# How We See Changes How We Feel: Investigating the Effect of Visual Point-of-View on Decision-Making in VR Environments

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Virtual reality (VR) can immerse users into engaging experiences, affording opportunities to study behaviour in simulated contexts such as decision-making processes. However, methodological research into designing meaningful VR experiences — experiences that promote appreciation and deeper understanding of a work — is still underdeveloped. In this two-part study, we investigate how visual point-of-view (POV) in VR impacts feelings of meaningfulness and empathy as well as objective decision-making processes. Our study revolves around a VR application that situates users in moral dilemmas from three different POVs. Data from the choices made is augmented with self-reported subjective data. We find that, from different POVs, users' subjective feelings do show change; users show greater empathy for virtual agents and have an increasingly meaningful experience from a first-person perspective, even if this is not always reflected in changes in their decisions. Finally, we discuss the implications of our findings in the context of VR application design.

CCS Concepts: • **Human-centered computing → Empirical studies in HCI**.

Additional Key Words and Phrases: virtual reality, meaningful experience, moral dilemma

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## 1 Introduction

Virtual reality (VR) has opened the door for deeply immersive applications for both entertainment and serious contexts. VR allows users to deeply engage in virtual worlds with a sense of presence and embodiment, resulting in increased perceived realism and emotional expression [15, 71, 87]. Within academic research, VR has allowed researchers to simulate virtual scenarios to study user behaviour within these simulated environments. For example, researchers have devised and developed VR applications to provide personal meditative spaces [67] and to create interactive storytelling experiences [75]. Using diverse VR-based scenarios, researchers have studied the potential of VR in promoting an equally diverse set of outcomes, such as improving the quality of sleep [17, 42], facilitating methods of education delivery [1, 66, 76], and addressing challenging issues in mental health [22, 68, 86].

One common academic application of VR is in studying human decision-making in difficult scenarios such as moral dilemmas — decision-making paradoxes without an unambiguous ethically acceptable answer. VR's affordances of immersion and embodiment help stimulate persuasive prosocial engagement, making it a promising tool for such purposes [14, 53, 63]. Organizations

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such as the UN have employed VR applications to inspire empathy and understanding of present humanitarian issues [26]. To garner a quantifiable representation of human ethics, past research has exploited the effects of simulated VR environments to better understand human ethical behaviour. [54, 56, 83]. As such, researchers have tried to generate an algorithmic system of ethics from a representative sample in such experiments [83].

Although numerous studies have proposed the use of VR to enhance empathy and engagement in moral decision-making, less has been done to investigate how effectively it attains these outcomes. We considered to what extent the methodological design of the VR experience impacted these factors — by understanding how users engage with simulated environments and the virtual agents within them, we can develop virtual worlds with more meaningful interactions. The concept of meaningfulness is imperative — it refers to a perceived quality of emotional and cognitive reaction in which users feel as though their virtual actions have potent consequences [35]. Past research has shown that meaningful choices augment feelings of relatedness and insightfulness, leading to a more thought-provoking and impactful experience for the user [35, 72]. This correlates with the actual prosocial outcomes of such experiences [35]; as such, it is important to explore how designers may develop more meaningful VR experiences.

Within this exploratory research work, we considered one such factor that may affect the meaningfulness of a VR experience — visual point-of-view (POV). VR experiences are almost always shown from the first-person perspective (1PP), in which the user simulates looking through a character's eyes; rarer is the use of the third-person perspective (3PP), in which the user can see the body of the character. Past games research has shown that there are significant differences in feelings of immersion and cognitive involvement between varying POVs of a common application [18, 52]. Similar effects hold in VR, as first-person VR applications are more immersive and generate increased sensations of body representation, stronger emotional responses, and heightened feelings of presence when compared to the third-person [24, 27]. Meaningful choice in virtual worlds encodes factors such as a heightened sense of moral ambiguity and perceived consequence [35]; Heron and Belford theorized that user identification, alongside the interactivity of virtual environments, can create such consequential outcomes in games [31]. Thus, we extend our hypothesis from this corpus of past research — that aspects of immersiveness, representation, and identification (as drawn from different POVs in VR) may affect the personal feelings of meaningfulness and empathy with virtual agents when facing ethical decisions in VR.

This work first looks to understand the extent to which visual POV might impact user decision-making. Furthermore, this work examines the feelings and thought processes of users when making those decisions. To address these goals, we designed two study components centred around a VR application in which users must make choices in virtual scenarios involving a moral dilemma from one of three possible visual POVs — the 1PP and 3PP discussed prior, with an added static perspective (SP) which fixes the camera's location within the scenario. We collected data from user choices and additional qualitative data through questionnaires and interviews which we analyzed using a mix of qualitative and quantitative methods.

In our first study, we focused on the outcomes of user decision-making — considering how objective choices made by users differ from POV-to-POV. The research questions we addressed in this study were "Do users make choices differently based on their moral judgment depending on the POV?" and "Do users feel differently in terms of empathy or meaningfulness when passing moral judgment depending on their POV?". Based on the results of our first study, we found that the latter question required a deeper dive to better understand the specific factors that impacted a user's subjective perception of their own feelings of meaningfulness across the three POVs. In the second study, we investigated the subjective feelings involved in decision-making — addressing the research question of "What aspects of meaningfulness in moral decision-making differ across

POVs?". We made comprehensive findings to address these research questions and we discuss possible implications from both a technological design and philosophical standpoint.

## 2 Related Works

To frame our study within the context of prior research, we look at past related work in areas of 1) philosophical perspectives of decision-making, 2) ethical decision-making in virtual experiences, 3) meaningful experiences in virtual environments, and 4) perceived differences in visual POVs.

### 2.1 Ethical Decision-Making — Philosophical Perspectives

*Normative ethics* refers to the fundamental principles that govern moral decision-making [36], often split into three main perspectives — consequentialism, deontology, and virtue ethics [37, 61]. Consequentialist ethics focusses on the consequences of an action, encompassing ideas such as utilitarianism, which aims to maximize "happiness". Deontological ethics focusses on adherence to the rules that drive decisions. In contrast to both prior perspectives, virtue ethics focusses on the inherent character of the individual making the decision rather than the decision itself, justifying the morality of action so long as the individual performs it virtuously.

The link between theoretical ethics and practical application is highlighted by the concept of pragmatism [80]. The application of these three fundamental ethical viewpoints has been theorized within several practical fields, including those of environmental guidelines [37], federal policy [48], and planning [34]. Chakrabarty et al. for example, evaluate these three forms of ethics regarding corporate social responsibility for microfinance organizations in developing countries, arguing that virtue ethics mitigates the most potential microfinance risk [13]. Yoon et al. showed how similar ethical perspectives apply within decision-making for online contexts, finding that decision-making and justice have a significant influence on behavioural intentions, which could inform future ethical software developments [92]. Arries argued for the virtue ethics approach for nurses in medical scenarios, focussing on developing virtuous character traits to allow for more flexibility in action and response [4].

Research into decision-making in VR has heavily focussed on the outcomes, taking a highly consequential view of the participants' ethics. However, what happens when the outcomes of the decisions are identical, yet the context and judgment in making the decision differ? We tie our findings into a discussion regarding the philosophy of normative ethics, demonstrating that focussing solely on consequences may fail to capture the complexities of decision-making.

### 2.2 Moral Dilemmas and Ethical Quantification in Virtual Experiences

Virtual experiences provide a simulated experience with an increased sense of immersion and embodiment, which helps stimulate strong empathetic responses in the participating user [14, 53, 64]. The most common moral dilemma within the literature of this field are variants of the famous "trolley dilemma", for instance, Skulmowski et al. used a VR implementation of this dilemma to understand decision-making within a simulated experience [79]. Similarly, Sütfeld et al. developed a VR application to assess ethical decisions within a traffic scenario, asking users to decide, under time pressure, which of two groups of virtual agents should perish [83]. Faulhaber et al. developed a similar traffic accident model in VR, finding that the main factor for decisions was utilitarianism — the choice that saved the most people [90]. Studies have shown that, as compared to similar experiments performed on desktop computers, immersive VR experiences tend towards more utilitarian responses [64]. The "Moral Machine" is perhaps the most viral example of an attempt to quantify data from an ethical dilemma [5], where researchers created an online platform in which users were presented with a series of moral choices involving vehicular accidents. Data from over

30 million decisions from 3 million users were collected and used to detect patterns in variables of utilitarianism, lawfulness, intervention, etc.

Furthermore, the immersion afforded by VR and its tendency towards ethical study has resulted in studies that aim to generate a foundation of ethics. Sholihin et al. use VR-based learning applications to teach business ethics, finding that this approach not only makes the experience more motivating but increases the ethical self-efficacy of users [76]. Although much prior study has been done into the ethical behaviour of humans in virtual scenarios, there has been less study into the methodological design of such scenarios. If changes in the design of the system could impact how users make decisions, then system design becomes an important facet to standardize for studying decision-making processes. Our study focuses on the design factor of visual POV and how it may affect decision-making variables — the decision outcomes themselves and how people feel when making them.

### 2.3 Meaningful Virtual Choices and Decision-Making

Meaningful virtual experiences have been the subject of media research in recent years. Within movie studies, Oliver and Hartmann regard "meaningful" as a prescribed term for films that provide an insight into lessons with life value, for example, narratives pertaining to human connection, struggle, or ephemerality [60]. Within social VR, Maloney and Freeman noted that meaningful activities derive from social connectedness and immersion within the virtual environment [47]. Within games, Steinemenn et al. stated meaningful experiences result in increased feelings of compassion and prosocial behaviour [82]. Such findings were validated by the work of Oliver et al., who showed that meaningful experiences in games correspond to human needs related to insight and relatedness; generating increased appreciation [59] — the gratification associated with thought-provoking and pensive media experiences [58].

One way of developing meaningful virtual experiences is through the use of meaningful choice, a subject that has received particular attention within ludological studies. Nay and Zagal explore what makes a choice meaningful through the lens of a virtue ethics perspective, concluding that personal reflection and morality can make even inconsequential choices feel meaningful to players [55]. Schulzke argues that choices are most meaningful when they contain aspects of morality and result in significant consequences [72]. Iten et al. demonstrate that meaningful choice consists of three core dimensions — shaping consequences, involving other agents, and demonstrating a moral dilemma [35]. They quantify meaningfulness through the use of quantitative scales, which we appropriate for use in our study as well.

We apply the same principles of meaningful choice to decision-making within serious VR applications, focussing on how a user's feelings and thought processes during the decision-making process are affected by POV. We choose to focus particularly on these subjective factors, as Nay and Zagal suggest that the impact and experience revolving around a user's decisions are more pertinent to meaningfulness rather than the actual decision itself [55].

### 2.4 Visual POV in Virtual Environments

We consider past research into the effects of visual point-of-view, specifically on their subjective effects on user experience. The bulk of past studies focus largely on the differences between the first-person perspective (1PP) and the third-person perspective (3PP). In 1PP, the user views the virtual environment directly from the perspective of a character in the scene, whereas in 3PP, the user views the environment away from the object of control [7]. Morrison and Ziemke argued that the POV provided to players when engaging with playable characters in video games could affect visuo-affective mappings, underlying distinctions in feelings of empathy and identification towards these characters [52]. Denisova and Cairns empirically validated this, showing that players playing

games were more immersed when playing from 1PP, even when they showed a general preference for the other POVs [18]. Shifting from a ludological approach to a VR approach, Monteiro et al. showed that 1PP in VR was generally perceived as the more immersive experience [51]. Galvan Debarba et al. found similar results, in that feelings of body ownership were generally stronger in the 1PP [24]. Gonzalez-Liencres et al. showed that 1PP facilitated a greater sense of emotions, including fear, helplessness, and vulnerability [27].

Past studies have also studied the potential affordances and outcomes of such immersive effects. For instance, studies have shown that, although 1PP in VR creates immersion, such effects are not always necessary for enjoyment [51]. Dib et al. showed that different POVs (1PP and 3PP) had limited differences in user learning in terms of a building construction management training system [19]. In this study, however, we consider how POV affects decision-making, considering the direct decisions made in the VR application and the reflective experience during and after the experience.

## 3 VR Application Design

The experimental VR application revolved around several scenarios featuring an ethical dilemma involving a traffic incident — a car coming up to an intersection loses control, and the user must select between letting the car continue in the same lane or swerving into the other lane. In either case, some group of agents will die; depending on the scenario, users must select between groups of pedestrians or between a group of passengers (including the driver) and a group of pedestrians. This application was largely inspired by the design of the well-known "Moral Machine" experiment (which extends the trolley problem). The motivation behind selecting such a scenario was to 1) borrow a well-known, easily-explainable dilemma, and 2) contextualize our findings within the rich breadth of prior research involving this similar moral dilemma.

### 3.1 Visual Point-of-View

Visual POV formed the independent variable for our study, in terms of both between-subject and within-subject analysis. Our study focussed on three POVs — 1) a first-person perspective (1PP), in which the user views the scenario through the eyes of an agent (specifically, the driver of the car) within the scenario, 2) a third-person perspective (3PP), in which the user views the scenario as an external observer a fixed distance away from the driver of the car, and 3) a static perspective (SP), in which the user's camera is fixated on the location of the crash and does not move with the agents. The first two derive from common POVs seen in past literature and existing applications, whereas the third simulates a static POV similar to the Moral Machine experiment. Views from each POV are shown in Figure 1.


Fig. 1. The three POVs investigated in the study: (a) 1PP from a driver's perspective, (b) 3PP following the car, (c) SP fixed on the intersection.

### 3.2 Scenario Dimensions

Our application consists of several scenarios that involve a common moral dilemma; these scenarios differ primarily in the consequences, i.e. how many and which group of virtual agents may perish or survive. We identified 3 core variables that we varied to analyze differences in decision-making across scenarios. These variables are motivated partly by past related works (e.g. [5]), but mainly through their relationship to normative ethics frameworks.

- **Utilitarianism** — The frequency to want to save more people — this was done through designing scenarios such that the number of casualties differed across scenarios. Utilitarianism ties to consequentialism, which bases moral judgment on a decision based on its outcomes — i.e. doing the most good.
- **Passengers/Pedestrians Bias** — The tendency for a user to save the passengers, including the driver, over the pedestrians (and vice versa). To do so, we created a variety of scenarios in which users must select between either a group of pedestrians or a group of passengers. The importance of this factor ties firstly into supporting the first factor, in qualifying consequentialism in terms of beneficiaries (addressing the question of "consequences for whom?").
- **Interventionism** — The bias between whether to passively let the car continue within the same lane or to make the more active choice to swerve the car into the other lane. A pure deontological framework may decide to take non-intervening actions, finding it morally incorrect to actively partake in an action that induces harm, regardless of the outcome.

### 3.3 Implementation Details

In each scenario of the experiment, a car loses control and uncontrollably accelerates down a suburban road. Depending on the primary POV, the user is either viewing the scenario from the driver's perspective (1PP), viewing the scenario from a fixed distance above and behind the driver (3PP), or viewing only the intersection (SP). After about 8 seconds, the car reaches the start of an intersection, in which the scenario pauses. At this point, a prompt appears on the screen that describes the scenario and asks the user to select the option that is more desirable for them. The user must decide between one of the two binary decisions (continue in the same lane or swerve); in each case, one group of virtual agents must die. To view the decisions, the user uses the controller to point towards either lane. In either case, a virtual option panel appears, providing an outline of the consequences (the type and number of people who will die). While pointing to either of the options, icons in the form of skulls and crossbones appear to reinforce which virtual agents in the scenario will perish. There is no time limit enforced while the users ponder over their choices. Once they have made their final decision, they can point and click on a button on the associated option panel to confirm their choice. At this point, the choice is recorded, and the next scenario plays.

The design decision to focus the first-person and third-person perspectives around the driver was a conscious one. We initially did consider using pedestrian POVs, but noted that it introduced a number of new dimensions that would complicate the study (e.g. to which pedestrian group and which specific pedestrian should the camera follow?). Thus, we decided to focus on the driver as the primary agent in which the perspectives revolve around. This was suitable for several reasons — there is always exactly one driver in each scenario, the pedestrians and obstacles are almost always in full view from the driver's perspective looking forward, and contextually, the driver is the agent in control of the decision (of whether to swerve or not). Nonetheless, future explorations could consider further POVs, such as comparing decision-making from first-person and third-person pedestrian-focussed standpoints (and perhaps a static perspective opposing the vehicle's view).

Several design details were considered to ensure that the scenarios would be immersive and familiar. Each scenario was crafted with realistic buildings, persons, and traffic assets, augmented with sound effects to provide a highly realistic, immersive simulation. The reinforcement of the consequences through icons on top of text was done to minimize confusion and ensure that users were aware of the consequences of their actions. The design of the user interface is such that the users have to actively make a series of motions to select an option — there is no default option. This was done to ensure that users were consciously making decisions rather than zoning out. We did not impose any time constraints on user decisions, as we were interested in having the participants make what they think is the morally correct choice without being burdened by time pressure, which could feed into inconsistencies in decision-making [83].

### 3.4 Hardware and Software

The VR application was developed in the Unity game engine (ver. 2020.3.18) in C# and was run on a Windows 10 computer (32GB RAM, Processor: Intel Core i7-9700K CPU @ 3.60 GHz) with an NVIDIA GeForce RTX 2060 Super Graphics Card. Assets used to develop the scenarios were a mix of free and paid assets from the Unity Asset Store. The VR hardware was the Oculus Quest (64GB) connected to the computer running the Oculus App (ver. 35.0.0.73.175) via Oculus Link.

The collected data from the VR application was fully anonymized — all identifiable information was removed when it was saved on a server. The relationship between VR application choices and questionnaire data was made by noting down a randomized hash provided by the server database automatically generated for each instance of the experiment and manually matching it with a participant ID assigned to each participant.

## 4 Study 1: Methodology

This initial study aimed to study the objective factors of decision-making. As such, it places a heavy emphasis on user decisions within a large number of moral situations, with the analysis largely focussed on the mechanical aspects of user decisions.

### 4.1 Experimental Design

The design of the scenarios for this study was motivated by our analysis goal of drawing insights into how each specific decision-making dimension (utilitarianism, interventionism, and passenger/pedestrian bias) of the scenario is impacted by the POV that users see the decisions from. To test utilitarianism, we considered decisions in which the binary outcomes differed in the number of people that could be saved. To test passenger/pedestrian bias, we considered decisions in which the binary outcomes differed in the type of people that could be saved — pitting a group of pedestrians against a group of passengers (including the driver). To test interventionism, our binary decisions differed in terms of active versus passive involvement — with letting the car continue in the same lane being the passive decision and swerving into the opposite lane being the active intervention. Ultimately, we aimed to vary these dimensions as much as possible in designing our scenarios (Figure 2) — a custom mix of these dimensions resulted in the design of a set of 21 standard scenarios (see supplementary materials).

Each participant would be presented with these 21 scenarios from one of three core investigated visual POVs (the **primary POV**), which would serve as the independent variable for analysis, and their choices were used for between-subject statistical comparisons.

To provide users with a within-subject understanding of the various POVs, we also showed users additional contextual scenarios. These scenarios would be used solely for the sake of providing the user the experience of seeing all three of the POVs such that they can provide within-subject subjective data on their experience; the choices that users selected during these scenarios were not

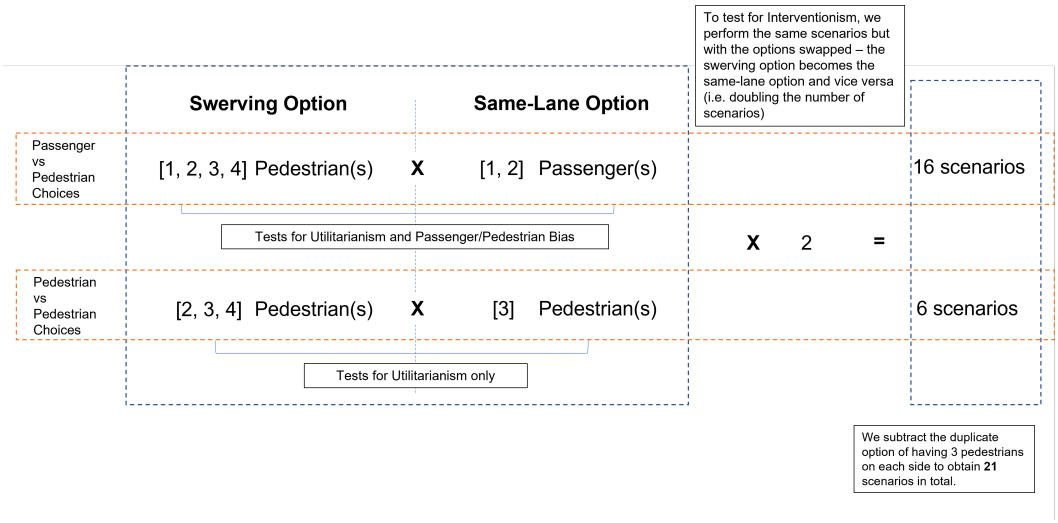


Fig. 2. The design of the scenarios involved in this study. We create a total of 21 core scenarios that are presented from the primary POV. The choices made in these scenarios are used for between-subject statistical analysis. For simplicity in denotation, drivers are included as passengers in this diagram (e.g. 1 passenger means that the passenger is a driver, 2 passengers mean 1 driver and one additional non-driver passenger)

used for between-subject statistical analysis. There were a total of 10 contextual scenarios; since there were two more POVs, this was split into 5 scenarios each for each of the remaining POVs (the **secondary POVs**).

Altogether, the design of the experiment included 31 total scenes: 21 from the primary POV, and 10 total from the secondary POVs. Details on the specific scenarios including information on the specific choices provided and the POV of each scenario can be found in the supplemental material.

As mentioned before, users saw scenarios from all 3 POVs. However, we differentiated between the primary POV, in which the choices that the user makes are recorded for further between-subject statistical analysis, and the two secondary POVs, which were shown to gather within-subject subjective feelings from the user. The chosen primary POV was randomized between-subjects to prevent ordering bias. The set of scenarios shown from each POV is constant, but their order was randomized between participants to prevent any ordering effects.

In presenting the scenarios, we split the experiment into 4 blocks, starting with 10 scenes from the primary POV, then 5 scenes from one of the secondary POVs, then the 11 remaining scenes from the primary POV, and then the 5 scenes from the final secondary POV. Between these blocks, users were allowed to take a brief break of up to 5 minutes, to help with alleviating nauseating effects and preventing jarring effects from immediately switching POVs.

### 4.2 Participant Recruitment

Participants were physically present in the lab for the experiment, since it required the Oculus headset and attached computer system. To recruit participants, a listing was made on our institute's paid studies list. The criteria for participation were threefold — 1) to be able to come in-person, 2) to be able to personally provide consent for the experiment (equivalently, be over the age of adulthood), and 3) to be fluent in the instructional language (English). Overall, we were able to recruit a sample of 37 participants (23 females / 14 males, mean age: 22.5 years, ranging from 18 to

34 years). Regarding VR experience, 15 participants had never used VR, 21 participants reported they had used it a few times in the past, and 1 participant reported using it at a frequency of once a month. As the experimental scenarios revolved around driving and traffic accidents, we also collected data on participants' driving experiences and whether participants had been involved in prior car accidents in the past. In terms of driving experience, 9 participants indicated 0 years of experience, 13 participants had 1-3 years of experience, and 14 participants had 4+ years of driving experience (1 participant declined to respond). In terms of involvement in accidents, 4 total participants indicated that they had been involved in traffic accidents in the past — 1 participant with experience being the driver, 2 participants with experience being passengers, and 1 participant having the experience of being both driver, passenger, and not in the car (i.e. as pedestrian or cyclist, etc.) during an accident.

In subsequent sections, specific participants from this study will be denoted with the letter P (e.g. P1, etc.) It is important to note that the nature of the recruitment methods that the participants tended to skew towards students and staff of the institute. The study procedure and health safety measures were approved by the institutional ethics board.

### 4.3 Study Procedure

Prior to the study, participants signed a consent form outlining the collection and usage of data provided in the experiment. Participants were also notified of the possible risks of VR and that they could choose to terminate the experiment at any time. We then provided each participant with an introduction to the overall research and the experiment as a whole. The overall study consisted of 3 main components:

- **Initial Questionnaire**: Participants were asked to answer an initial questionnaire. The purpose of this initial questionnaire was to collect relevant demographic data such as age, preferred gender, past VR experience, driving experience, and potential past traffic accidents.
- **VR Experiment**: The researcher helped the participant get set up with the VR headset and controllers. To familiarize the participant with the VR environment, the controller buttons, and the menu screens, the researchers walked the users through the main menu and the first scenario. In virtual space, when the car reached the intersection and users were to make the first decision, the researchers reminded the users of the prompt (which was also apparent on the screen) of deciding which of the two options would be more desirable to them — which outcome would they want to occur? After making their decision for the first scenario, users generally did not have any issues and the rest of the experiment proceeded smoothly. Users were prompted that they could take a brief break of up to 5 minutes between blocks, at which point the visual POV would change for the next block. The goal of the experiment was to collect data about the choices that users would make in various ethical scenarios and to provide them with exposure to the various visual POVs.
- **Final Questionnaire**: After completing the VR experiment, participants were prompted to complete a final questionnaire. The purpose of this questionnaire was to reflect on the decisions that they had made, the factors that affected the decision, and how the variable of POV may have affected the experience. Questions in this questionnaire involved asking about what factors made decisions easy and hard, whether they believed POV affected their decision-making process, and how each POV affected their perception of the meaningfulness of the choice and empathy towards the virtual agents. This questionnaire aimed to use the collected subjective information to 1) understand how users make decisions and 2) understand how visual POV may affect subjective feelings of empathy and meaningfulness.

Overall, the entire study took approximately 45 minutes for each participant, and each participant was compensated $10 CAD for participating.

## 5 Study Part 1: Findings and Results

We used an alpha level of 0.05 for all statistical tests. These tests were carried out in Python using a Jupyter notebook. Due to the ordinal nature of all of our data, we used non-parametric tests that avoided assumptions of data normality. The main tests used were the Wilcoxon rank-sum tests to compare between two sets of data and the Kruskal-Wallis tests to compare between three. Quantitative data regarding the choices made by 3 participants in the application during the experiment were discarded due to technical faults of the system during data collection.

The mean average response time (excluding the very first scenario, which was used for guidance and familiarization) across the considered participants was 14.53 seconds, with a standard deviation of 6.20 seconds. The maximum average response time for a single participant was 29.98 seconds, and the minimum was 6.42 seconds, with the 95th percentile being 25.87 seconds. Although we do not perform any formal analysis on the response time for decision-making (given that we specifically told participants to take as long as they wanted), we still report this as an important metric, as time pressure and duration can affect decision-making in terms of dimensions such as risk-acceptance [3, 20, 62, 69].

### 5.1 Decision-Making Factors in Ethical Scenarios

The responses to the open-ended questions regarding the hardest and easiest decisions to make were analyzed through inductive thematic analysis [10]. We first performed a round of open coding to create a summary of the collected data. We then iterated and grouped the codes into broader categories, using an affinity diagramming method to develop a categorical understanding of the factors that participants consider when making their decisions.

To investigate how POV affects decision-making, we generated a general model of factors that were considered in user decisions across all POVs. Our qualitative analysis process allowed us to dig into user thought processes and develop a model of what factors users considered deeply when making their selections. As stated, our qualitative analysis revealed three core categories from our qualitative analysis that shaped the general decision-making process of the participants: 1) social factors — how users view and form relationships with the virtual agents, 2) consequential factors — how users model "what happens after" in regards to the decision they make, and 3) moral factors — how users weigh the lives of different virtual agents.

*5.1.1 Social Factors.* Despite the limited time in which the user viewed the agents in each scenario, some participants were able to establish facets of empathetic relationships and bonds with the virtual agents. 5 of the participants mentioned an attachment they have with their friend, and 2 of them even concocted real-life analogues to the virtual agents with indications relating to aspects of friendship and assignment of blame, for instance. Although friendship with the passenger was implied by the prompt, these participants visualized this as a personal relationship rather than a relationship with the virtual driver — *"I weighed the number of deaths against killing my best friend"* (P13) and *"While I'd be okay with killing myself, the choice also impacts people I care about"* (P7).

*5.1.2 Consequential Factors.* A small number of participants furthermore considered the consequences of their decisions, thinking about not only the direct results of their actions (in which one party survives and the other party dies) but also possible feelings of survivorship guilt, legal responsibility, etc. For example, one user considered aspects of legal responsibility if they actively chose to veer into another lane to kill the pedestrians while saving themselves and their passenger — *"I would have been fine with going to jail if she would live, but I wondered if she could have lived*

*with it"* (P13). Aspects of responsibility were also discussed by one participant in the context of self-preservation, e.g. *"I would be responsible for the death of multiple people because I had no other choice"* (P15), and another in the context of interventionism, *"I would have no active responsibility for the choice [of staying in the same lane]"* (P12).

*5.1.3 Moral Factors.* Essentially all participants considered their own personal moral compass when making the decisions. The main moral dilemma that was faced was between making a utilitarian choice versus making some agent-preserving choice (in particular, the driver/passenger-preserving choice). In these cases, participants made difficult decisions weighing the value of "personal" life against the value of other virtual agents, e.g. *"Should I kill myself instead of sacrificing other people… What's more important — killing less people or my own life?"* (P4). Other participants cited the most difficult decisions as *"The scenario which I need to choose between myself and 5 people"* (P22) or *"Choosing between I die or 4 people died — I think to save 4+ people it might be worth it if I die"* (P23). Ultimately, this shows that a variable at play in ethical decision-making is value-of-life calculations, in which users have to balance how much they value certain lives over others. When the calculations came out to be the same for the users, for example, in the case of 3 pedestrians in each lane, users were sometimes stumped by which decision to pick, with this being the most commonly cited difficult decision by users — *"When the number of deaths of people caused is the same… I don't know what to choose, the decision I make seems more random"* (P17), *"I have to kill the same number of people no matter what"* (P14).

We identified these three variables as the main factors that participants considered when engaging in an ethical dilemma. Each participant balanced these variables differently; for instance, some users struggled with weighing the value of the lives of the driver and passenger over the lives of the pedestrians, while others valued the lives of the former group above all. Nevertheless, these three variables emerged as the core aspects considered by users in making their ethical decisions. These three factors almost mirror Iten's three themes that comprise meaningful choice [35]. This affirms that in making the moral choice in our simulation, participants draw upon previously established factors that make a choice meaningful — the facets of choice meaningful also comprise the similar facets that inform their decision-making. In the next sections, we consider how these subjective measures of meaningfulness may change across POVs.

### 5.2 Visual POV, Meaningfulness, and Empathy

People lean on the three factors of meaningful choice when they make ethical decisions. We aimed to investigate how the influence of these factors may change when the moral dilemma is viewed from a different POV. To assess these effects, we performed statistical analysis on 2 5-point Likert-scale questions:

- "How much did seeing the scenario from this perspective affect your emotions in a way in which you felt the decisions were meaningful?"
- "How much did seeing the scenario from this perspective allow you to empathize with the agents involved in the scenario? (drivers, passengers, pedestrians)"

The descriptive statistics for each of the responses can be seen in Table 1, and the mean value bar graphs with 95% confidence error bars can be seen in Figure 3.

The data suggests that 1PP tends towards the highest levels of meaningfulness and empathy among the 3 POVs, while the difference between 3PP and SP is more minute. This was then validated through statistical testing. To first compare the three groups of data to see if there existed a statistical effect across the medians, we performed a Kruskal-Wallis test (Meaningfulness: $H(2) = 8.04$, $p = 0.018$, Empathy: $H(2) = 5.37$, $p = 0.068$), which provided strong evidence in terms of a difference

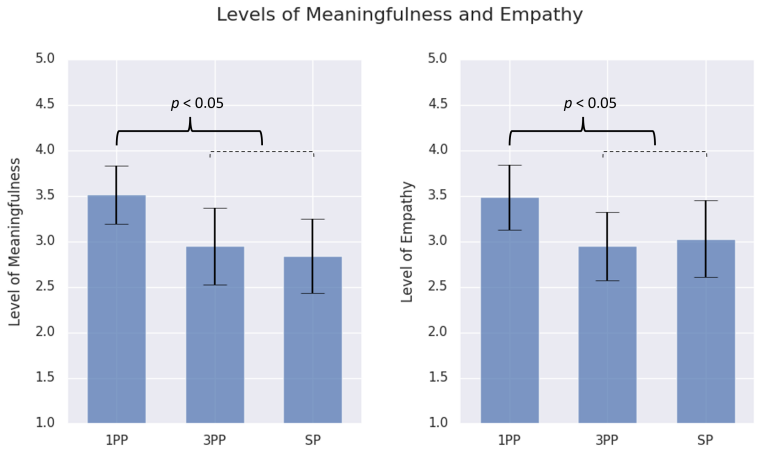


Fig. 3. Mean levels of empathy and meaningfulness from self-reported user data. Error bars depict 95% confidence intervals. The dashed line indicates a one-vs-rest comparison between the 1PP metrics versus the combined 3PP and SP metrics.

in meaningfulness, and weak evidence in terms of a difference in empathy. We then performed pairwise one-against-rest comparisons, starting with a one-tailed (greater) Wilcoxon rank-sum test between the 1PP and the rest of the data (Meaningfulness: $Z(1) = 2.73$, $p = 0.0031$, Empathy: $Z(1) = 2.23$, $p = 0.013$), showing that the 1PP distributions for both meaningfulness and empathy are significantly higher than the other POVs (this is highlighted in Figure 3). To then compare between the other two POVs, we performed a Wilcoxon rank-sum test between the SP and 3PP data (Meaningfulness: $Z(1) = -0.24$, $p = 0.81$, Empathy: $Z(1) = 0.30$, $p = 0.76$), showing that there is no statistical difference between the distributions from the 3PP and SP POVs. Ultimately, we saw a statistical pattern emerge — participants in the 1PP generally found their decisions to be more meaningful and empathetic than those in the SP and 3PP. We delve further in depth in terms of what it means for a scenario to be meaningful in Study 2.

To test the correlation between empathy and meaningfulness, we used Spearman's rho test. We found a positive correlation between the two variables ($r(35) = 0.805$, $p = 1.78e\text{-}26$). The correlation between the factors of empathy and meaningfulness is expected since empathy towards virtual agents is strongly associated with the social factor of meaningfulness — the relationships between the user and characters in the virtual simulation. Overall, it is largely unsurprising that 1PP had the highest associations with empathy and meaningfulness. Within ludological studies, this had been previously theoretically suggested — because 1PP is the most immersive POV, it garners a higher relatedness through visuo-affective mappings to create a more empathetic response in users [52]. This finding also suggests a correlation between immersiveness, empathy towards virtual agents, and the meaningfulness of the choices made.

### 5.3 Visual POV and Objective Decision-Making

Our prior analysis focussed largely on self-reported subjective metrics from the questionnaire, identifying several subjective factors that change with POV. In this section, we aimed to understand the extent to which user decisions may change based on different POVs. To do so, we revisited the three variables that initially motivated our scenario design — utilitarianism, passenger vs. pedestrian

Table 1. Summary Statistics across the 3 POVs. Sample size is denoted by *N*, and the mean (standard deviation in brackets) for each of the metrics is presented.

| | 1PP | 3PP | SP |
|---|---|---|---|
| Meaningfulness and Empathy (min: 1, max: 5) | | | |
| *N* | 37 | 37 | 37 |
| Meaningfulness | 3.51(0.95) | 2.95(1.25) | 2.84(1.20) |
| Empathy | 3.49(1.06) | 2.95(1.11) | 3.03(1.24) |
| Objective Choice Metrics (min: 0, max: 1) | | | |
| *N* | 13 | 10 | 11 |
| Fraction of Utilitarian Choices | 0.67(0.23) | 0.79(0.12) | 0.70(0.16) |
| Fraction of Passenger-Preserving Choices | 0.40(0.31) | 0.28(0.16) | 0.40(0.27) |
| Fraction of Non-Intervening Choices | 0.55(0.10) | 0.48(0.06) | 0.45(0.09) |


Fig. 4. Mean percentages of moral metrics from user choices during the experiment. Error bars depict 95% confidence intervals.

preservation, and interventionism, and considered how these variables may be impacted across the various POVs. For each participant, we considered solely the decision data from the primary perspective. To obtain a metric for utilitarianism for each user, we first extracted scenarios in which they had to decide between agent groups of different sizes. We divided the number of choices in which they chose the agent group with the larger number to survive by the total number of extracted scenarios. Similarly, to obtain a metric for passenger-preservation, we extracted scenarios in which a user had to decide between a group of passengers and a group of pedestrians, dividing the number of choices that the user made to save the passengers by the number of extracted scenarios. Lastly, to obtain a metric for interventionism, we divided the number of choices in which the user chose to swerve by the total number of scenarios (as every scenario involves an interventionist

choice). The summary statistics for these choice metrics across all participants can be seen in Table 1 and bar graphs of the means with 95% confidence rates can be seen in Figure 4.

For the choice metrics of utilitarianism and passenger-preservation, we found no strong significant effects across a comparison of the 3 POVs (utilitarianism: $H(2) = 2.45$, $p = 0.29$, passenger-preservation: $H(2) = 1.05$, $p = 0.59$). Further investigation through pairwise one-vs-rest Wilcoxon rank-sum tests yielded similar conclusions. However, we noticed that for the interventionist metric, even though the 3-way comparison yielded no significant statistical effect ($H(2) = 3.56$, $p = 0.17$), analysis through a one-tailed (greater) Wilcoxon rank-sum test between the 1PP and the rest of the data ($Z(1) = 1.84$, $p = 0.033$) showed that, statistically, the users placed in the 1PP driver's perspective may be more willing to take an active interventionist selection when compared to the other POVs during an ethical dilemma. We are careful to note that the low sample sizes of data in this section may generate noisy results.

## 6 Study 2: Methodology

The latter study of this two-part work, performed chronologically after the first half had been completed, was developed largely based on the findings of the initial study. In particular, it focussed on the findings regarding subjective feelings of meaningfulness and empathy, emphasizing looking at what specific facets of subjective meaningfulness are affected by visual POV. We note that some of the questions regarding empathy and meaningfulness within our first study are largely subject to the participant's own interpretation; in this study, we more precisely constructed these questions to be more specific (using established scales) to cover the breadth of factors that could affect subjective decision-making. The focus shifts in this part of the study from the objective choices made to subjective feelings regarding choices.

### 6.1 Scenario Design

In contrast to the first study, the second study was motivated by a desire to learn about the subjective factors that users considered when making the choice. As such, this study primarily compares the within-subject subjective metrics of meaningfulness across all three POVs. Participants for this study see the same set of scenarios from each of the three POVs (forming the 3 blocks of the experiment) and are prompted to answer a questionnaire to collect subjective data after each block. The order of the POVs and the order of the scenarios in each POV were randomized across each user to prevent ordering effects. The set of scenarios chosen for this study was a selected subset of the ones from the first study. In particular, we chose a set of 6 choices that vary based on the scenario dimensions (utilitarianism, interventionism, passenger/pedestrian bias). The set of choices is shown in Table 2. Overall, each user makes 18 choices in total — 6 from each POV.

A questionnaire was presented to each participant after each block of 6 choices, to capture the participant's subjective feelings of meaningfulness regarding that prior block. In particular, the design of this questionnaire is motivated by a similar methodology found in Iten et al.'s exploration of "meaningfulness" in game development contexts [35] (which we find valid as our first study revealed that a user's decision-making is motivated by similar sub-facets). Our questionnaire consisted of a total of 15 7-point Likert scale questions, combining two scales developed independently. The first scale, developed by Oliver and Bartsch, measures appreciation, a form of gratification associated with moving and pensive experiences [58]. The second scale, developed by Busselle and Bilandzic, measures 5 dimensions of narrative engagement, which refers in whole to the story's ability to engage and influence audiences [12]. The 5 dimensions refer to facets of narrative realism, distraction, narrative presence, empathy, and sympathy, which are measured using twelve statements about narrative media. The full set of questions can be found in the work's supplementary material. In subsequent sections, these statements are labelled with S (i.e. S1 to S15).

Table 2. The set of 6 scenarios selected for this study. Each participant is shown these 6 scenarios in randomized order from each of the 3 POVs. For simplicity in denotation, drivers are included as passengers.

| Scenario Number | Casualties From Swerving Option | Casualties From Same-Lane Option |
|---|---|---|
| 1 | 1 pedestrian | 1 passenger |
| 2 | 2 pedestrians | 1 passenger |
| 3 | 2 pedestrians | 2 passengers |
| 4 | 3 pedestrians | 2 passengers |
| 5 | 2 pedestrians | 3 pedestrians |
| 6 | 3 pedestrians | 3 pedestrians |

### 6.2 Participant Recruitment

Participant recruitment was done in a manner identical to the protocol presented in the first study, as we made a posting on our institute's paid studies list. For this study, we were able to recruit a sample of 40 participants (28 females / 12 males, mean age: 24.0 years, ranging from 18 to 41 years). Out of the 40 participants, 21 participants had never used VR, 16 participants reported they had used it a few times in the past, 1 participant reported using it at a frequency of once a month, and 2 participants reported using it at a frequency of once a week. In terms of driving experience, 8 participants indicated 0 years of experience, 16 participants had 1-3 years of experience, and 16 participants had 4+ years of driving experience (1 participant declined to respond). For this study, 2 participants indicated that they had been involved in traffic accidents in the past — 1 participant as a passenger and 1 participant having been involved but not in the car (i.e. as a pedestrian or cyclist, etc.). To differentiate from participants from the first study, quotes and references to participants from this study will be denoted with Q as opposed to P (e.g. Q1).

### 6.3 Study Procedure

Similar to the prior study, participants signed a consent form, were also notified of the possible risks of VR, and were provided an introduction to the overall research. The overall study consisted of 3 main components:

- **Initial Questionnaire**: Participants were asked to answer an initial questionnaire to collect relevant demographic data such as age, preferred gender, past VR experience, driving experience, and potential past traffic accidents.
- **VR Experiment**: The experiment was performed seated, and the researcher helped participants set up and familiarize themselves with the VR hardware and environment. During the first scenario, when the car reached the intersection and users were to make the first decision, the researchers reminded the users of the prompt of deciding which of the two options would be more desirable to them — which outcome would they want to occur? After each block of 6 decisions, users were prompted to remove their headset and answer the questionnaire relating to the scenarios from the POV they had just seen. In addition to capturing qualitative data, this break served as a method of resetting and readjusting the user mentality, starting up the next block with a blank slate.
- **Exit Interview**: A short (approximately 5-10 minute) semi-structured interview was performed to capture added qualitative information about the user's feelings towards the scenarios, their decision-making processes, etc. Sample questions included "What factors did you prioritize the most across the scenarios?" and "Did you make the same decisions for the same

scenarios across the three POVs, why or why not?". The goal of the interview was to capture qualitative data to support the quantitative questionnaire and objective choices made; as well as to capture any additional details or subjective thoughts that may have been missed in the prior methods. Interviews were audio-recorded when permission was provided; otherwise, notes were directly taken during the discussion (for 2 participants).

Overall, the entire study took approximately 45 minutes for each participant, and each participant was compensated $16 CAD for participating.

## 7 Study Part 2: Findings and Results

We used an alpha level of 0.05 for all statistical tests and a Benjamini-Hochberg procedure for multiple comparisons with a false discovery rate (FDR) of 0.10. These tests were carried out in Python using a Jupyter notebook. Similar to the first study, we relied on non-parametric tests that avoided assumptions of data normality due to the ordinal nature of the data. Data regarding the questionnaire choices and objective choices made by 2 participants during the experiment were discarded due to technical faults in the system during data collection.

The mean average response time (excluding the first scenario) across the considered participants was 20.33 seconds, with a standard deviation of 11.49 seconds. The maximum average response time for a single participant was 75.16 seconds, and the minimum was 9.49 seconds, with the 95th percentile being 35.57 seconds.

### 7.1 A Deeper Look at Meaningfulness

Our prior study suggested that the facet of meaningfulness differs across perspectives — that 1PP affords a higher level of these two factors. However, this study did not ascertain which specific facets of POV make one more meaningful compared to others. To address this question, we performed statistical analysis on the questionnaire responses of 15 Likert-scale questions — which encompass aspects of appreciation and narrative engagement. To compare these questions across the three POVs, we performed Kruskal-Wallis tests. We first verified the internal consistency of our instrument, calculating Cronbach's alpha (n = 15, $\alpha$= 0.74), which we deem an acceptable level [84]. Then, through hypothesis testing, we found significant effects in 4 statements: S1 -"I was moved by these scenarios" ($H(2) = 8.51$, $p = 0.014$), S2 — "I found these scenarios to be meaningful" ($H(2) = 9.23$, $p = 0.010$), S9 — "I had a hard time keeping my mind on these scenarios" ($H(2) = 7.47$, $p = 0.024$), S13 — "The story affected me emotionally" ($H(2) = 8.22$, $p = 0.016$). The mean value bar graphs for the statistically significant statements ($p<0.05$) with 95% confidence error bars can be seen in Figure 5. When relating these statements to the "dimensions" of meaningfulness, we find that this suggests differences in appreciation (S1, S2), distraction (S9), and empathy (S13) respectively across the three POVs. In particular, the latter dimension of empathy corroborates our findings from the first study.

To further investigate the individual effects of each specific POV, we performed pairwise one-against-rest Wilcoxon rank-sum tests for these statements. These test results for the 1PP-vs-rest and SP-vs-rest trials generally corroborated the expected findings — that 1PP showed strong statistical differences in regards to increased meaningfulness when compared to the other POVs, and vice versa for the SP (full statistical values can be found in the supplemental material). Ultimately, our findings suggest that participants from the 1PP find this perspective to afford more meaningful scenarios because it touches upon the three specific facets of meaningfulness. From 1PP, participants indicated the same scenarios as being more emotionally poignant, participants were less distracted in regards to paying attention to the narrative, and participants felt greater empathy towards the virtual agents (followed by 3PP, and finally SP).

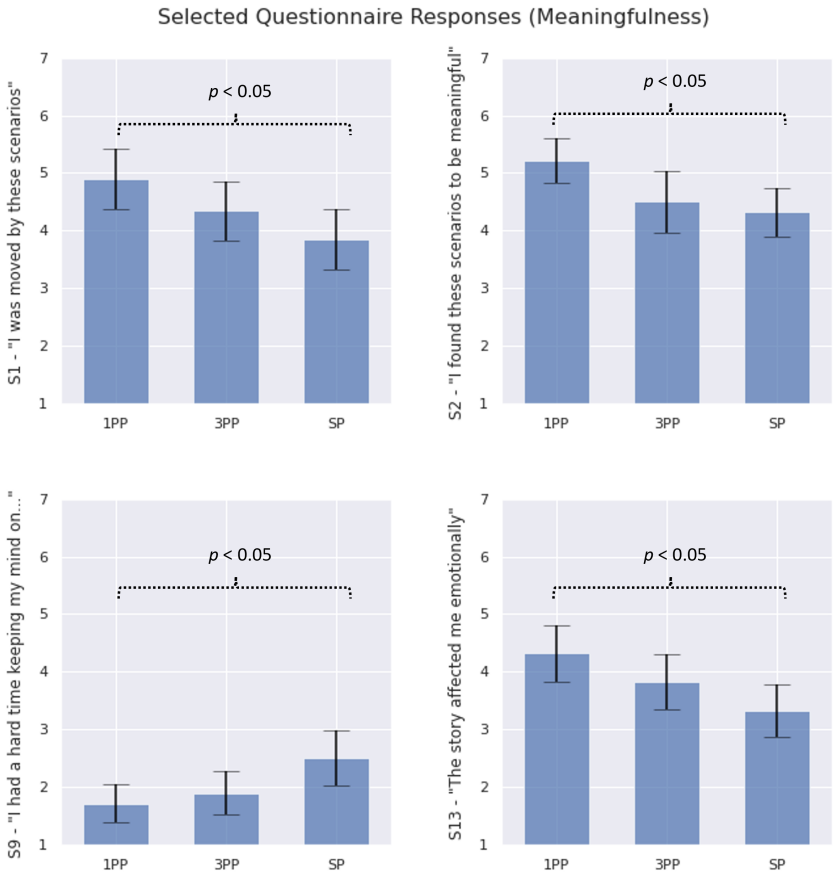


Fig. 5. Mean values for selected Likert-scale questions from questionnaire data. The dashed line shows significant differences across the mean metrics across the 3 groups. Error bars depict 95% confidence intervals.

### 7.2 Another Look at Choices Made

In our first study, we did not observe many significant differences in objective decision-making across ethical variables (through analyzing specific user decisions). In this part of the study, we aimed to further test this finding — as users see the same set of scenarios from the lens of 3 different POVs, we calculated the pairwise Hamming distance across them as a measure of disparity to investigate the difference in choices made. This distance represents the number of scenes in which the participant made a different choice for the same scenario, and can range from 0 (all the same choices) to 6 (all different choices). Frequencies of the pairwise Hamming distances can be found in Figure 6, and the summary statistics (mean and standard deviation) are shown in Table 3. The low-skewing central tendencies across all perspectives suggest that participants are fairly consistent in their choices — on average, only about one change is made regarding their decisions across each of the POVs. This provides some level of added evidence to corroborate one of the findings in the prior study — that objective decisions may not necessarily show large changes across different POVs.

On the contrary, however, in the qualitative interview data, a small number of participants indicated specific changes in decision-making made across POVs. For example, Q6 mentions that

Table 3. Summary statistics regarding pairwise Hamming distance across the three POVs

| Pair of POVs | Mean | Std. Dev. |
|---|---|---|
| 1PP and 3PP | 0.868 | 0.951 |
| 1PP and SP | 1.184 | 1.335 |
| 3PP and SP | 1.158 | 1.496 |

from the *"first-person perspective I would put more priority on the survival of the people in the cars and for the static view is completely utilitarian — the less casualty the better... the third-person perspective is between that"*. However, others indicated that they made the same decisions in all three blocks, even if they had to think harder about the choices in certain POVs compared to others. For example, Q35 indicated that although they believed they made the same decisions across the 3 blocks, that *"the one [where] I'm actually in the car, that one's obviously more difficult and it was more real, it was more obvious that you were the decision-maker"*, adding that *"it was more emotional from the [1PP] block"*.

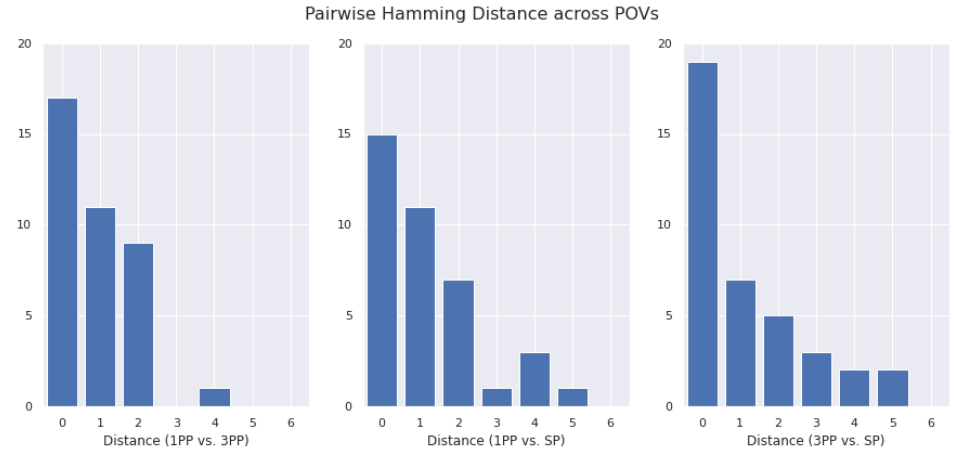


Fig. 6. Pairwise hamming distances between each POV represent the amount of change in choice across two POVs. Larger distances indicate participants made different decisions more frequently.

## 8 Discussion

### 8.1 Implications on Past and Future Research

We consider the implications of our research within the context of similar studies done in the past. Many past works have employed similar methodologies in considering human decision-making processes in VR contexts. We find that the designs of such similar VR ethical scenarios in past studies do not put a heavy emphasis on point-of-view as a dimension for design [64, 83], rather relying on literature focussing on spatial presence or involvement in regards to general POV considerations as a whole [79]. We notice that many of the prior studies involving similar vehicular-related moral dilemmas to this study, such as studies done by Faulhaber et al. [90] and Sütfeld et al. [83], default to using a 1PP during the experimental studies. However, the findings in our study elucidate the differences across different POVs, making this an important design factor

to standardize for cross-study consideration. Much prior work thus defaults to the design that affords the most immediate empathy (especially to the passengers of the car). We also compare our study against the "Moral Machine" experiment — finding the latter study views the ethical dilemma from a singular, unmoving perspective [5], most similar to the SP perspective in our experiment. In our study, we find that even in the short moments of motion and animation, users can see the characters come to life and develop empathetic effects.

Furthermore, we consider how our work fits into prior research on POV. In both VR and non-VR settings, past work has shown that 1PP offers a greater sense of immersion for the user [18, 51]. In addition, researchers have demonstrated that the choice of perspective can affect body representation and presence, and elicit heightened emotional responses [24, 27, 52]. Heron and Belford theorized that aspects of self-representation drawn from presence and immersion could impact moral reflection [31], and we draw inspiration from their work in our studies. By using POV as an independent tuning variable, we find that POV does have an impact on feelings of empathy and meaningfulness in a moral dilemma (acknowledging that our work is overgeneralized to one specific traffic scenario based on the trolley problem). When discussing meaningful choice in the context of games, Iten et al. focussed primarily on dimensions associated with the choice and its context within the game (including a dimension of morality) [35]; thus, our work could suggest that meaningful choice can also be affected by the level of immersion and bodily identification (as determined by POV) that one has within the virtual scenario. This could potentially open up future exploration in determining what other game design decisions, independent of the game's narrative, can generate an increased sense of meaningfulness and appreciation.

Within our study, it is difficult to draw definite conclusions on how POV affects objective decision-making regarding ethical factors; however, a lack of significant differences across POVs in Study 1 and low Hamming distances in Study 2 suggest that POV may not have a strong observable effect on the choices themselves. On the other hand, both our studies show that POV does significantly impact how users feel during these decisions during our experiments, and as such, can form an important conscious design decision for researchers. POV alters specific considerations when it comes to decision-making scenarios and serves as an important design aspect that should be actively selected based on the experience desired. With future research that will inevitably be done on decision-making aspects in VR, whether in entertainment or serious contexts, we believe our research can suggest initial guidelines for consciously selecting a specific POV for designers.

Firstly, we find that within contexts that aim to create increased emotional investment and decreased distractions may want to use the 1PP. However, applications that are developed to require relatively lower narrative engagement may prefer a more detached perspective, utilizing the 3PP. Certain participants did indicate that 3PP has benefits because of their prior video game experience considerations, for example, the field of view (e.g. *"you can see a lot more"* (Q1) and *"personally I prefer seeing the person just because that's just my preference... you feel somewhat restricted in the first person POV"* (Q3)).

Secondly, some participants also found the 1PP to be too immersive for this study, which may extend to other contextual uses as well, e.g. *"I want to immerse but not be too involved ... the [1PP] one was too much"* (Q9), and *"I think the immersion of first person can be really jarring for me."* (Q16, when talking about games they had watched in the past). Although lower immersion and engagement may not seem like a desirable outcome in general, a possible example of an area in which this may be applicable is idle games, which reflect a much different cycle of engagement / disengagement compared to traditional games [16, 81]. This genre of games open manners of play that are much less committal than the constant attention that most games demand, and may benefit from a more detached player perspective.

### 8.2 Designing Prosocial Virtual Applications

VR has been shown potential for use in perspective-taking within serious applications for increased prosocial outcomes. The impact of VR on empathy has been studied quite heavily, with many highlighting the technology as providing a positive effect on this outcome [29, 44, 73]; however, these works tend to default towards a first-person perspective. Our findings suggest that taking on a POV that is more distant from the first-person view can create different empathetic feelings towards agents in the scene and affect the perceived meaningfulness of decisions regarding moral dilemmas in VR and that these user-reported subjective feelings hold even though they may not reflect actual differences in objective decisions. Within our study, the impact of POV could potentially be hidden had we only considered the moral choices made by users. Thus, when considering the prosocial impact of a VR application, we find that it is as important to study the feelings of the user during the application as it is to study the actual decisions that a user makes during the application. This research also motivates the potential of subjective probing as a methodology for understanding user intention since we find that the user's changes in feelings may not be reflected directly in their behaviour.

The research suggests that developers can potentially control the level of meaningfulness and empathy that a user engages in based on the utilization of POV. For VR applications with prosocial effects (e.g. for VR applications designed to evaluate and teach empathetic principles), designers would likely want to use the 1PP, to generate higher feelings of empathy and meaningfulness, extending from findings from games. From past research into meaningfulness [35], this would result in higher levels of appreciation for the experience, and the impact of the application would be more likely to hold after the experience has been completed. On the other hand, perhaps for VR games in which designers want to avoid feelings of empathy (e.g. for VR games in which the user controls an immoral player character), it may be better to employ the 3PP to avoid such effects. For example, Ho and Ng developed a prosocial VR game, finding that first-person perspective-taking can enhance empathy towards a character and feelings of closeness [32]. However, perhaps there are instances in which this is not a desired effect by the game designer when it comes to meaningful decision-making; we suggest that using a third-person perspective can reduce this influence. Choices are a prevalent mechanic in games that can add meaning and stakes to the experience [35, 91]. If, for example, there are instances in the game in which the player has moral choices that could result in engaging in immoral acts (e.g. torture against NPCs), it could potentially be disturbing to have a more empathetic connection with the agents in the game. Furthermore, Hoppe et al. describe the potential for a perspective continuum in VR — which adapts and manipulates the sense of agency within the VR world to broaden the design space [33]. Thus, a possible extension could also evaluate how such a continuum affects character relationships compared to a static 1PP or 3PP POV. Previous VR research has underpinned the importance of perspective-taking as a key affordance of VR, yet has also highlighted the risk of improper distance — when the other (the virtual agent) becomes indistinguishable from the user [53]. If VR provides increased immersion and presence to such a degree that choices feel 'real' and 'consequential', what considerations and responsibilities must researchers and developers contemplate ensuring participant safety? We suggest that one way to address such concerns is through the use of POV.

From a more social standpoint, our research suggests POV can be an important consideration when designing for collaborative experiences in VR. Taking the stance of considering user behaviour in VR as a form of continuous decision-making, then the choice of POV in such environments could potentially fundamentally affect behaviour in such experiences. For instance, collaborative workspaces are an important area of research within social computing, and past systems represent users as avatars [30, 85]. However, some works have started to explore novel uses of perspective,

for example, Piumsomboon et al. developed a system that asymmetrically allows a large AR user (a *giant*) to interact with and control the perspective of a small VR user (a *miniature*) [65]. This work evaluated primarily the functionality of providing such novel perspectives; a study focussing on metrics regarding how this implementation could affect the relationship and feelings of empathy between users is a potential exploration extending off our work; which can have potential productivity outcomes as interprofessional empathy can foster improved teamwork [2].

Another emergent area of social computing that could benefit from understanding the use of POV is that of VR livestreaming applications. Vincent and Frewen investigated VR livestreams for collegiate sports captured from a 360 camera; finding increased presence from the VR view [88]. However, this represents a rather static POV; future potential explorations could look at a livestream directly following the players (or even capturing the first-person POV of a specific player). Emmerich et al. did, in fact, compare VR livestreams from first-person and third-person perspectives, focussing primarily on the metrics involving immersion and involvement [21]. However, aspects of relationship and empathy towards a streamer could also be additional metrics to consider, especially in the context of the complex nature of streamer-viewer relationships [41, 46, 49].

Ultimately, our study found that visual POV can impact feelings in a virtual scene during decision-making moments. Although our work is tied to the specific traffic scenario used in our experiments, the implications could potentially allow developers and researchers to control empathetic and meaningful content in creating a wide range of experiential outcomes; even if more research is needed to understand the generalizability of our findings.

### 8.3 Theoretical Implications of Moral Decision-Making

Past experiments that have examined moral decision-making with a similar simulated moral dilemma have focussed solely on the outcomes of the decisions. Past research by Bergmann et al. [9], Sütfeld et al. [83], Frison et al. [23] and Faulhaber et al. [90], have all centred their analysis and discussion around the objective choices of their participants made, finding a high tendency towards utilitarianism — saving the most lives. As such, past moral discussion largely fits within the normative ethics framework of consequentialism, implying that the outcome is what weighs heavily regarding user decisions. Prior works have attempted to use outcomes to develop a quantifiable ethical framework based on the value-of-life judgments made by people (e.g. potential AI systems) [56, 83]. However, one reason that past research may tend towards consequentialist results is that the setup of such systems bypasses one of the criticisms of such an ethical framework, as Nyholm and Smids highlight, aspects of risks, probabilities, and uncertainty make outcomes much more complex than the simplified, deterministic outcome presented often presented in experiments [57].

The possible outcomes of the trolley problem present an interesting counterbalance between consequentialism and deontologism. Whereas a pure consequentialist approach may find it morally acceptable to save a greater number of lives, the choice is vaguer from a pure deontological approach — which would suggest that deciding to intervene is wrong [11, 74], or at the very least, see both outcomes as morally unacceptable [25]. However, our study outlines a shortcoming of focussing squarely on the outcomes of moral decision-making. In particular, in cases in which the differences in outcomes cannot be easily disentangled, it is difficult to retrace less tangible facets such as human feelings and emotions, and their fit within the context of the scenario. Although the decisions that users made did not change much across each of the perspectives in our study, we found that their subjective feelings regarding factors of meaningfulness did differ. We suggest that a person's moral judgment, thus, cannot be fully captured through simply looking at the outcomes of their decisions.

As shown in the study, meaningfulness comprises several facets, including distraction, appreciation, and empathy; however, the latter is the most important to discuss regarding morality. Although the trait of empathy has been argued for and against as a "virtue" [8, 78], it nonetheless

remains a very individual trait, which aligns part of our research more closely with virtue ethics — looking to evaluate the morality of choices based more closely on the intrinsic qualities of the individual decision-maker [28]. To extend upon this exploratory idea, one possible research area that we propose for future research is looking into moral decision-making (in virtual environments) from a virtue ethics perspective. Such research could probe for a participant's virtuous traits and understand what moral decisions they deem acceptable under their character traits, and perhaps compare and contrast user responses with research involving consequentialist or deontologist perspectives.

## 9 Limitations and Extensions

Although we aimed to generalize our results and discussion towards all instances of ethical choice in VR, we have only tested this within the context of a single type of ethical scenario. It would have been beneficial to extend the generalizability of our findings by running the experiment through another type of moral dilemma, for example, the mad bomber problem [56]. We note that the trolley problem can be a controversial selection as a thought experiment, however, as 1) our study is not focussed on the practical application of the outcomes and 2) it offers a degree of comparison in the context of past studies, we found it to be a suitable selection for our purpose. The trolley problem is not emblematic of all ethical dilemmas and could potentially be seen as an unrealistic one. However, one could argue that ethical dilemmas in virtual environments all suffer from a similar problem with realism — in some sense, it is appropriate for studying meaningfulness in virtual environments. Nonetheless, it would be important to see whether similar differences in decision-making factors arise when confronted with different moral dilemmas.

We acknowledge that the sample of participants tends toward students — a younger sample that may not be representative of the entire population. This is pertinent as age can potentially influence ethical considerations [70, 77], decision-making processes [89], and emotional outcomes [6, 40]. Furthermore, the participants may have prior experiences with ethical decision-making scenarios (e.g. the trolley problem), which may factor into their choices during the experiments. In addition, the small sample size in regards to statistical analysis may indicate that small effects may not be statistically distinguishable at this sample size, and potentially a much larger sample of a more generalized population would be ideal to draw more definitive conclusions. This would provide more statistical power to our studies.

We recognize that there are limitations within our VR application. Firstly, the short-form experience likely hampered the ability of participants to potentially generate a rich sense of empathy for the social agents (especially when compared to a long-form experience, such as a game). This was in part due to the number of dimensions we wanted to vary within-subject — having a long-form experience would not work under time constraints. An extension to this work could study the impact of POV and its impact under long-form narrative experiences. Furthermore, aspects of decision-making within this study may be muted because studies have shown that, in simulated ethical dilemmas such as the one presented, participants can recognize that there is no actual real danger or consequences due to current limitations in VR regarding presence and immersion [39, 63]. Within our study, this may manifest as decisions with a higher likelihood of self-harm. A potential extension to this could be the use of haptic feedback to simulate this sense of inflicted harm. Prior research has considered pain sensations and tactile sensations in VR mediated through wearables [38, 45, 50]; integration of such systems into our work could address this issue of perceiving actual stakes in the decisions made. Finally, the aspect of being observed in a lab setting could also affect the decision-making processes of participants [43], who know their decisions will be recorded and become the topic of discussion with the experimenter. Future experiments can consider options such as removing the observer from the room, or on the complete contrary, using the experimenter

as a lens into more qualitative findings [43], e.g. to have the participant talk through their decisions with the experimenter to get a different lens into their decision-making processes.

## 10 Conclusion

In this paper, we considered how visual POV may affect a user's subjective decision-making feelings during a virtual moral dilemma as well as the objective choices actually made. We developed a VR application that places users within scenarios of a moral traffic dilemma from 3 different POVs, asking them to judge which virtual agents should perish and which would survive. In the first study, we found that users primarily consider three groups of factors when making their decisions — social factors that relate to the user relationship with the virtual agents, consequential factors that relate to "what happens next", and moral factors that relate to the user's personal moral priorities. Furthermore, we find that these aspects correlate with past studies on meaningfulness and that user feelings of meaningfulness and its associated components can vary from different POVs. These differences in self-reported subjective effects occur even when the ethical variables behind the actual decisions may not reflect a level of statistical difference. In the second study, we delved deeper into the specific facets that contribute to increased feelings of meaningfulness, finding that appreciation, distraction, and empathy were the three main affected features. Finally, we discuss how the ability of POV to control levels of meaningfulness and empathy could potentially be exploited by developers, and how our work may open new doors to different ethical perspectives in decision-making research.

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