

Not *really* the same:

Computerized and real lotteries in decision making research

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Abstract

Computer technologies are routinely employed for many experimental procedures in decision-making research. Because computer-supported conduct has been shown to bias certain types of measures, the study evaluated the impact of computerized presentation of lotteries on risky choice tasks. A sample of 187 German undergraduates (147 women) participated in an experiment on financial decision-making. After presenting two types of lotteries participants had to choose between the risky and the conservative lottery. The experiment followed a 3 (presentation mode) x 2 (type of payoff) factorial design. Results indicated that the risky lottery was chosen more frequently when the lotteries were presented on computer as compared to real lotteries where participants drew balls from a closed box. Differences in risk perceptions mediated the mode effect on choice behavior. Moreover, risk taking decreased when the monetary payoff was made salient. Hence, computerized sampling and artificial payoffs (e.g., points) increased risky choices. Our findings therefore suggest that computer-supported sampling procedures in decision-making research might overestimate risk-taking behavior as compared to risk-taking in applied practice (i.e. in non-virtual sampling scenarios using monetary payoffs).

Keywords: decision-making, risk taking, computer, mode effect, payoff

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Computers have become indispensable commodities for many research endeavors. An increasing number of studies rely on computer technologies to collect data in the lab, over the Internet or even in ambulatory assessments (cf. Buhrmester, Kwang, & Gosling, 2011; Couper, 2011; Mason & Suri, 2012; Stiglbauer, Gnambs, & Gamsjäger, 2011; Trull & Ebner-Priemer, 2013). However, the introduction of computers also raised concerns whether results from these studies can be generalized to traditional non-computerized research scenarios (Noyes & Garland, 2008). Indeed, a number of studies found that computer-supported conduct might bias measures and distort research findings (e.g., Andersson, Westöö, Johansson, & Carlbring, 2006; Drapeau, Bastien-Toniazzo, Rous, & Carlier, 2007; Mead & Drasgow, 1993; Steinmetz, Brunner, Loarer, & Houssemand, 2010). The present study contributes to this debate by investigating the impact of computer-supported procedures in an area, which has not received much attention so far – research on risky choice. A controlled lab experiment examined whether computer presentation of lotteries made a difference and led to more risky choices than real lotteries. In addition, the study explored the recently identified description-experience gap in decision making research (Barron & Erev, 2003; Hertwig, Barron, Weber, & Erev, 2004) and examined whether administration mode effects might contribute to this gap. Finally, auxiliary analyses evaluated whether the type of payoff (i.e. using money) used in decision making experiments had an impact on participants' choices and risk perceptions.

Mode Effects of Computerized Assessments

In light of the continuous rise of computer use in research and practice a number of studies examined whether computerized forms of stimulus presentation and test administration introduced a bias that might distort resulting effects. However, respective

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findings were quite inconclusive (Noyes & Garland, 2008). For example, studies assessing personality traits generally concluded that the presentation mode does not affect the measurement properties of self-report questionnaires (e.g., Meade, Michels, & Lautenschlager, 2007; Vecchione, Alessandri, & Barbaranelli, 2012; Weigold, Weigold, & Russell, 2013). Similar results were obtained for many cognitive measures (cf. Schroeders & Wilhelm, 2010). Meta-analyses indicated that results from mathematical tests (Wang, Jiao, Young, Brooks, & Olson, 2007), reading assessments (Wang, Jiao, Young, Brooks, & Olson, 2008), or non-timed cognitive tests (Mead & Drasgow, 1993) are not distorted by a switch from paper-and-pencil to computerized modes. Even experimental studies conducted over the Internet seem to replicate well-known effects from respective lab studies (Germine, Nakayama, Chabris, Chatterjee, & Wilmer, 2012). However, equivalence across assessment modes cannot be taken for granted. For example, the manual and computer version of the Wisconsin Card Sorting Test, a popular measure of executive and frontal lobe functioning, lacked psychometric equivalence (Steinmetz et al., 2010), making it doubtful that scores obtained from the different test versions can be meaningfully compared. Participants also exhibit poorer performance on many computerized variants of speeded cognitive tests (Drapeau et al., 2007; Mead & Drasgow, 1993). Some procedures such as the well-known Stroop task even produced opposite effects when transferred to the computer (Andersson et al., 2006), leading the authors to conclude that traditional and computerized Stroop tasks measure two entirely different concepts. On the other hand, in some instances computer-supported conduct seems to be superior, such as in the case of text composition (Goldberg, Russell, & Cook, 2003) or the assessment of sensitive information (Kays, Gathercoal, & Buhrow, 2012; Gnambs & Kaspar, 2014; Tourangeau, 2004).

In sum, the findings on computerized research paradigms are highly inconsistent and comparability of results across different assessment modes is all but self-evident. Rather,

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previous research points to different conclusions for different types of task: for some tasks (e.g., self-report questionnaires) computerized conduct doesn't seem to produce systematically different results than traditional procedures, whereas other tasks (e.g., speeded cognitive tests) might result in quite different conclusions when conducted on the computer. So far, no study has contrasted computer-supported with traditional conduct in the realm of risky decision making. Although several computerized versions of specific research paradigms such as the Iowa Gambling Task (Bechara, Damásio, Damásio, & Anderson, 1994), which have previously been conducted without computers, are routinely employed in research, no systematic comparisons have been reported to date. The only study including both the original card version and a computerized version unfortunately did not allow for a meaningful comparison because both versions differed with regard to a number of aspects such as the frequency of punishment, the magnitude of rewards, or the number of cards per deck (Bechara, Tranel, & Damasio, 2000). However, based on descriptive comparisons of the response patterns of healthy participants and patients with brain lesions (no statistical analysis were reported) the authors clearly argued for non-equivalence of the computerized and the traditional version of the Iowa Gambling Task. This indicates that an exploration of potential mode effects in decision-making research is highly warranted.

Implications for Research on Risky Choice

Many everyday decisions such as the choice to buy a lottery ticket or the selection of a vacation destination for next summer are guided by experiences gathered throughout one's lifetime (Betsch & Haberstroh, 2005). In contrast, for a long time decision making research has adopted a rather different approach. Instead of gathering active experiences participants in experimental lab studies were confronted with short vignettes of risky choices that visually stated all possible outcomes including the respective probability for each outcome. For example, in a classical study by Kahneman and Tversky (1979) subjects were instructed to

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choose between two gambles that either resulted in a certain (or less risky) but smaller payoff (“Get \$3 for sure”) or an uncertain (or risky) but larger payoff (“Get \$4 with probability .8 and \$0 otherwise”). These situations neither required participants to gain experience with the presented gambles, nor was it even possible (see Goldstein & Hogarth, 1997, for an overview). Thus, it has been questioned whether such artificial results from description-based research scenarios can indeed be generalized to real world decisions. In light of this critique decision making research has recently undergone a paradigm shift: Instead of requiring decisions from description (DFD) that presented all outcomes including their exact probabilities Barron and colleagues (Barron & Erev, 2003; Hertwig et al., 2004) introduced a study design that required subjects to form decisions from experiences (DFE). Here, participants sampled from the environment (e.g., by repeatedly drawing from two decks of cards) and only through this process learned about the probability distributions of the outcomes. For example, Barron and Erev (2003) had their participants make repeated selections between two gambles by pressing one of two buttons and infer the outcome distribution from the returned results. Crucially, this approach yielded significantly different decisions than the DFD paradigm. Whereas DFD studies consistently demonstrated an overweighting of rare events (Kahneman & Tversky, 1979) that resulted in preferences for the options with rare, but highly valuable gains (i.e. the risky option) the DFE paradigm typically led to fewer risky choices, indicating an underweighting of rare events (Barron & Erev, 2003; Hertwig et al., 2004). The discrepant findings from DFD and DFE designs have since then been replicated under a variety conditions (cf. Fantino & Navarro, 2012; Glöckner, Fiedler, Hochman, Ayal, & Hilbig, 2012) and, thus, been coined the description-experience gap (Hertwig & Erev, 2009). Somewhat unnoticed, the switch from the description-based to the experience-based research paradigm was also accompanied by changes in the assessment mode. Whereas description-based experiments on decision making primarily used paper-and-

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pencil based formats, the overwhelming majority of studies using information sampling were computer-supported; that is, participants gathered “experience” on screen in virtual scenarios. Although more realistic than DFD, these types of DFE tasks still remained somewhat artificial as compared to decision tasks in everyday situations. So far, no study has addressed whether participants’ decisions are affected by computerized stimulus presentation and mode effects contribute to the description-experience gap.

Overview of Research Hypotheses

Recent decision making research heavily relied on computerized stimulus presentation to create experience sampling tasks. Despite the implicit assumption that computerized conduct yields comparable results to offline methods equivalence is all but self-evident (Noyes & Garland, 2008). There is even reason to expect mode differences in risky choices across computerized and real tasks: First, marked mode effects have already been identified in research on pathological gambling. Electronic gambling such as Internet poker has been found to be more addictive and cause more problems than traditional forms of gambling (Breen & Zimmerman, 2002; Griffiths, Wardle, Orford, Sproston, & Erens, 2009). For example, Breen and Zimmerman (2002) observed that electronic gamblers developed pathological patterns of gambling behavior nearly three times as fast as participants in traditional gambling environments. This has been attributed to differences in the illusion of control, erroneous beliefs that the outcome of random events can be influenced by deliberate actions of the gambler. Indeed, a recent study confirmed that Internet gamblers are significantly more prone to such cognitive distortions than non-Internet gamblers (MacKay & Hodgins, 2012). Thus, the computerization of gambles led to an overestimation of skills or, rather, the superstitious belief in inexistent skills. Second, a similar mode effect has been recently identified in educational research on learning processes (Ackerman & Goldsmith, 2011; Ackerman & Lauterman, 2012). Students instructed to learn a short text either on

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computer screen or on paper subsequently exhibited different meta-cognitive beliefs.

Although actual learning outcomes did not differ across groups, the former felt that they had mastered the material significantly better than participant learning from paper. Thus, computerized learning resulted in overconfidence in students' perceived abilities, a divergence of subjective and objective abilities, whereas paper learning led to more realistic self-evaluations. It might be speculated that similar distortions are in effect when individuals learn the risks of different outcomes from computerized and real choice tasks. If computerized environments lead to an illusion of control or overconfidence in one's abilities, identical choices should be perceived as less risky in computerized decision tasks (DFE-C) than identical choices that are presented in non-computerized (i.e. "real") environments (DFE-R).

H1: DFE-C lead to more risky choices than DFE-R.

Following prospect theory (Kahneman & Tversky, 1979) decisions from descriptions succumb to an overweighting of small probabilities leading people to opt more frequently for risky positive outcomes than their objective probabilities of occurrence would warrant. In contrast, accumulated empirical evidence indicated opposite effects for comparable decisions in DFE conditions (Barron & Erev, 2003; Hertwig et al., 2004): people tend to underweight rare events and consequently opted less frequently for risky choices than in DFD conditions. Although some studies also reported reversed patterns under some conditions (i.e. more risky choices in DFE; Camelleri & Newell, 2011), the description-experience gap is generally viewed as an increase in risky choices in DFD as compared to DFE conditions. So far, the description-experience gap has been exclusively documented for DFE-C. As a consequence, if the first hypothesis (H1) receives support, it could be expected that the description-experience gap would be larger for real than for computerized lotteries.

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H2: The difference in the number of risky choices between DFD and DFE is larger for real than for computerized lotteries.

Albeit not the primary focus of this study, the experiment also examined the effect of different types of payoffs on participants' choices. In order to create more realistic situations, lab studies on decision making typically couple participants' choices in the decision tasks with real rewards (e.g., Barron & Erev, 2003). For example, after choosing between a low and high risk gamble the selected option is actually played out and respondents receive monetary payoffs according to the outcome of this gamble. Recent research demonstrated that the prospect of monetary rewards influences experimental outcomes in decision-making (cf. Brandt, Szykiel, & Pietras, 2013; Weatherly, McDougall, & Gillis, 2006). For example, Weatherly and Brandt (2004) showed that participants placed more risky bets in a simulated game when the credits used in the gambles were worth less money (e.g., \$0.01 versus \$0.10); thus, experiments resulting in less compensations for the participants (i.e. less real payoff) observed more risky decisions. Even simply showing money can alter participants' behavior: subjects actually handling a banknote before a gambling task made more conservative choices than individuals playing with credits having the same monetary value (Weatherly et al., 2006). Thus, the present experiment also examined whether making the exact monetary outcome of the gambles salient during the decision tasks had an impact on participants' choices. Specifically, we investigated whether knowing about an absolute payoff (e.g., 3€ or 30€) or knowing about a relative payoff (e.g., 30 points have a ten times greater value than 3 points) would affect risky choices.

H3: Payoffs labeled as generic points lead to more risky choices than payoffs labeled as money.

In sum, the present experiment studied two design factors in risky choice tasks. First, it was examined whether the type of experience (computerized versus real) in a DFE paradigm

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made a difference and, subsequently, altered the DFD-DFE gap. Hence, the computerized DFE condition was contrasted with a condition, in which participants drew balls from a box. Second, it was evaluated if making the monetary payoff salient had an impact on participants' choices and risk perceptions.

Method

A Priori Power Analysis

Using a power of .80 and an error probability of .05 the required sample size to identify the hypothesized effects was determined with G*Power (Faul, Erdfelder, Buchner, & Lang, 2009). Following Ferguson's (2009) guidelines for moderate effects these analyses suggested a minimum sample size of 116 (logistic regression) to 158 (ANOVA).

Participants

A sample of 187 undergraduates (147 women) from a German university volunteered to participate in an experiment on financial decision making. Their mean age was 22.13 years ($SD = 3.44$). Due to technical errors during the experiment two participants had to be excluded from the analyses. All participants received a financial compensation, which was made up by a fixed amount of 7 Euros and a variable amount contingent on participants' choices in the experiment.

Procedure

Upon arrival in the lab students were seated in separate cubicles and learned that they were about to choose between two lotteries: lottery A resulted in a payoff of either 0 Euros ($p = .90$) or 30 Euros ($p = .10$), whereas lottery B had a certain payoff ($p = 1.00$) of 3 Euros. Participants were encouraged to make a good choice since their decision would add to their payment at the end of the experiment. After presentation of the lotteries all participants were administered a short self-report questionnaire and their financial compensation was determined according to their choice of lottery. Participants choosing lottery A could earn

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additional 30 Euros by drawing one card from a deck of ten, whereas participants favoring lottery B received the fixed amount of 3 Euros extra.

Experimental Conditions

The experiment manipulated two factors between subjects: the mode of presentation and the type of payoff.

Mode of presentation. Participants were randomly assigned to one of three conditions that presented identical lotteries in different modes. Two conditions that comprised of about two thirds of the total sample required participants to actively experience the lotteries A and B and conduct several drawings in order to make an informed decision (DFE conditions). These drawings did not contribute to their payment at the end of the experiment (sampling paradigm, without replacement¹). These DFE conditions were further manipulated in terms of virtuality. That is, for one half of the participants in the DFE conditions the lottery was presented on computer (DFE-C), whereas the other half drew real balls from a box (DFE-R). For participants in the virtual condition DFE-C, the outcome of a lottery drawing was presented on the computer screen (e.g., 30 Euros) until the participant clicked on a button. Then, a black screen appeared for 250ms followed by the next drawing. In the real lottery condition DFE-R participants drew a single ball from a nontransparent box and, subsequently, put the ball into another box. Participants were unable to inspect the contents of the two boxes to prevent insight in the distribution of the remaining balls. In both conditions (DFE-C and DFE-R) participants conducted 100 drawings in total (50 from lottery A and B respectively; sampling without replacement). The number of drawings was fixed for both

¹ Sampling without replacement was implemented by specifying a fixed amount of 100 drawings in total that consisted of 50 drawings of 3 Euros / points each, 45 drawings of 0 Euros (90% of risky drawings), and 5 drawings of 30 Euros / points (10% of risky drawings). For example, after drawing 30 Euros / points a participant was left with only 4 drawings of the same payoff. For the computerized version this procedure was accomplished programmatically by randomly presenting one of these drawings on the computer screen. In the real lottery condition this was realized by providing participants with a box containing a fixed amount of balls to draw.

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lotteries to avoid sampling error (Fox & Hadar, 2006; see also Ungemach et al., 2009).

Because drawings from the two lotteries were presented in random order, lottery A and lottery B were distinguished by different colors (blue, green) that were balanced between subjects.

Thus, the different outcomes from the two lotteries (50 x 3 Euros, 5 x 30 Euros, 45 x 0 Euros) occurred randomly. In order to ensure encoding of all information participants were instructed to read aloud the outcomes of the drawings. Overall, both DFE conditions were comparable in terms of the drawings, the information presented, and the self-paced procedure.

The third condition required participants to form decisions from descriptions of lotteries (DFD). They were presented with a written summary on screen (see also Hertwig et al., 2004) that described the outcomes of two lotteries identical to lottery A and B as presented above. Instead of inferring the chance of winning from personal experience as in the DFE conditions, participants were directly presented with the respective information.

Type of payoff. The second experimental factor manipulated the type of payoff. For one half of the participants the payoffs were labeled as money; hence, the outcomes of the two lotteries were 0, 3 or 30 Euros. The remaining sample was given payoffs in the form of points (0, 3 or 30 points). Participants were informed that these points would be converted into money at the end of the study (i.e. after participants' choices) to determine their additional financial compensation. Specifically, at the end of the session they were informed of the exact conversion from points into money (e.g., that 3 points equal 3 Euro).

In sum, the experiment assigned all participants randomly to one of six conditions formed by the mode of presentation (DFE-C, DFE-R, or DFD) and the type of payoff (money or points). In the payoffs as money condition, 32 participants were randomly allocated to the DFE-C lottery, 29 to the DFE-R lottery, and 30 to the DFD lottery; in the payoffs as points condition the respective frequencies were 31, 31, and 32. These six groups did not differ with regard to sex or age, all $ps > .30$.

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Measures

After presentation of lotteries A and B according to the experimental condition participants had to decide which of the two lotteries to use for their extra compensation. In addition to this binary choice, they also indicated their preference on a response scale from 1 “*definitely prefer sure thing*” to 25 “*definitely prefer risky option*”. In the two DFE conditions participants also estimated the frequency with which each outcome had occurred. From these estimates the perceived risk of lottery A was derived as the relative frequency of the unfavorable event (0 Euros): Lottery A resulted in two possible outcomes, either 0 Euros ($p = .90$) or 30 Euros ($p = .10$); the perceived risk was calculated as the estimated frequency of 0 Euros $f(0)$ divided by the estimated frequencies of both outcomes $f(0) + f(30)$. Thus, larger values indicated *greater* perceived risk.

Results

It was hypothesized that the mode of presentation (DFE-C, DFE-R, or DFD) and the type of payoff (money or points) would result in different risk perceptions and, as a consequence, in different behavioral outcomes. Real lotteries were expected to lead to more conservative decisions than computerized lotteries, as were lotteries distributing money instead of points. These hypotheses were examined in two steps: First, we analyzed the effects of the two experimental factors on choice behaviors and preference ratings. Then, the implied indirect effect was examined by incorporating the perceived risk of the lottery as a potential mediator in the model.

Differences in Choice Behaviors

A logistic regression model was specified that predicted participants’ choices of lottery A versus B. The conservative choice B was coded 0, whereas the risky choice A was coded 1. In the first step, mode effects of the two DFE lotteries were examined. Thus, the regression model included a single independent variable representing the presentation mode of the two

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DFE lotteries (coded 0 for DFE-R and 1 for DFE-C). In line with hypothesis 1, computerized lotteries (DFE-C) resulted in significantly more risky choices than real lotteries (DFE-R), $B = 0.77$, $SE = 0.38$, $p = .04$, Odds ratio (OR) = 2.16.

In the next step, the description-experience gap was analyzed. The relative frequencies for participants' choices by experimental conditions are summarized in Figure 1. The respective regression model specified two dummy coded indicators of the lotteries' presentation mode using DFD as reference category. However, DFD had no discernible effect, neither DFE-C, $B = 0.51$, $SE = 0.37$, $p = .17$, OR = 1.67, nor DFE-R, $B = -0.26$, $SE = 0.39$, $p = .51$, OR = 0.77, led to significantly different choices. Moreover, in contrast to our expectations descriptive analyses (see Figure 1) indicated that the DFD condition did not yield the most risky choices; rather, DFE-C resulted in more risky choices than DFD. This renders no support for hypothesis 2.

Finally, a further regression model included the type of payoff (coded 0 for points and 1 for money) as independent variable. In line with hypothesis 3, lotteries using monetary payoffs exhibited significantly more conservative choices than lotteries distributing points, $B = -0.66$, $SE = 0.31$, $p = .03$, OR = 0.52 (see Figure 1). Sensitivity analyses that included both independent factors, presentation mode and type of payoff, within a single regression model did not identify any significant interaction effects, all $ps > .10$.

Differences in Preference Ratings

In order to gain insight into participants' subjective evaluations beyond their binary decisions, we also examined their preference ratings for the two lotteries. A 3 (mode of presentation) x 2 (type of payoff) between-subjects ANOVA revealed a significant main effect of the administered payoff, $F(1, 179) = 4.28$, $p = .04$, $\eta^2_p = .023$. Payoffs in Euros led consistently to more conservative preference ratings ($M = 10.30$; $SD = 5.66$) than payoffs in points ($M = 12.00$; $SD = 5.51$). Neither the presentation mode, $F(2, 179) = 1.37$, $p = .26$, $\eta^2_p =$

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.015, nor its interaction, $F(2, 179) = 0.98, p = .48, \eta^2_p = .010$, reached significance. The mean preference ratings by experimental conditions are summarized in Figure 2.

Mediation of Risk Perceptions

The estimated relative number of the unfavorable outcome in lottery A (0 Euro) was used as a proxy for participants' risk perceptions. These estimates were obtained for the two DFE lotteries, but not for the DFD lottery. Thus, the following analyses are limited to the former conditions. With regard to these estimates two outliers falling three standard deviations above the mean were identified and, thus, were removed. In both DFE conditions, the true relative frequency ($p = .90$) significantly exceeded the estimated relative frequencies of the outcome, as indicated by one-sample t -tests for DFE-R ($M = 0.87, SD = 0.08$), $t(56) = -3.40, p = .001$, and DFE-C ($M = 0.83, SD = 0.08$), $t(62) = -6.99, p < .001$. Thus, participants tended to underestimate the actual risk of the lottery in both conditions. Moreover, in line with hypothesis 1 computerized lotteries (DFE-C) were perceived as less risky than real ones (DFE-R), $t(118) = 2.61, p = .01, d = 0.47$.

It was hypothesized that the previously demonstrated difference in objective choices between computerized and real lotteries was a result of differences in risk perceptions. Evidence for the implied mediation effect (see Figure 3) would be at hand, if two conditions were satisfied (cf. Judd, Yzerbyt, & Muller, 2014): (a) The independent variable—the presentation mode of the lotteries (coded 0 for DFE-R and 1 for DFE-C)—had a significant effect on the mediator—the risk perceptions (a -path). (b) The mediator had a significant effect on the outcome (b -path)—the objective choice between the risky lottery A (coded as 1) versus the conservative lottery B (coded as 0). Moreover, the indirect effect ($a * b$) should be significant. Results from respective regression analyses supported these hypotheses: the presentation mode had a significant effect on risk perceptions, $B = -0.04, SE = 0.01, \beta = -.47, p = .01$, and, in turn, the latter significantly predicted participants' choices, $B = -5.17, SE =$

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2.59, $\beta = -.42$, $p = .046$. However, based on bias-corrected bootstrap confidence intervals (cf. MacKinnon, Lockwood, & Williams, 2004) the indirect effect was only marginally significant, $p < .10$.²

Discussion

The pervasive use of computer technologies in research projects gave rise to concerns whether results from these studies generalize to real-life scenarios (Noyes & Garland, 2008). These reservations were fueled by several empirical mode experiments that identified markedly different results in computerized and traditional study designs (e.g., Andersson et al., 2006; Drapeau et al., 2007; Mead & Drasgow, 1993; Steinmetz et al., 2010). In light of the predominance of computer-supported conduct in research on experience-based decision making (Barron & Erev, 2003; Hertwig, et al., 2004) the presented experiment explored whether risky choices are affected by the way experiences were gained. After either viewing the outcomes of two lotteries on screen or manually drawing balls from a box, participants had to decide between the risky and the conservative lottery. The results of the experiment lent support to two main conclusions. First, non-computerized drawings led to more conservative choices than drawings presented on a computer screen. The effect of the presentation mode on choice behavior was mediated by respective differences in risk perception. Thus, albeit the lotteries in both conditions presented outcomes with identical objective risks, computerized lotteries were perceived as less risky and, consequently, resulted in more risky choices. Second, the type of payoff used in the choice experiment had a profound impact on participants' choice behaviors. Drawings associated with real money led to more conservative choices than drawings labeled as generic points. This highlights that artificial experiments using abstract compensations (e.g., credit points) observe significantly

² Because real lotteries took significantly, $t(118) = 8.84$, $p < .001$, $d = 1.60$, longer ($M = 16.18$ minutes, $SD = 3.66$) than computerized lotteries ($M = 11.02$ minutes, $SD = 2.69$), we also examined whether the longer

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more risk behavior than realistic scenarios where the personal consequences of one's choices are made salient. Finally, hypotheses with regard to the description-experience gap were not supported. Descriptive analyses hinted at different gaps for computerized and real conditions; however, these differences were not confirmed statistically. Overall, participants' behaviors were the more conservative the more realistic their experiences—in appearance and consequence. Further studies replicating our findings for different decision problems and payoff distributions are desirable in order to examine the generalizability of our findings. But taking our findings seriously the question arises as to which processes might account for presentation mode effects in experience-based decisions.

Potential Causes for the Mode Effect

One factor that has been shown to mediate decision making is the perceived risk of the presented options (Sitkin & Weingart, 1995). Accordingly in the present study risk perceptions varied significantly between both DFE conditions. Participants in the computerized sampling condition underestimated the frequency of the unfavorable outcome (i.e. 0 Euros in lottery A) more strongly than participants in the non-computerized sampling condition. Hence, participants in the DFE-C condition perceived a lower risk which in turn led—by trend—to different choices. But even if risk perceptions mediated the mode effect, the reason for these differences remains unclear. Two factors might serve as potential explanations: quantitative and qualitative differences between the two experience-based conditions.

Comparing the frequency judgments of the lottery outcomes with the objectively true values, participants in the DFE-R condition were closer to the truth than those in the DFE-C condition. According to Hasher and Zacks (1979, 1984) influential model of frequency

information processing time might mediate the mode effect on risky choices. However, the processing time had no significant effect on choice behavior, $B = -0.05$, $SE = 0.07$, $\beta = -.21$, $p = .42$.

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processing, frequencies of events are presumed to be encoded directly online. Although they revised their earlier account with regard to the automaticity of that recording and later acknowledged that attention to the events in question is crucial (Zacks & Hasher, 2002), the fundamental idea is nevertheless, that participants should be fairly accurate in their frequency judgments as long as attention is ensured (see also Cosmides & Tooby, 1996; Gigerenzer & Hoffrage, 1995). The presented experiment tried to secure all participants' attention by having them read out aloud the outcome of each drawing (and this was controlled by the experimenter). However, there is evidence that information presented on screen is processed differently. For example, people provide less cognitive resources such as attention or concentration when reading on screen than on paper (Liu, 2005; Morineau, Blanche, Tobin, & Guéguen, 2005). As a result risky decisions are less likely to be based on the objective information presented on screen, but rather are influenced by a general positivity bias in self-appraisals (Robins & Beer, 2001) which contributes to the previously documented overconfidence effect in computerized learning (Ackerman & Goldsmith, 2011; Ackerman & Lauterman, 2012). Thus, in the present study the non-computerized conditions might have resulted in deeper information processing and more realistic risk assessments of the presented lotteries.

The two DFE conditions also differed qualitatively. Non-computerized sampling provided a richer sensory experience since it included haptic information. Some authors (Mangen, Walgermo, & Brønnick, 2013) speculated that additional haptic and tactile cues may explain the superiority of paper versus screen in reading comprehension. Cotte and Latour (2009) also identified the lack of haptic stimulation as one essential difference between electronic and real gambling that was important to gamblers. Similar effects have been reported for the evaluation of products in consumer research (Peck & Childers, 2003). Last but not least, numerical cognition has been empirically linked to embodiment. Number

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magnitude, for instance, has been shown to benefit from sensori-motor spatial movements (Fischer, Moeller, Bietzle, Cress, & Nuerk, 2011). Although we are not aware of any studies on frequency estimations, it is reasonable to assume that such numerical cognition might likewise benefit from accompanying spatial movements. Finally, in the realm of memory research it has been suggested and empirically supported that information retrieval is facilitated, if the same information is presented in different formats (e.g., word and picture; Kazén & Solís-Macías, 1999). Thus, the additional haptic information provided in real lotteries could have fostered information retrieval and resulted in more accurate risk perceptions that, consequently, determined choice behavior.

Consequences for the Description-Experience Gap

So far, research on experience-based decision-making has exclusively relied on experiences gathered on screen. However, the presented results clearly did not point to comparable decisions for computer-supported and non-computerized experiences. Thus, it was expected that the presentation mode might contribute to the description-experience gap identified previously (e.g., Fantino & Navarro, 2012; Glöckner et al, 2012; Hertwig & Erev, 2009). However, the present study was unable to statistically confirm the respective gap. Descriptive analyses (see Figure 1) even pointed to contradictory results: whereas draws from real lotteries resulted in less risky choices than DFD (thus, replicating the previously reported effect), computerized lotteries led to more risky choices than DFD (thus, indicating an opposite effect). Looking at other studies highlights that results for the description-experience gap are generally all but straightforward. Whereas some experiments replicated the original pattern (e.g., Camilleri & Newell, 2011, Exp. 1; Ungemach et al., 2009, Exp. 1), others did not find any significant difference at all (Ungemach et al., 2009; Exp. 2) or even reported a similar reversed pattern as obtained in this study (Camilleri & Newell, 2011, Exp. 2). Moreover, all studies differed with respect to various aspects such as whether participants'

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choices were consequential (i.e., contributed to their compensation), whether sampling error was controlled for, or how sampling was realized (i.e., whether participants were able to choose from the different lotteries themselves). Hence, the results of these studies are difficult to compare and, thus, definite conclusions as to what triggers the description-experience gap cannot be readily drawn. All these aspects were held constant in the DFE conditions of the presented experiment and, therefore, cannot account for the observed differences. Despite the comparable conditions, our results were also unable to shed light on the description-experience gap; computerized sampling-procedures offered no viable explanation. Rather, our findings align with others that found a reversed description-experience gap (Camilleri & Newell, 2011, Exp. 2) and, thus, clearly call for more research in order to clarify the conditions under which the description-experience gap occurs.

In sum, the presented study identified marked administration mode effects for decisions from experience. This paper is the first to document such administration effects since previous study were mostly limited to computerized stimulus presentation. More importantly, our findings suggest that computerized environments do make a difference with regard to decision-making as they lead to decreased perceptions of risk and more frequent choices of the risky option. Our findings therefore question the generalizability of previous DFE research with regard to decisions that are made outside computerized environments.

Limitations

Some constraints might limit the generalizability of the presented findings. First, differences in involvement across experimental conditions were not controlled for. Although high levels of involvement were intended to be induced for all participants by making their choices consequential in that they added to their final compensation, differences between both DFE conditions cannot be precluded. Thus, non-negligible differences in involvement that has been show to affect decision making (e.g., Kelton et al., 2010; Lurie & Mason, 2007)

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could have confounded the presented results. Second, the results for participants' choices and preferences were not readily comparable because the ratings were not consequential.

Participants first provided their choices and knew that this decision would affect their compensation. The subsequent preference rating, instead, was introduced as a more fine-grained measure to assess their preference for the respective options, but did not contribute to their monetary payoff. Thus, the observed discrepancies between objective choice behavior and subjective preference ratings might be attributed to differences in the practical relevance for the participants. Finally, the study was limited to differences in risk perceptions as one potential factor contributing to the observed mode effect. Future studies are encouraged to include additional measures or manipulations, which allow for more fine grained insights into the underlying processes guiding the effect of the presentation mode on risky choice behavior.

Conclusion

Although computer technologies greatly facilitate many research processes, in some instances they also yield an undesirable impact on study results. The presented experiment demonstrated a respective distortion in the realm of risky choice. Computerized presentation of lotteries that are commonly used in decision making research led to markedly stronger risk behavior than was observed after conducting realistic lotteries without computers. Moreover, drawings that were associated with monetary payoffs resulted in more conservative choices than comparable drawings using abstract points. In conclusion, more realistic experimental designs—that is, using real lotteries with monetary payoffs—observed more conservative choice behaviors.

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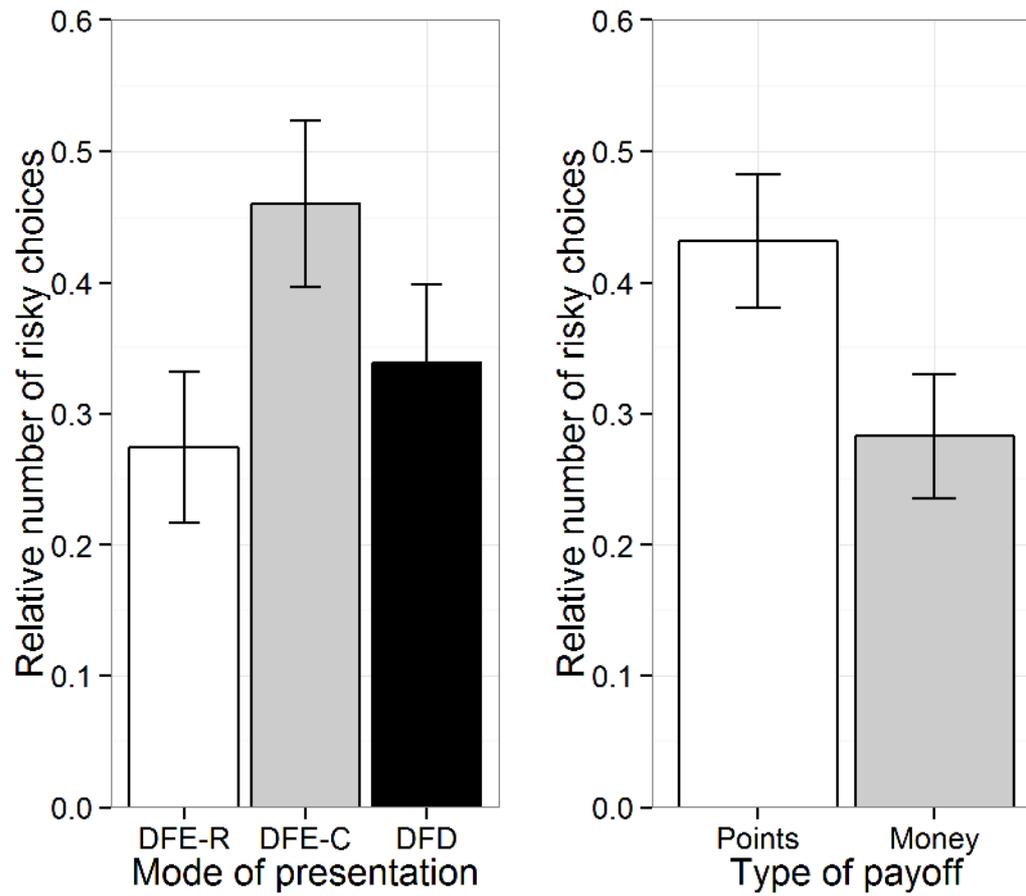


Figure 1. Relative number of risky choices (with standard errors) by experimental conditions.

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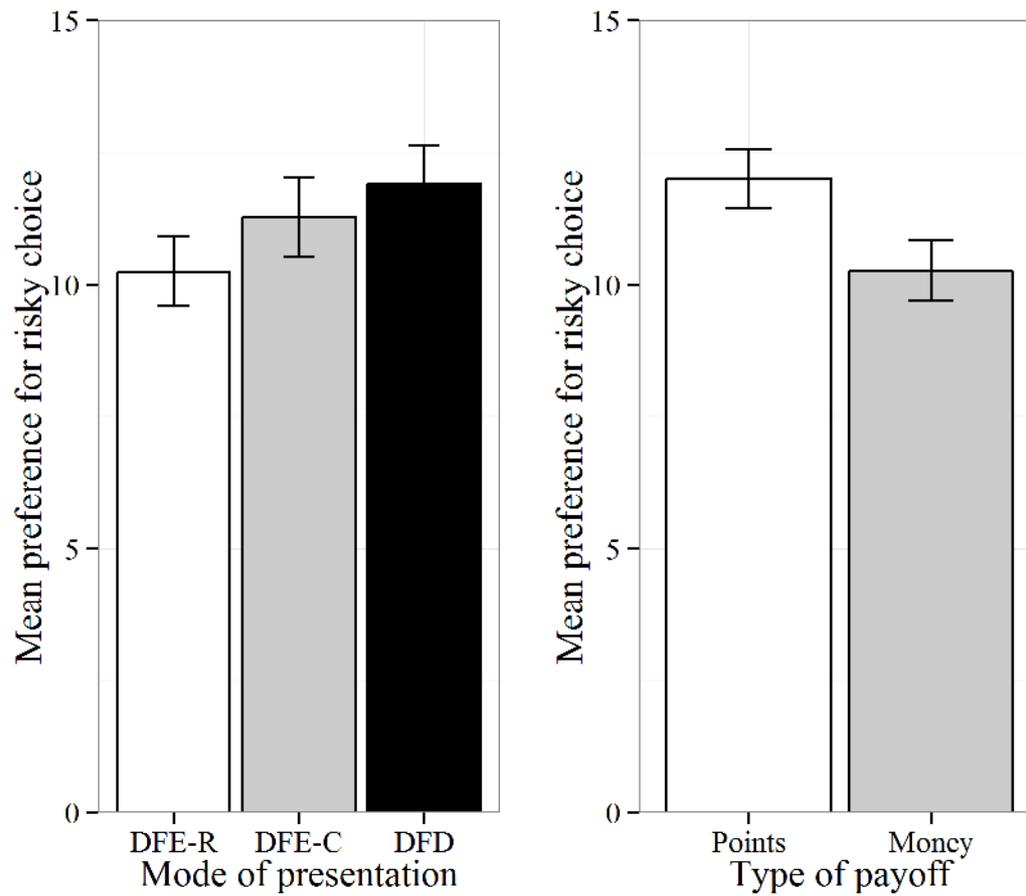


Figure 2. Mean preference for risky choice (with standard errors) by experimental condition

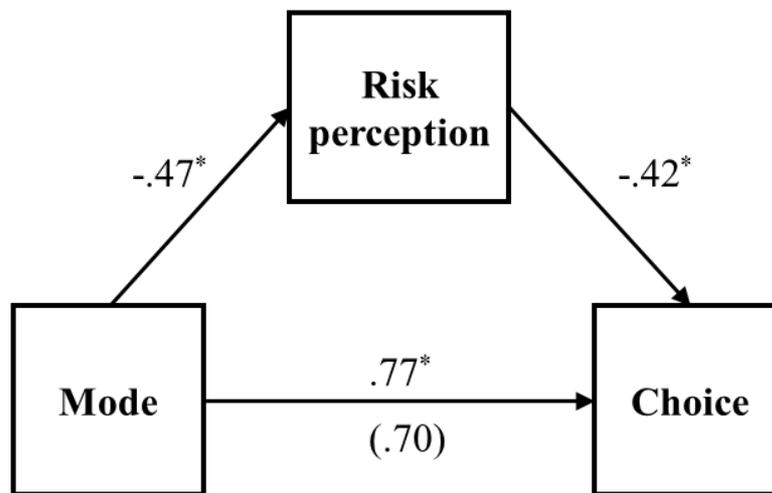


Figure 3. Effect of presentation mode (DFD-R versus DFD-C) on objective choices (conservative versus risky) mediated by risk perceptions