2010). Henrich et al. (2010) state that WEIRD people ("people from Western, Educated, Industrialized, Rich, and Democratic […] societies" [Henrich et al., 2010 p. 61]) are highly unrepresentative for the human population in many fundamental areas, e.g. visual perception and economic decision making. They criticize that a majority of the research in the field of behavioural science is based solely on these kinds of people, in particular American undergraduate psychology students, although they are very unusual compared with the whole human population (Henrich et al., 2010). The current sample might also over-represent WEIRD people. In the present data, every participant had at least graduated from high school. Moreover, the mean of perceived resource availability during childhood was 6.58 out of 10. Looking at different societies and cultures around the world, this is not representative of the vast majority of the human population. Moreover, it has to be taken into account that the measure of resource availability consists of the participants' retrospective self-report and is based on comparison with other people in their environment, which is, again, based on populations in Western societies. When examining whether, and how, harshness influences risk taking, this is done based on evolutionary theories. One important aspect of these theories is the adaptation of the human race to its environment in order to survive and produce offspring. A sample that consists primarily of university students might not fully capture the possible range of variation within the human race in respect of people's exposure to harshness, other environmental conditions and differences in risk-taking behaviour.

Third, it has to be recognized that an exposure time of seven minutes might be too short to evoke significant changes in risk-taking willingness. Exposure time to stimuli of harshness also varied in the research that was discussed at the beginning of this paper. Nettle et al. (2014) exposed participants to a neighbourhood for approximately 45 minutes and reported significant changes in attitudes. Harrison et al. (2019) exposed participants to cues of harshness for only a relatively short time, approximately a few minutes (20 pictures for two seconds each). Importantly, this affected participants' alcohol consumption but not their performance on the BART. It can be questioned whether seven minutes is a sufficient time to evoke a change in risk-taking behaviour on a laboratory-based measure. Research shows that there is a correlation

between real-world risk behaviour and laboratory-based measures of risk behaviour. However, the study by Harrison et al. (2019) can be seen as an incentive to further investigate whether a stronger effect or more exposure is needed to evoke changes that manifest on a laboratory-based measure than for changes in real-world behaviour. This can be seen as a possible limitation to this study since the absence of significant effects might be due to the short time of exposure. However, it might also be something that can be discussed further in future research.

Directions for Research in the Future

Despite the above mentioned problems as to sample variation, it is important to conduct further research in this direction. It can be of particular interest to further examine the role of situational cues of harshness. Research suggests that exposure to cues of harshness during childhood could partially account for the difference in risk-taking behaviour between individuals. However, when creating strategies to reduce risk taking, knowing how situational cues affect these tendencies is important. The role of harshness as a situational factor could play an important role in informing intervention design to reduce risk-taking behaviour. There is consistent evidence that people who have a lower socioeconomic status show higher health related risk-taking behaviour and poorer health outcomes (Mackenbach et al., 2008; Feinstein, J. S., 1993; Ross, C. E., & Wu, C. L., 1995). There are many potential reasons for this relation discussed in the literature and the role of time-preference resulting from early exposure to harshness could be one. Do fewer cues of harshness lead to decreased risky behaviour for some people but not for others? It can be questioned, for example, whether visual fear appeal messages on cigarettes have a different effect on people who grew up in environments that displayed a high level of cues of harshness than on people who grew up in environments that displayed a low level of cues of harshness. The findings of Griskevicius et al. (2011) would suggest that people who have experienced much harshness while growing up would react to pictures on cigarettes who contain cues of mortality with increased risk-taking behaviour, meaning an increased chance of smoking. Adams (2009) found that time perspective (present-orientation vs future orientation) played a mediating role in the relationship between socioeconomic position and smoking. Higher socioeconomic position was associated with increased future-orientation and increased future orientation was associated with lower risk of being a smoker. The found effect was only small and the sample was limited to people over the age of 50. However, much of the here discussed literature shows that situational cues of harshness play an important role in influencing risk-taking behaviour.

In order to get a more complete picture of how harshness influences risk taking, further research could consider taking into account people's age. Participants in this sample had a mean

age of 21.35 (*SD* = 1.9) and there was a total age range from 18-27 years. Neither adolescents nor people outside their reproductive life span were included. Since reproduction and evolutionary fitness are strongly related to the age of an organism, it can be asked whether age plays a significant role in this relation. This could also have implications for intervention design that is e.g. specifically targeted at the youth. Adolescence has been discussed in research as a phase in which risk-taking willingness is particularly high

In terms of future research, it can also be considered to further examine the usefulness of VR. When manipulating situational cues of harshness, traditional mediums such as pictures and texts have been used. VR is an option to potentially improve this manipulation in terms of creating the same imagery within all participants and thus to have better control over what they perceive. Therefore, it might be beneficial to improve VR as a tool for manipulation and thereby increasing its use in future research.

Much work remains to be done before a full understanding of the extent to which harshness influences risk-taking behaviour is established. Despite the potential limitations, this research is among the first studies to take into consideration the influence of harshness, both during childhood but also in the current situation, to explain risk-taking behaviour. Moreover, this was done by making use of VR as a tool to manipulate cues of harshness. The hypotheses could not be confirmed and therefore stand contradictory to some research that has been done on this topic. However, this emphasizes that there is a need to conduct more research and to improve tools for manipulation and assessment in order to fully understand how harshness influences risk-taking behaviour.

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Appendix A
Recruitment Poster

Appendix B

First Questionnaire

Welcome!
You are invited to take part in a study investigating how people experience a Virtual Reality neighbourhood.

The project is conducted by Salome Hackenfort, Stella Scholz and Maike Wohlgemuth (BSc Psychology students at University of Twente) and supervised by Jeanette Hadaschik, MSc (Department of Psychology of Conflict, Risk and Safety, University of Twente; Work and Social Psychology, Maastricht University) and Dr. Marielle Stel (Department of Psychology of Conflict, Risk and Safety, University of Twente) as well as Dr. Karlijn Massar and Prof. Dr. Rob Ruiter (Maastricht University). The study is approved by the Ethics Committee of the Faculty of Behavioural, Management and Social Sciences at University of Twente (request number 210124).

Please take time to read the following information carefully before you decide whether or not to take part, it is important for you to understand what participation in the study will involve.

Who can take part?
We are looking for women and men who are above 18 years old. Your English language skills need to be sufficient in order to understand instructions and answer the questionnaires. Participation is completely voluntary and anonymous.

What is involved?
If you decide to take part, your session will consist of the following parts:
1. You fill in a short questionnaire.
2. You experience Virtual Reality for about 10 minutes. You will receive instructions on how to put on the headset and how to move in the virtual world.
3. Right after experiencing the Virtual World, you play a series of short games on the computer. Instructions will be provided.
4. You fill in a questionnaire.
One session takes about 45 minutes.

Will I get paid?
If you are a SONA participant, you will receive 1.5 credits for your participation. Non-SONA participants will receive a 5 Euro VVV-voucher via email after completing the study. In addition, based on performance in two games among all participants, the **top 5 performing participants will each receive a 20 Euro VVV-voucher**. The winners will be announced once the data collection is finished. If you'd like to be notified in case you win one of the prizes, you need to provide your email address at the end of the study.

Are there risks?
Some people get nauseous during or after experiencing Virtual Reality. This usually goes away after a brief period of rest.
The questionnaire includes questions about positive and negative childhood experiences (which some people might find uncomfortable).

What about Covid-19 prevention?
Our team will adhere to a strict safety protocol including thorough disinfection of equipment after every participant, opening windows, wearing masks, keeping distance, etc. You can participate only if you are free of relevant symptoms.

What happens with the data?
All data collected during the study will be kept strictly confidential and anonymous. That is, **your response cannot and will not be traced to you personally** and no identifying information will appear in any documents or in the final report. A unique, random identifier code will be sent to you via email after completing the study. You can use it in case you would like to withdraw your consent after taking part. Only the main researchers have access to the collected data. Therefore, we ask you to answer as honestly as possible.

Do you have any general questions?

If yes, please ask the researcher now.

In this section, we ask you to provide some general information.

Please indicate your gender below

- ○ Male
- ○ Female
- ○ another gender

Education Please indicate your highest achieved educational level

- ○ Elementary school
- ○ High school
- ○ College/University - Undergraduate degree (e.g. Bachelor of Science, Bachelor of Arts or equivalent)
- ○ College/University - Graduate degree (e.g. Master of Science/Arts or equivalent)
- ○ Doctoral degree/PhD
- ○ Other

Please indicate your age:

Nationality What is your nationality?
▼ Afghanistan (1) ... Zambia (283)

ChildhCountry Please choose **the country you lived in until you were about five years old**. If you lived in more than one country, indicate the one that most influenced your early childhood.
▼ Afghanistan (1) ... Zambia (283)

Appendix C

Informed Consent

By clicking **YES** below, I agree to the following:

I understand that my participation is voluntary. I also understand that I have the right to withdraw my consent at any time without needing to give a reason, if I experience any discomfort or distress.

Furthermore, the following points are clear to me:
- All data that are collected by the researcher are treated completely anonymously and cannot and will not be traced back to me personally.
- I understand that I have to provide my email address if I want to be notified in case I win a prize. If I provide my email address, it will also be used to send me a copy of the debriefing information including my response identifier code (which is needed to request deletion of the data).
- I understand and agree that the purpose and hypotheses of the current study cannot be revealed to me because it could bias my answers. However, after completion of the study I will receive a full debriefing.
- I agree to keep the procedures and explanation of this study to myself and will not pass this information on to others because this might negatively influence the study results.

I agree to participate in the study:

○ YES, I fully understand the contents of this consent form and agree to participate in this study. I also agree not to disclose the details of the study to other parties.

○ NO (you will be directed to the end of the study)

Appendix D

Information about VR procedure

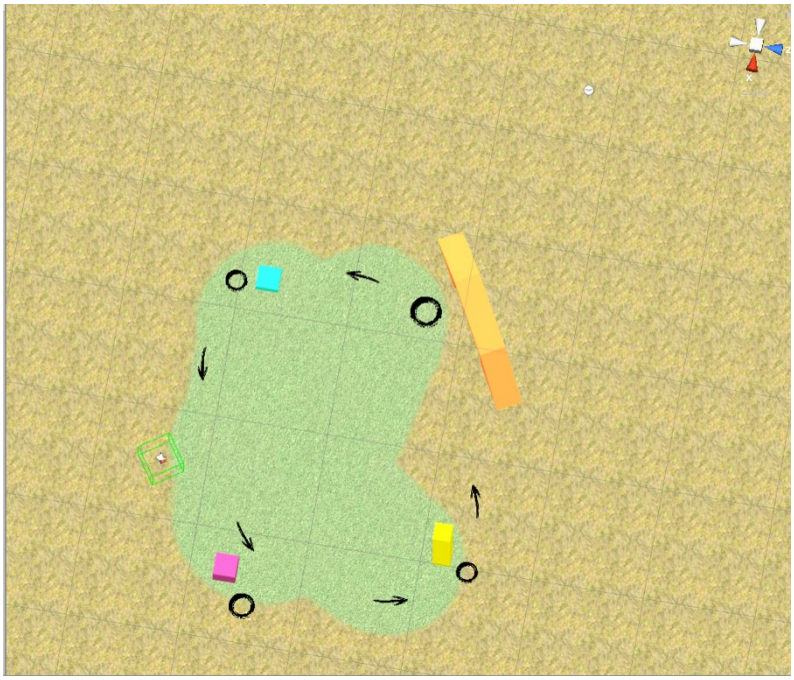
In the next part of your session you will experience Virtual Reality. You will walk around a **virtual neighbourhood** that is modelled based on examples of real neighbourhoods in the United Kingdom and USA. **Please imagine that you are walking around this neighbourhood in reality**. Arrows are painted on the ground to guide you. Please follow them to do a small tour of the neighbourhood. Take your time. When you see a circle painted on the ground, please stop walking, have a break, look around and get a good impression of your environment and your surroundings. When you feel ready, continue to follow the next arrow. When you have completed your tour, you can continue walking around and exploring other areas and corners until your time is over. Your stay in the neighbourhood takes 7 minutes.

Before you enter the virtual neighbourhood, you will enter a *'practice' world* where you will learn to use the controllers, try to orient yourself and become familiar with how to move. If you have any questions, please make sure you to ask the researcher **while you are still in the practice world**, that means, **before you enter the virtual neighbourhood**. The researcher will let you know when you are about to leave the practice world. Once you are in the virtual neighbourhood, we would like you to **fully focus on the experience and not be distracted**. Therefore, it's important that you ask any questions before. Of course, in case that you would like to withdraw from the experiment or in case you feel nauseous, you can always stop without giving a reason.

○ Ok, I understand (

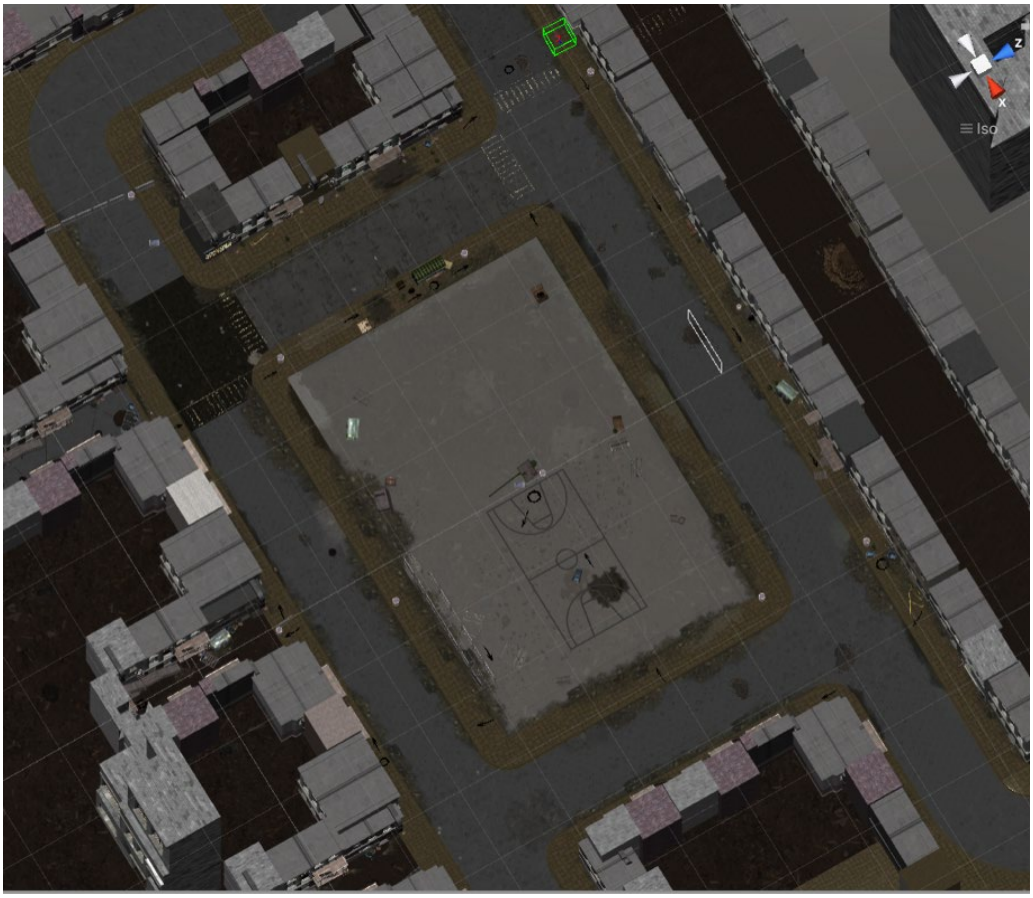
Appendix E

Example Picture of Practice Environment



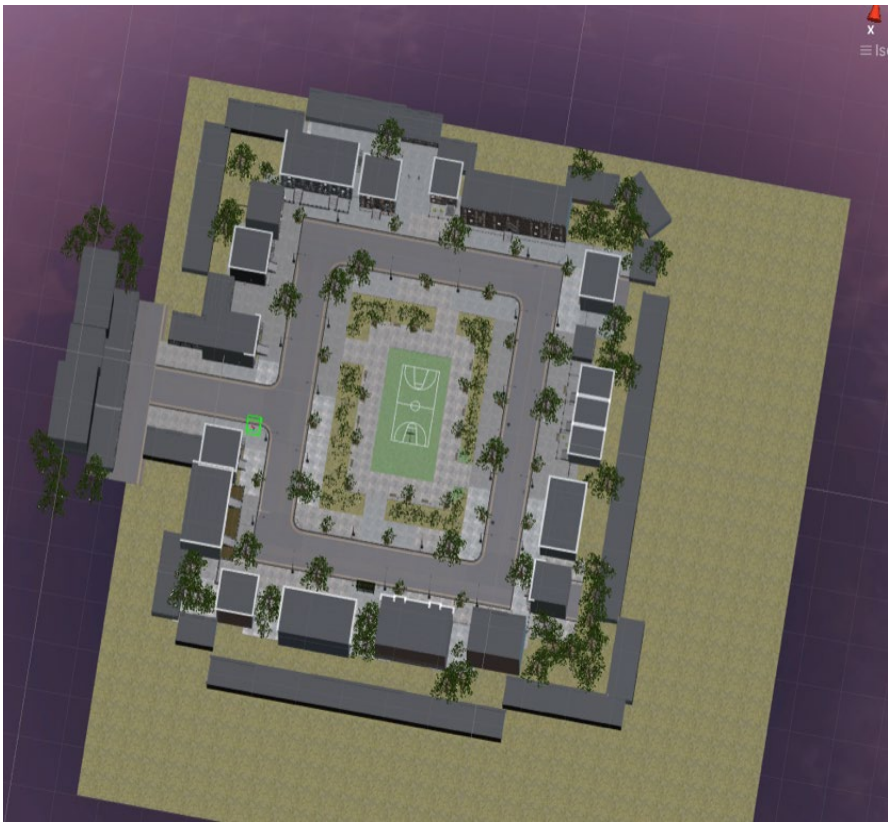
Appendix F

example picture of deprived neigbourhood scene



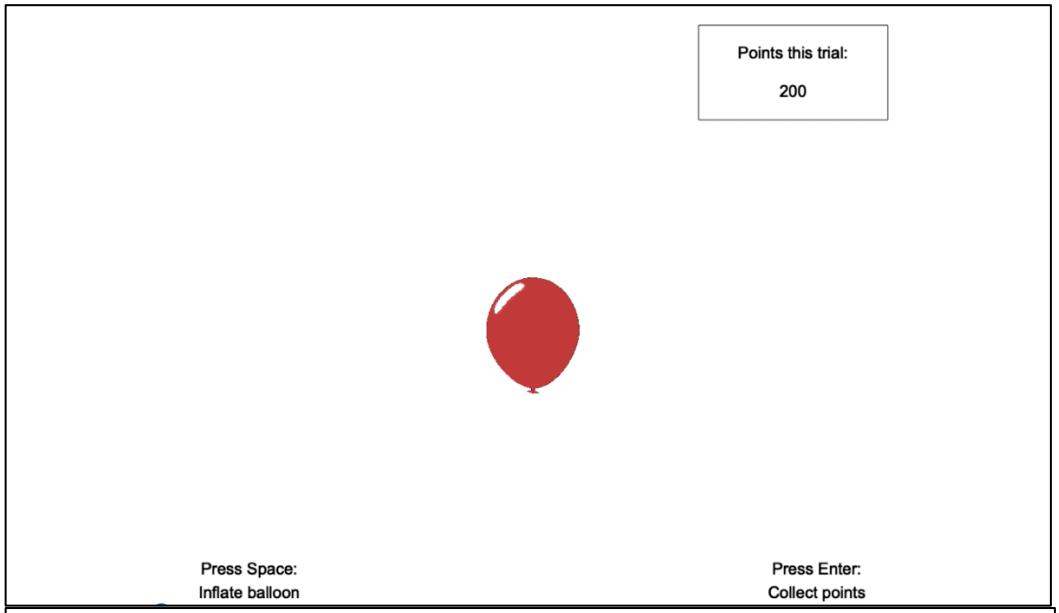
Appendix G

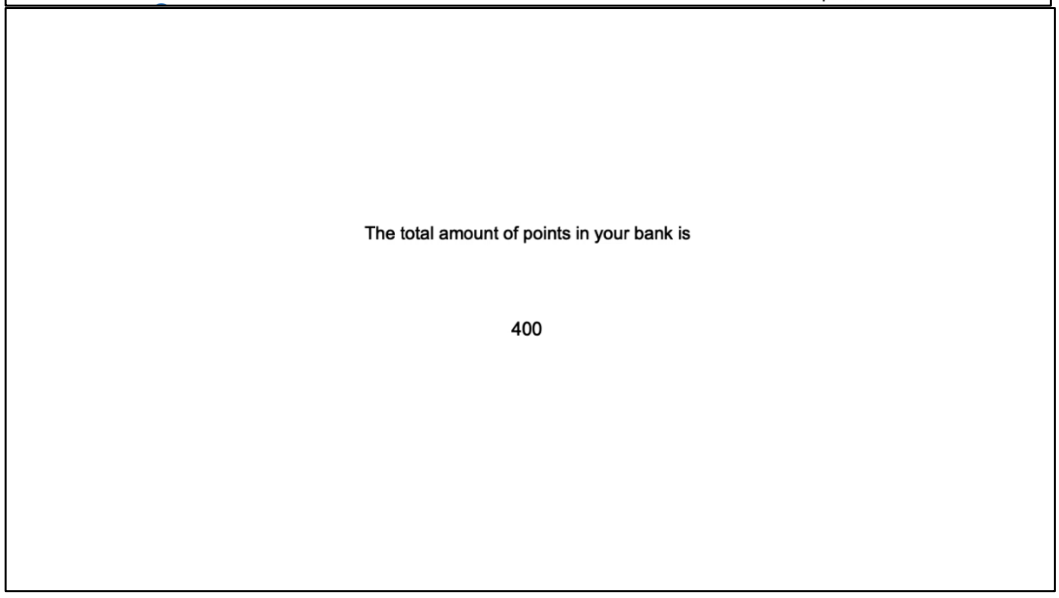
Example Picture of Control Neighbourhood



Appendix H

example pictures of the BART





Appendix I

Balloon Analogue Risk Task Instructions

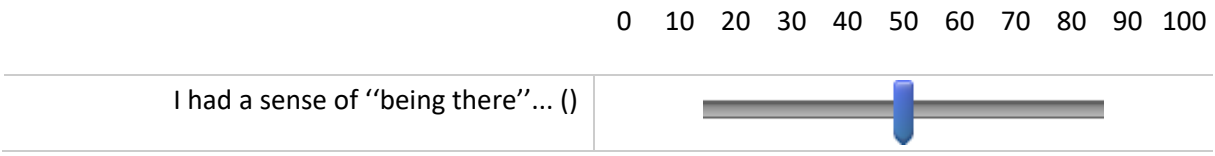
Welcome to the Balloon Game! In this game you can win points by inflating a balloon There will be 5 trials. Press the space bar on the keyboard to inflate the balloon. Every time you inflate the balloon you'll earn 50 points. The bigger it gets, the more points you can earn. At any point while blowing up a balloon you can decide to stop by pressing Enter and your points will be stored in the bank. If you inflate the balloon too much there is a risk of it exploding. If the balloon explodes, you lose the points you've earned on that balloon. The next two trials are practice trials to get the hang of it. The points you win or loose during the practice don't count. Press any key when ready to continue.

Appendix J

Example Questions from second Questionnaire and Debriefing

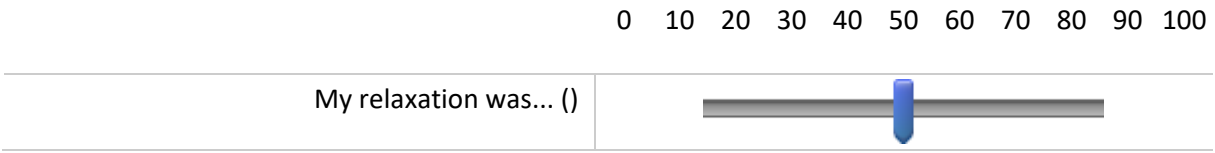
While being in the virtual neighbourhood, did you have a **sensation of 'being there'** (in the virtual environment)?

Please rate your sensation of being in the virtual environment, on the following scale from 0 to 100, where **100 represents your normal experience of being in a place**.



Please rate how **relaxed** you felt in the virtual neighbourhood,

where **100 represents highest relaxation possible** and **0 represents not** feeling relaxed at all.



Did you experience any technical issues while being in the virtual neighbourhood? For example, graphic distortions (e.g. zig zag lines, black patches) in your visual field, non-responsive controllers, problems with the audio, etc.

- ○ No issues at all
- ○ Minor issues but they didn't distract or confuse me
- ○ Some issues that were moderately distracting/confusing
- ○ Major issues that were very distracting/confusing

The following questions focus on **your perspective and subjective perceptions**. Please do not think too long over each question and choose the response that you feel fits best.

Please think back to the family environment and living situation in your childhood family, from **when you were born to when you were about 5 years old** to answer these questions. We are aware that you might only remember things vaguely or that you might have been told stories about things that happenend when you were small. Please answer to the best of your

knowledge and ability.

Please indicate how much you **agree or disagree** with the following statements on a scale of 1 to 10, where **1** represents **strongly disagree** and **10** represents **strongly agree.**

Until I was about 5 years old...

	Strongly disagree 1	2	3	4	5	6	7	8	9	**Strongly agree** 10
My family usually had enough money for things	○	○	○	○	○	○	○	○	○	○
I grew up in a relatively wealthy neighbourhood	○	○	○	○	○	○	○	○	○	○
I felt relatively well-off compared to other children in my nursery, kindergarden or school	○	○	○	○	○	○	○	○	○	○

Please indicate your response to the following statements on a scale of **1** to **10**, where **1** represents **never** and **10** represents **always**.
Until I was about 5 years old...

	Never 1	2	3	4	5	6	7	8	9	**Always** 10
I generally felt safe in my neighbourhood (including at home, day-care facilities, playgrounds, etc.)	○	○	○	○	○	○	○	○	○	○
The buildings, streets and facilities in my environment were run-down or in bad condition	○	○	○	○	○	○	○	○	○	○
People around me enjoyed living or spending time in my neighbourhood	○	○	○	○	○	○	○	○	○	○

DEBRIEFING: This study's aim is to investigate whether there is a relationship between the environment that participants experience in Virtual Reality and their behaviour in decision-making games. In addition, our early experiences in family and neighbourhood might also have an influence on our decision-making and what effect an environment has on us. We are not interested in individual responses but rather in comparing trends across different VR environments.
Results from this study might help us to further understand how different environments influence our decision-making. Not much is known about this topic and our research ultimately aims to support intervention development that helps people make decisions that increase their well-being. If you have concerns about your participation or would like to withdraw from the study, you can contact the researchers and provide your identifier code. *Please don't share this information with others as it might influence how future participants behave during the experiment.* Based on the number of points that you won during the square and the balloon game you can win one of five 20 Euro VVV vouchers. The winners will be notified via email after data collection has ended. Due to the pandemic, data collection is expected to take longer than usual, therefore it can take a while until we can announce the winners.

Appendix K

SPSS Syntax

```
#computing the variable for 'average number of pumps per participant', by taking the mean of the five individual measures of number of pumps

COMPUTE
average_pumps=MEAN(log_count_inflate_exp_1,log_count_inflate_exp_2,log_count_inflate_exp_3,
    log_count_inflate_exp_4,log_count_inflate_exp_5).
EXECUTE.

#computing the total number of explosions per participant by adding all 5 variables that inficate of a baloon exploded or not COMPUTE
nr_explosions=SUM(log_exploded_exp_1,log_exploded_exp_2,log_exploded_exp_3,
    log_exploded_exp_4,log_exploded_exp_5).
EXECUTE.

#comuting the variable for childhood resource availability by taking the mean of the three individual measures of resource avilibility COMPUTE
child_res_availibility=MEAN(resource_available_1,resource_available_2,resource_available_3).
EXECUTE.

#recoding childhood resource availability into a categorical variable with three categories (based on percentiles) RECODE child_res_availibility (Lowest thru 6=1) (6.00001 thru 7.67=2) (7.68 thru 9=3) INTO
    res_avail_cat.
VARIABLE LABELS  res_avail_cat 'resource availibility categorical'.
EXECUTE.

#independant sample t-test to compare means of control and experimental condition with regard to the number of pumps

T-TEST GROUPS=condition(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=average_pumps
  /ES DISPLAY(TRUE)
  /CRITERIA=CI(.95).

#conducting a Mann Whitney-U test to compare means of control and experimental condition with regard to the number of explosions per participant

NPAR TESTS
  /M-W= nr_explosions BY condition(1 2)
  /MISSING ANALYSIS.


#Conducting a two way ANOVA to test whether there is an interaction effect between resource
```

availability during childhood and VR condition on pumps on the BART

```
UNIANOVA average_pumps BY condition res_avail_cat
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /PLOT=PROFILE(condition res_avail_cat condition*res_avail_cat) TYPE=LINE ERRORBAR=NO
    MEANREFERENCE=NO YAXIS=AUTO
  /EMMEANS=TABLES(OVERALL)
  /EMMEANS=TABLES(condition) COMPARE ADJ(BONFERRONI)
  /EMMEANS=TABLES(res_avail_cat) COMPARE ADJ(BONFERRONI)
  /EMMEANS=TABLES(condition*res_avail_cat)
  /PRINT ETASQ DESCRIPTIVE HOMOGENEITY
  /CRITERIA=ALPHA(.05)
  /DESIGN=condition res_avail_cat condition*res_avail_cat.
```