Implementation and Feasibility Analysis of a Javascript-based Gambling Tool Device for Online Decision Making Task under Risk in Psychological and Health Services Research

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Keywords: Decision Making, Online-surveys, Game of Dice Task, Javascript.

Abstract: Decision making is one of the most complex tasks in human behavior. In the past, researchers have tried to understand how humans make decisions by designing neuropsychological tests to assess reward related decision making by evaluating the preference for smaller but immediate rewards over larger but delayed rewards or by evaluating the tolerance of risk in favor of a desired reward. The latter are also known as gambling tasks. Today, information technology offers a variety of possibilities to investigate behaviour under risk. After a short introduction on gambling tasks and in particular the game of dice task, this article describes the development and implementation of a JavaScript-based gambling tool for online surveys based on a game of dice task. In a pilot feasibility study with 170 medical students, participants were randomly assigned to a "REAL condition", based on the probabilities of the chosen bet and a "FAKE condition" where participants lose all the time independently of the chosen bet. We were able to show that the software was well accepted with only 14.7% of drop outs. Moreover, we also found a difference between the FAKE and the REAL group: Participants in the FAKE condition in the mean steadily increased their stake while then control group quite early tended to run a safer strategy. This is also obvious when the overall stake mean is compared: While in the REAL condition the mean stake is 310.89 ± 222.98 €, the FAKE condition has an overall mean of 390.38 ± 296.50 €. In conclusion, this article clearly indicates how a JavaScript based gambling tool can be used for psychological online research.

1 INTRODUCTION

Decision-making is one of the most complex tasks in human behavior (Brand, et al., 2005). In the past, researchers have tried to understand how humans make decisions, especially in risky situations. A few researchers found neuropsychological correlates of decision-making in risk situations and designed neuropsychological tests to assess reward related decision making by evaluating the preference for smaller but immediate rewards over larger but delayed rewards or by evaluating the tolerance of risk in favor of a desired reward (Brand et al., 2006). The latter are also known as gambling tasks.

Various types of those gambling tasks have been used for experimental situations to investigate decision-making under ambiguous conditions. The most commonly known gambling tasks are the *Iowa Gambling Task (IGT) (*Bechara et al., 1994). In this task, the subjects can win or lose virtual money by repealing cards from four different decks. Due to the fact that the expected values are unknown, participants have to learn by experience which decks are advantageous. Bechara et al. (1994) developed the IGT with two decks who are either overall advantageous or overall disadvantageous. In previous studies the research group has found that the participants took cards towards the advantageous decks.

Wagar & Dixon (2006) explained this fact that the participants base their decision on conscious pleasant feelings. Later in the IGT the participants got a feedback (negative or positive) from the result by picking cards the four different decks. In this game, the participants were given a 2000 Euros as a bank balance. They saw decks in front of them and had to choose one of them. The players have 100 trials, but this fact is unknown to the participants.

After picking cards from one of the four decks the participants got a feedback, some cards generate a profit and some cards generate a loss (Figure 1).

Franckenstein, S., Appelbaum, S. and Ostermann, T.
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DOI: 10.5220/0010826700003123
In *Proceedings of the 15th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2022) - Volume 5: HEALTHINF*, pages 469-474
ISBN: 978-989-758-552-4; ISSN: 2184-4305

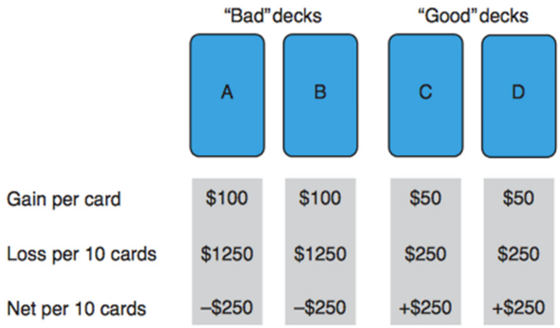

Figure 1: Screenshot of the *Iowa Gamling Task* from Bechara, Damasio, Tranel & Damasio (2005).

The instruction of the game is that participants play in such a way that they would win as much money as possible, meaning the subjects had to learn by previous trials, which is the best strategy for winning. If participants decided to play cards mostly from the disadvantageous decks, they lose 250 Euros in every ten cards and if they play cards mostly from the advantageous decks, they gain 250 Euros in every ten cards (Bechara et al., 1994).

The Balloon Task

Another task to investigate research questions by using computerized method is the Balloon Analogue Risk Task (BART) (Lejuez et al., 2002) which measures risk behavior of participants.

In the task, the subjects are presented different kind of balloons. The participants` aim is to earn as much money as possible by pumping air in the balloon. Every click inflates air in the balloon, but with each following click the balloon can explode (Figure 2).

Thus, the participants entered a high risk by inflating a lot of air by clicking the button. On the other hand, they have the opportunity to gain more money by taking the risk option. However, the balloon breakpoints are unknown for the participants. In this experimental design the subjects have 10 opportunities to win money by inflating air into balloons.

The Game of Dice Task

In the original task which was developed by Brand et al. (2006) the participants have to guess the outcome of the game. The participants are introduced to the gain maximum which can be achieved within 18 attempts with a virtual dice task.

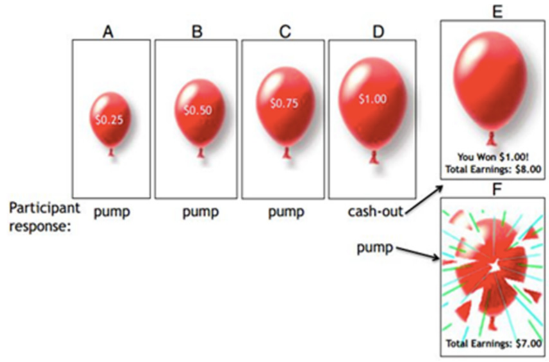

Figure 2: Screenshot of *Balloon Analogue Risk Task* (BART) from (Lejuez et al., 2002).

In the game, the participants can choose between different options to play the game. There are the options to choose one dice or a combination of two, three or four dices. These different options are associated with different bets. The bets are associated with different expected values for gains and losses (associated with 1:6, gains/losses 1000 Euros, 2:6, 500 Euros, 3:6, 200 Euros and 4:6, 100 Euros; Figure 3)).

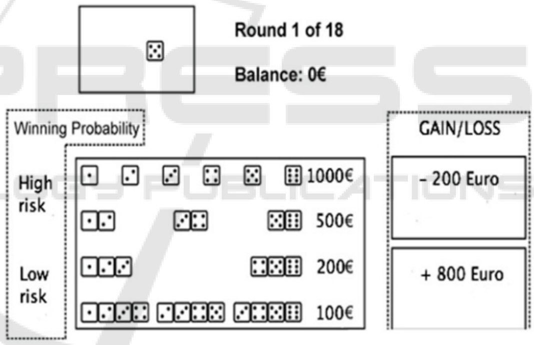

Figure 3: Screenshot of Game of Dice task from Gorini et al., (2014).

The game starts with a virtual capital of 1000 Euro. The participants lose, when there is incongruency between the bet option and the real outcome of the die. The different bet options die or a combination of two, three or four dice are associated with a risk or safe decision-making, because the best choice is to play with four dice (expected values are positive). In contrast, participants who choose the bet options (one die), make a high-risk decision, because they lose in 1:6 times.

In the original version the strategy of decision making is reflected by the virtual starter capital. Participants who make a safe decision-making gain a higher starter capital at the end.

One important impact on decision-making processes are the executive functions. In the Game of Dice task the participants were explicitly informed about the rules and the outcome was defined by probabilities. Thus, the best choice to play this task is to estimate the expected values. In the past, researchers have focused on decision-making with patients, who suffer from diseases like Korsakoff's syndrome (Brand et al., 2005) or Parkinson's disease (Brand et al., 2006).

Most gambling tasks originally were run without a computer, however, today computerized versions of gambling tasks are useful, as they allow for the task to be used in more complex experimental and online settings and can make the task more standardized across studies (Dancy & Ritter, 2016).

Although there is a high demand for computerized versions, only a few platform independent versions of such tasks are freely available for download.

This article presents a JavaScript-based gambling tool device for decision making tasks in psychological research based on the Game of Dice from Brand et. al. (2006).

2 MATERIAL AND METHODS

We took the Game of Dice task from Brand et al. (2006) as a template and developed a new version of the Game of Dice task to investigate decision making with negative Feedback.

For this reason, we developed a software in JavaScript in which the participants either are exposed with the mathematically expected feedback based on the winning probabilities (control condition "REAL") or with negative feedback in all bets and thus, lose all their virtual capital in the course of time independently of the true probabilities (experimental condition "FAKE").

The software can be freely configured to deliver random results as well as always losses for the player.

Figure 4 shows the different available bet options. The players have to choose if they play the game with one, two, three or four dices. In the heading, participants have the opportunity to see the expected values. Thus, all of them have the opportunity to choose the best strategy.

Normally, the best mathematical strategy has to be retained independently from processed feedback. Therefore, we record all user responses. For further processing, data is stored as a Comma Separated Value (CSV-) file.

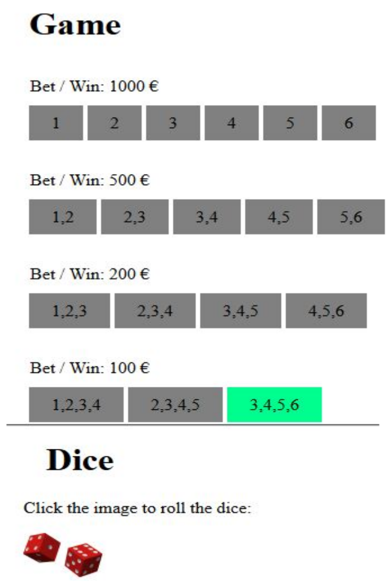

Figure 4: Screenshot of our proposed *Dice Game.*

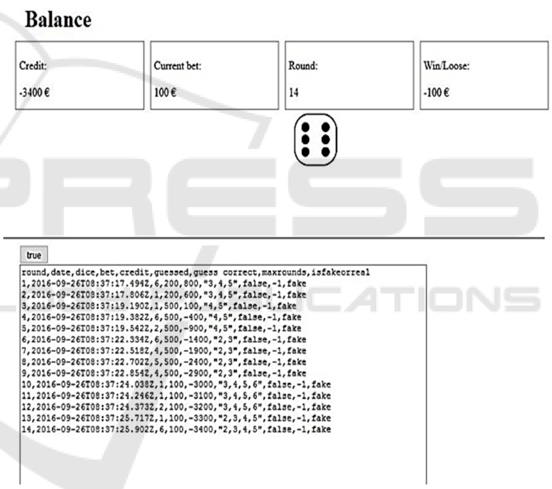

Figure 5: Screenshot of bank balance and the hidden capture choices.

Figure 5 shows the hidden capture choices. Firstly, we document some standard information like the day, time or reaction time of a player. Additionally, we record which bet options were chosen by each participant. Moreover, information whether the bet was performed correctly and if the subjects won the bet is documented. Furthermore, we gather the experimental conditions (FAKE or REAL).

Figure 6 shows the decision diagram in the experimental conditions.

As can be seen, the outcome in the FAKE condition is independent from the participant's behavior, because the participants lose all the time anyway.

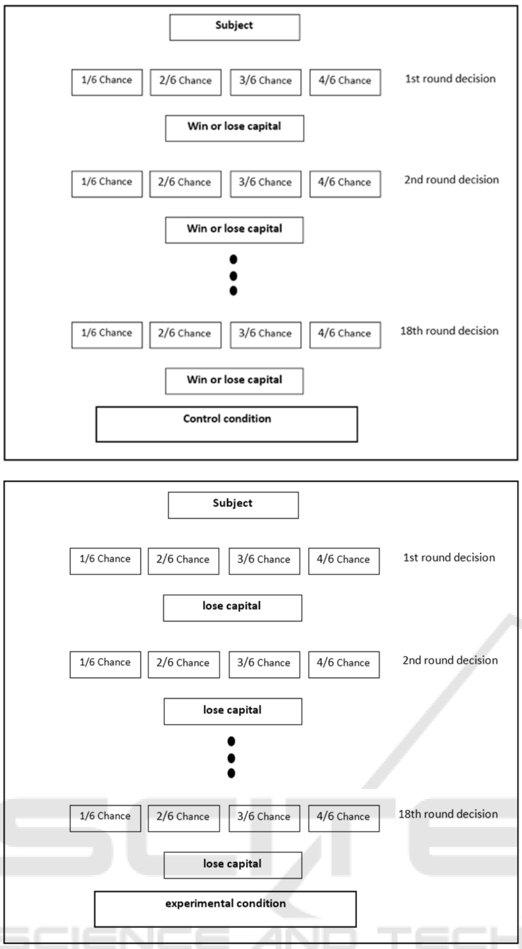

Figure 6: Flow chart of the control conditions “REAL” and the experimental condition “FAKE”.

Based on JavaScript and HTML we developed a program that it is platform independent. The participant only needs a common Web-Browser to play the game.

For our pilot study, we decided to integrate our program into the survey tool “Unipark“ using the common library jQuery which is already provided by „Unipark“ (Questback GmbH, 2015). The source code of our JavaScript gambling tool can be obtained from the authors.

3 RESULTS

In a first pilot study, we tested the feasibility of our approach in 170 students and staff members of the School of Medicine of Witten/Herdecke University. Two third of the participants were female (N=113, 66.5%) and 57 were male (33.5%) with a mean age of 24.18 ± 8.05 years.

Participants were equally allocated to either the FAKE or the REAL condition. A total of 40 rounds were preset. Participants were able to stop the experiment after each round and 145 participants (70 in the FAKE group and 75 in the REAL group) completed at least one round, which corresponds to a dropout rate of 14.7%.

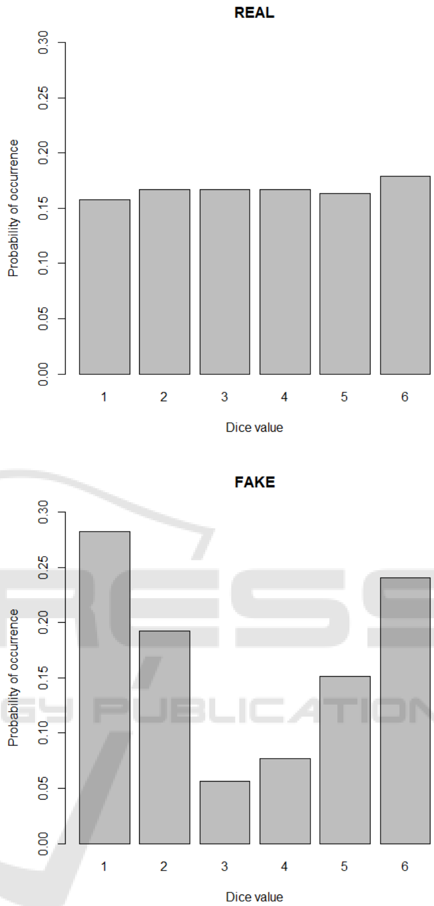

Figure 7: Distribution of the dice values in the FAKE and the REAL condition.

Figure 7 shows the distribution of the dice values in the FAKE and the REAL condition. As to be expected, there is an almost uniform distribution in the REAL condition whilst in the FAKE condition shows a U-shaped distribution, which was also to be expected based on the dice pattern distribution from Figure 4. Thus, from the technical point of view, the dice algorithm works.

Next, we wanted to know, whether the participants behaved different in the two groups with respect to the gambling strategy. We suspected that participants in the FAKE group would increase their bets as the game progressed due to the continued losing streak. Figure 8 shows the mean stake in € in the course of the game subdivided by the two groups.

In accordance with our hypothesis, participants in the FAKE condition in the mean steadily increased their stake while then control group quite early tended to run a safer strategy. This is also obvious when the overall stake mean is compared: While in the REAL condition the mean stake is 310.89 ± 222.98 €, the FAKE condition has an overall mean of 390.38 ± 296.50 €. However, this overall mean difference did not turn out to be significant (t-test; df= 127.85, p= 0.07193 95% CI: [-7.19; 166.17]).

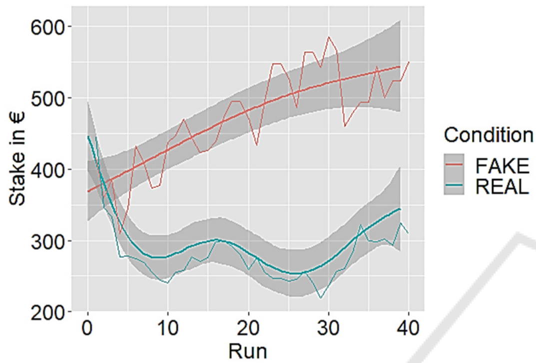

Figure 8: Mean stake in € in the course of the game subdivided by the FAKE and the REAL condition. The grey area denotes the 95% confidence interval.

The difference in the gambling behavior is also obvious in type of bet the participants in each group did choose. While for the 100€ and the 200€ bet (the 4-dice and 3-dice pattern bets) the number of blue dots increase within the course of time, we similarly observe an increase of the red dots in the risky bet of 1000€ (the 1-dice bet).

Fig 9 shows the distribution of the bets over the four betting types as a scatterplot.

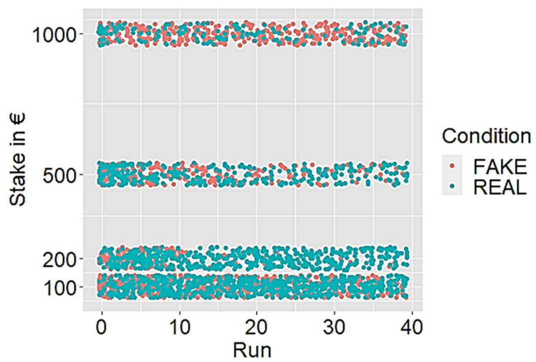

Figure 9: Distribution of the bets over the four betting types as a scatterplot subdivided by FAKE (red dots) and REAL (blue dots).

4 CONCLUSIONS

This study demonstrates the feasibility of a software bundle for studies in decision-making analysis. We were able to show that the software worked in line with our hypotheses and was well accepted of the participants of the study.

It clearly shows how an implementation of the dice game in JavaScript can enrich online surveys in psychological research i.e. in the framework like "Unipark" (Questback GmbH, 2015).

Online behavioral experiments have a number of new technical and scientific challenge opportunities (Gureckis et al., 2014). Testing participants online with this kind of approach is more efficient and due to its JavaScript based approach can be integrated in other kinds of online surveys. Thus, accessibility and availability for various populations are enhanced, whereas Paper-Pencil studies are limited by geographic reasons with respect to selecting participants. Especially in challenging times such as lockdowns this might serve as a good opportunity to carry our behavioral experiments without a loss of quality as demonstrated in (Nalbantoglu, 2021).

With respect to our survey a number of interesting aspects to use our software are given: It might be interesting to know whether an increased disposition for risk taking behavior or tolerance of ambiguity might correlate with a certain type of gambling behavior.

Findings of a relationship between risk taking behavior and gambling behavior was shown in the study by Müller et al. (2021). They studied subjects with problematic social network use. Problematic social network use is a kind of gambling behavior and Bouna-Pyrrou et al. (2018) showed that problematic social network use has an addiction like potential.

Similar findings were found by Meshi et al. (2019). They investigated whether subjects with excessive SNS (social networking sites, like Instagram) utilization correlated with difficulty making decisions.

In other studies, the duration of use of social media would be an interesting point, since the age of our sample has a mean age of 24.18 ± 8.05 years. In addition, FAKE`S analysis reveals a group of subjects that chose a high-risk gambling behavior. This might correspond to older findings of Huber (2004), who showed that subjects under ambiguity use emotional feedback from similar situations for the current situation to make decisions.

An exciting question for further work would be, whether the permanent use of social media, especially among young people, leads to a permanent change in decision-making.

In conclusion, there are other relevant psychological correlations to be investigated. Nevertheless, physiological parameters should not be neglected.

A further promising step is to combine this software with the measurement of physiological measures such as skin conductance response or heart rate variability, which in current studies have shown a response when manipulating the decks in the IGT (Priolo et al., 2021)

Thus, the analysis of such traits and experimental parameters in combination with this software bundle will be the next challenge to be faced.

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