EXPLORING DECISION-MAKING IN SERIOUS GAMES VS. TRADITIONAL SURVEYS: COMPARATIVE STUDY OF MEDIUM EFFECTS ON RISK ASSESSMENT

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Abstract:

This study evaluates the impact of experimental mediums — serious games and traditional online surveys — on decision-making processes, risk assessment and the risky choice framing effect bias. Conducted with 77 participants from the University of Belgrade, the experiment utilized a serious game developed in Unity Engine and a standard text-based survey, presented in a counterbalanced experimental design to assess participant responses in different mediums. The primary aims were to compare how these mediums affect decision-making times and responses and to test the validity of serious games for cognitive research. Response times and decision patterns were analysed using paired T-tests and ANOVA, revealing no significant differences between the two mediums. These results suggest that serious games provide an experiential depth comparable to traditional surveys, maintaining consistent decision-making outcomes. The study underscores the potential of serious games as a robust platform for psychological research, capable of simulating decision-making environments while preserving the integrity of experimental conditions. Future research should focus on enhancing game realism and participant engagement to possibly uncover more subtle distinctions in decision-making behaviour across these mediums. This research confirms the suitability of serious games for exploring complex cognitive processes, setting a foundation for their broader application in scientific studies.

Keywords:

Decision making, Human-computer interaction, Serious games, Risky choice framing effect.

INTRODUCTION

Technological developments in the last decades have introduced new mediums of human-computer interaction. One of the notable mediums that has gained popularity since its early development is computer video games. In the current digital age video games, although primarily developed and distributed for the purpose of entertainment, offer an interactive experience towards a clear goal, based on a set of agreed rules and constraints, often accompanied by challenges and constant feedback. [1] This tight feedback loop, usually immediate and common to both regular and video games, offers a unique experience to the players in which they challenge themselves to overcome certain goals. One way of using this rich medium for non-entertainment purposes is by implementing

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pedagogy as subordinate to the story, described by Michael Zyda as: "Serious game: a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives." [2] A systematic literature review done by Rissanen et al. [3] establishes the role of serious games in knowledge and skill acquisition, as well as behaviour modification [4]. Such cognitive or educational objectives, embedded within entertaining gameplay and game design, create grounds for simulating complex decision-making scenarios.

Although primarily used in education and corporate training [5], [6], [7], serious games have potential in other fields as well. The one explored in this paper relates to cognitive science and the intricacies of risky decision-making processes and the risky choice framing effect bias. The goal is to compare standard text-only online surveys, traditionally employed in cognitive psychology "on paper", and the implementation of the same survey in a virtual environment in the form of a serious game. By conducting an experiment in which participants take a basic decision-making questionnaire in both mediums, we compared the validity of conducting experiments through serious games. One of the main reasons why we chose to use a serious game medium to conduct the survey is because of the engagement aspect of computer video games. Providing well-designed levels, serious games can offer a dynamic platform for creating a more immersive environments to explore risky decision making. Level design is essential for creating immersive experiences that integrate game mechanics with the storytelling and the visual environment, fostering greater emotional and cognitive engagement with the player than simple text on a screen. [8]

The game design principle in serious games offers a platform to explore the risky choice framing effect and prospect theory within the context of decision-making. Prospect theory, developed by Kahneman and Tversky, suggests that individuals evaluate potential losses and gains differently, leading to the dependence of the decisions on how choices are presented or "framed". [9] Examples of positive and negative framing, along with their certain and uncertain or risky choices, are shown in Table 1. The reversal in the preference of risk due to the different descriptions of the same choices is dubbed as risky choice framing. By developing game levels that simulate decision-making scenarios with different framing and providing players with immediate feedback on their decisions (i.e. losing health points or gaining gold coins), serious games provide an immersive environment to observe and understand these cognitive biases in action. This level design approach enables players to experience the consequences of their choices in a controlled setting, illustrating the impact of loss aversion and the influence of positive or negative framing on decision-making processes. We propose that serious games, through purposely designed levels, can be an effective tool for studying the risky choice framing effect, decision-making processes, and other cognitive biases practically and engagingly. This study aims to make the first step towards that idea by exploring if serious games are as valid as online surveys for conducting decision-making questionnaires.

2. METHOD

2.1. GAME DEVELOPMENT AND DESIGN

The serious video game was developed in Unity Engine [10], and is an upgraded version of the pilot game [11], with the goal of presenting participants with seven decision-making scenarios involving risk, requiring choosing between certain and risky choices. The game aimed to create a step towards a more immersive experience, given that players would face immediate consequences of their choices within the simulated 3D fantasy environment. The complete game interface was in Serbian and included a consent form in the beginning for data collection, including response times, question responses, age, gender, and educational level.

Table 1. Examples of positive and negative framing, and their corresponding certain and risky choices.

	Certain choice	Risky choice
Positive Framing	Guaranteed receipt of €5000, enhancing your financial stability and enabling potential investments.	50% chance of receiving €10 000, doubling your financial gain, and significantly boosting your investment opportunities.
Negative Framing	Immediate reduction of financial uncertainties with only €5000, possibly insufficient for larger plans or emergencies.	50% chance of receiving nothing, potentially missing out on financial growth and necessary funding.

Central to the game's mechanism was a decision-making questionnaire, reviewed and approved by cognitive scientists, made up of seven tasks (questions) presented by non-playable characters. These tasks are created to fit the narrative of the game, as the tasks themselves tell the game story. The player's (participant's) character is a traveling adventurer in this fantasy world, and the choices they make immediately affect them, and the consequences are provided visually, audibly, and concerning the story. In this way, we personalized the reference point for gains or losses. This personalized approach aimed to bring the risk assessment closer to the player, in comparison to the usual way of completing these questionnaires – by reading questions and trying to imagine the hypothetical scenario in their mind.

The game's environment is thematically consistent, extending to the dialogue and interactions, which are designed to immerse the player in scenarios that enhance the relevance of the tasks to the player's character. This game design choice aimed to contextualise the decision and its consequence. The game's architecture is strict in its task ordering and sequence. For instance, completing the third task allows for initiating the fourth task. This decision was made to make sure that the online and gamified versions show the questions in the same sequence, as well as to ensure no logical fallacies are created within the story (e.g. interacting with the doctor before you are ill). This progression is crucial in illustrating the consequences of the player's decisions, which are reinforced by in-game metrics like health points and gold coins, which alter based on the player's choices.

Through this design and structured implementation, the game serves as a dynamic platform for exploring decision-making processes and the framing effect. Situating theoretical concepts in a vivid, interactive environment, can help illustrate how framing can influence decisions. This approach could theoretically not only engage players on a deeper level but also provide insights into human cognition and decision-making behaviours.

2.2.DESIGNING DECISION-MAKING SCENARIOS

The questionnaire consists of seven questions (tasks). Each question was developed with both a positive and negative framing, and the final version of the questionnaire in both mediums included the following framings, in question order: negative (N), positive (P), negative (N), positive (P), negative (N), negative (N), and positive (P). This was done to strategically influence the player's decision-making process. Each question offers a choice between a certain choice and a risky one, regardless of the framing, challenging players to weigh their decisions within the context provided and embodying the essence of risk assessment in human cognition.

The final version of the questionnaire, with its fixed sequence of framed questions, serves as a direct investigation into the framing effect's influence on decision-making, providing a novel comparison point to conventional survey techniques. By integrating simple game mechanics and narrative elements, this game aims to validate the effectiveness of game-based simulations as a viable and innovative method for conducting psychological research on decision-making under risk. The questionnaire was the same across both mediums.

However, the decisions that the players make directly affect their in-game character in terms of health points or the amount of gold coins they have – making their decisions in a similar vein to the standard risky choice framing effect introductory questions regarding economics or health.

Risk decision questions are comprised of two key components: surface and deep structure. Deep structure relates to the question itself presenting the situation in which the decision maker is placed, the certain choice, and the risky choice in probabilistic terms, while surface structure represents anything that does not affect the meaning of the deep structure, such as the risk type, whether it is monetary, health-based, etc. [12]

The assumption then follows that the phrasing of the question, as well as the phrasing and framing of the available responses, will affect the decision-makers feeling about the problem at hand and influence their relationship with risk by placing them into a position of loss or gain. The expectation, in accordance to the prospect theory, is that if the person is placed in a situation of loss, they will respond in a way that will move their reference point towards gain, making them risk-prone, while placing them in a situation of gain will influence them to pick the choice that keeps the reference point in place or towards more gain, making them risk-averse. Emotions play a significant role in decision-making and that is why the framing effect is so effective, as it directly affects choice based on what emotions are evoked within the person responding to the questions.

2.3. DATA COLLECTION

In this study, the participants, all students at the University of Belgrade, were randomly assigned into two groups that alternately responded to the questionnaire (serious game and online questionnaire), with a difference of 7 days between conducting the tests. On the first day (phase 1), one group completed the questionnaire by playing the serious game, and through the written online form on the seventh day (phase 2). The other group completed the questionnaires in the opposite order. This design allowed each participant to experience both forms of the questionnaire, maintaining identical questions across both platforms to ensure consistency in data collection. Both mediums provided unlimited response time and mandatorily required responses to continue to the next question. While the questions were identical, the serious game provided the participants with immediate feedback on the player's decisions in contrast to the survey where participants simply proceeded to the next question without any feedback. The recorded data was the response (choice made) and response time, as well as demographic info in the beginning (gender, education level, age), preceded by a consent form. The online survey was conducted using the SoSciSurvey platform [13], and the game was distributed as an executable file, ensuring ease of access and participation. In further analysis, the following variables are taken into consideration: reaction time and response choice as dependent variables, and type of medium as the independent variable.

3. RESULTS

In total, 77 participants completed the survey across both mediums – 77 participants across both phases completed the gamified survey (90.28% women, mean age 19.9 SD +/- 3.28), 72 participants in both phases for online survey (83.12% women, mean age 20.38 SD +/- 5.11). All participants completed the survey in both mediums. Phase one included 35 participants responded to the online survey, while 39 participants responded to the gamified survey. Phase 2 included 37 participants in the online survey, and 38 participants in the gamified survey.

The average response time across both phases for the online surveys was 31.15 seconds SD 6.16, and for the gamified survey it was 29.53 seconds STD 5.28. Average response times calculated across both phases for each medium per question are shown in Figure 1. A single-tailed paired T-test performed on the response speeds PER QUESTION across both mediums and both phases yields a value of 0.23 ($p > 0.05$), which is statistically not significant and shows that there is no significant difference in response time speed for online and gamified surveys. An ANOVA was conducted to compare response times between participants taking an online survey and those engaged with a gamified survey. The between-groups sum of squares (SS) is 9.09, with 1 degree of freedom (df), resulting in a mean square (MS) of 9.09.

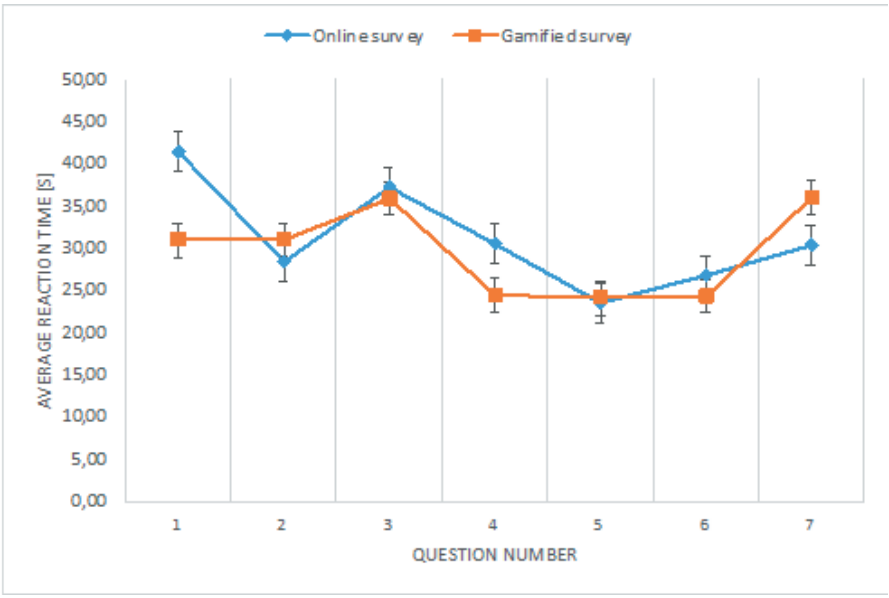

Figure 1. Average response time for each question across both groups and both phases.

The within-group SS is considerably larger at 395.16 with 12 df, giving an MS of 32.93. The F-statistic, calculated by dividing the between-groups MS by the within-groups MS, is 0.28, indicating the ratio of variance between the groups to the variance within the groups. The critical F-value at an assumed common significance level of 0.05 for 1 and 12 degrees of freedom is 4.75. Since the calculated F-value is much lower than the critical F-value, and the p-value is 0.68 ($p > 0.05$), the results fail to reject the null hypothesis. This suggests that there is no significant difference in response times between the online survey and gamified survey participants. The ANOVA indicates that the gamified survey is just as valid as the online survey in terms of response times. This supports the hypothesis that gamified surveys can be an effective alternative to traditional online surveys for collecting response time data.

For all of the 7 questions, across both phases and both mediums, participants had the choice between a certain and risky choice, regardless of framing. We explored if there exists any significant difference between the number of times the participants picked certain or risky choices across both mediums and both phases. In the gamified survey, for both phases, the total number of risky responses was 240 (44.53% of all responses). The individual question response distribution is shown in Figure 2. In phase 1, the number of risky responses was 124 (45.42% of all phase 1 gamified survey responses). In phase 2, the number of risky responses was 116 (43.6% of all phase 2 gamified survey responses).

In the online survey, for both phases, the total number of risky responses was 218 (43.25% of all responses). The individual question response distribution is shown in Figure 3. In phase 1, the number of risky responses was 105 (42.86% of all phase 1 online survey responses). In phase 2, the number of risky responses was 113 (43.63% of all phase 2 online survey responses).

The chi-square statistic calculated for the sum across phases of certain and risky responses across both mediums is 0.1714, and the associated p-value is 0.68. The p-value ($p > 0.05$) indicates that the difference in the counts between the "Certain" and "Risky" responses for both mediums is not statistically significant. This suggests that regardless of medium, participants decision making process was consistent across two mediums, that is that they responded in a similar pattern in terms of choosing risky or certain choices in our survey.

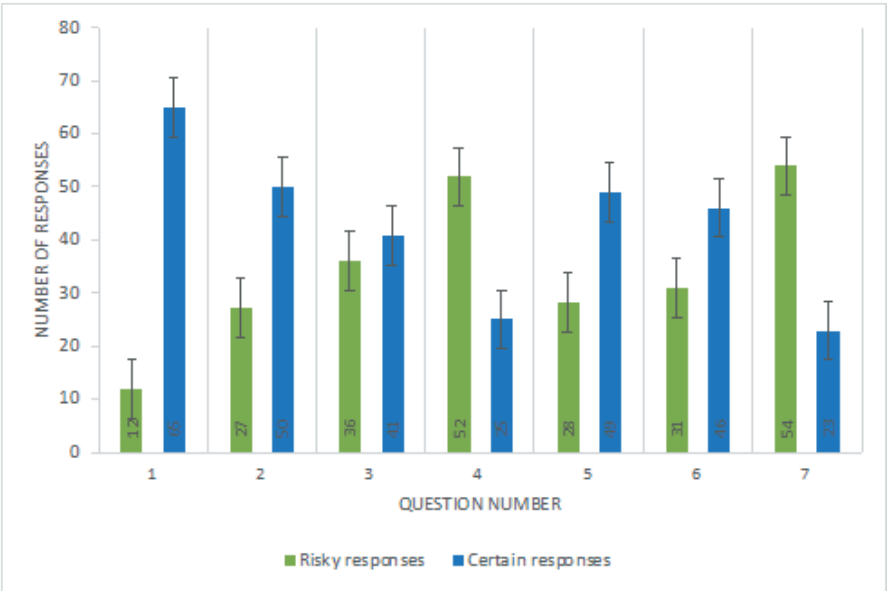

Figure 2. Gamified survey, distribution of risky and certain responses for both groups and phases.

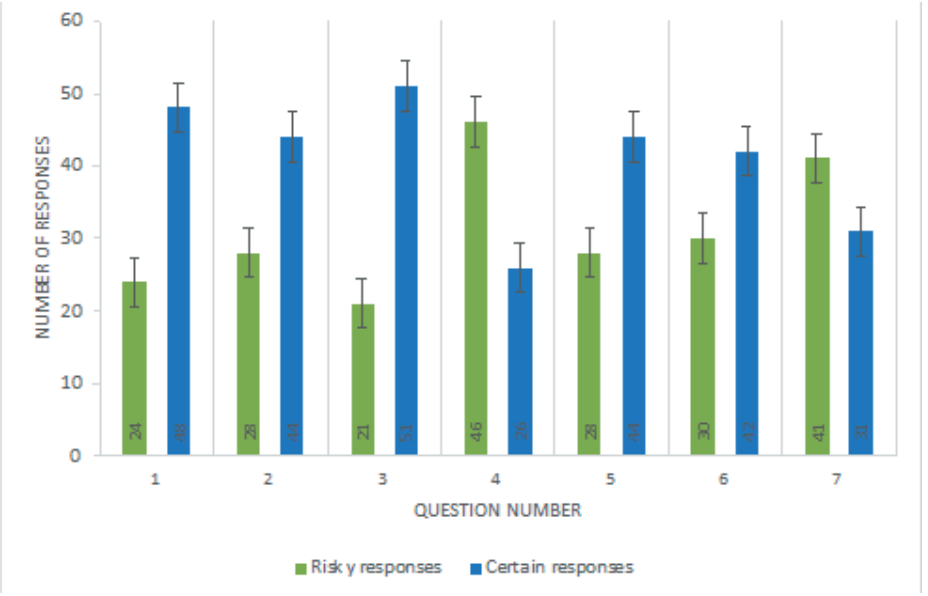

Figure 3. Online survey, distribution of risky and certain responses for both groups and phases.

4. DISCUSSION

The immersive qualities of the video game do not substantially alter the fundamental aspects of decision-making processes as they relate to risk preference, as suggested by the consistent patterns of participants' responses in two mediums, in the simulated environment and the online questionnaire. This outcome supports the hypothesis that decision-making mechanisms are robust across various presentation mediums. However, it also highlights the necessity for further advancements in simulation technology and game design to increase the realism and engagement of such environments, potentially uncovering nuanced differences in future research, most importantly considering engagement as related to behaviour or cognition. [14] Because the lack of significant differences in decision outcomes between the two environments, this research underscores the potential of video games as a medium for examining decision-making processes. The immersive nature of video games, which can simulate real-world experiences, hold promise for advancing our understanding of how individuals make decisions under risk.

Developing and enhancing the realism and engagement of such environments could uncover more nuanced differences in decision-making processes in future studies. The potential of video games not just as a medium for posing questions but to observe decision-making through gameplay dynamics itself also poses a task for future research. For example, future serious games might feature decision-making scenarios that do not provide explicit instructions. Engaging respondents more deeply in the simulation could lead to a greater sense of responsibility for their decisions. Creating more intricate and clearly defined questionnaires for studying the framing effect, along with developing highly immersive games, possibly in virtual reality (VR), could enhance the study outcomes in terms of immersion and engagement. However, our present findings indicate a promising beginning and demonstrate that games are an effective method for conducting decision-making experiments related to the framing effect, although there is potential for further refinement.

5. CONCLUSION

Our research demonstrates the consistency of decision-making processes across two distinct mediums and underscores the untapped potential of video games for cognitive science research. Future work should aim to enhance participant involvement and engagement in simulations, which could provide deeper insights into how people evaluate risks and make decisions. This may reveal new angles on behaviour and cognition within simulated settings. As we advance simulation technology and game design, video games could not only serve to explore decision-making psychology but also as a potent instrument for influencing it.

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