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Gender differences in preference for reward frequency versus reward magnitude in decision-making under uncertainty

Astin C. Cornwall, Kaileigh A. Byrne, Darrell A. Worthy*

Texas A&M University, United States of America

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ABSTRACT

Extensive research has focused on gender differences in intertemporal choices made from *description* in which participants must choose from multiple options that are specified without ambiguity. However, there has been limited work examining gender differences in intertemporal choices made from *experience* in which the possible payoffs among choice alternatives are not initially known and can only be gained from experience. Other work suggests that females attend more to reward *frequency*, whereas males attend more to reward *magnitude*. However, the tasks used in this research have been complex and did not examine intertemporal decision-making. To specifically test whether females are more sensitive to reward frequency and males are more sensitive to reward magnitude on intertemporal decisions made from experience, we designed a simple choice task in which participants pressed a response button at a time of their own choosing on each of many trials. Faster responses led to smaller, but more frequent rewards, whereas slower responses led to larger, but less frequently given rewards. As predicted, females tended to respond quicker for more certain, smaller rewards than males, supporting our prediction that women attend more to reward frequency whereas men attend more to reward magnitude.

1. Introduction

Decision-making is a complex process that is often surrounded by varying levels of risk and uncertainty. Given the significance of decision-making and the far-reaching consequences decisions can have, it is critical to understand how people make decisions and how individual difference factors affect decision-making strategies. Considerable work has focused on gender differences in risk-taking and description-based intertemporal decision-making (e.g., Eckel & Grossman, 2008; Jianakoplos & Bernasek, 1998; Overman, 2004; Reavis & Overman, 2001; van den Bos, Homberg, & de Visser, 2013; Weafer & de Wit, 2014). Recent work also suggests that males may focus more on reward *magnitude*, or on seeking options with the highest possible payoffs (Byrne & Worthy, 2016). In contrast, females tend to focus more on reward *frequency*, or on seeking options that provide smaller, but more consistent rewards. However, there has been limited work aimed at identifying how gender differences may influence experience-based intertemporal decisions. Thus, the purpose of this study is to assess whether females are more sensitive to reward frequency and males are more sensitive to reward magnitude on a novel experience-based intertemporal decision-making paradigm.

One broad way to dichotomize decision-making situations is whether they involve making decisions from description or experience (Hertwig, Barron, Weber, & Erev, 2004; Johnson & Busemeyer, 2010). In decision-making from description, the risks and rewards associated with each option are provided before the individual must make a choice. For example, people might choose between an insurance policy that is very cheap, but has a high deductible of several thousand dollars, versus a policy that is more expensive, but has a lower deductible. The key point is that the relevant information needed to make the decision is explicitly described rather than learned. Conversely, in decision-making from experience, the risks and rewards associated with each option are unknown, and the individual must learn from experience which alternative is best. For example, two new restaurants open up nearby and residents must try them out and learn from experience which one has the better food and atmosphere.

There is now extensive evidence that males are more risk seeking than females when making decisions from description (e.g., Croson & Gneezy, 2009; Eckel & Grossman, 2008; Jianakoplos & Bernasek, 1998; Powell & Ansic, 1997). In the example above, males would be more likely to prefer the insurance policy that has a low premium, but a high deductible if an accident happens. Females would more likely prefer the higher premium in order to avoid the risk having to pay a high deductible. Increased risk taking has also been found in one decision from

* Corresponding author at: Department of Psychology, Institute for Neuroscience, Texas A&M University, 4235 TAMU, College Station, TX 77845. United States of America.
E-mail address: worthyda@tamu.edu (D.A. Worthy).

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experience task, the Balloon Analog Risk Task (BART; Cross, Copping, & Campbell, 2011). These findings suggest that compared to females, males are more willing to tolerate increasing levels of risk in order to pursue a large magnitude reward (Cross et al., 2011).

In addition to differences in risk sensitivity, recent work examining decision-making from experience suggests that males exhibit greater sensitivity to reward magnitude than females, while females demonstrate more sensitivity to reward frequency (Byrne & Worthy, 2016; van den Bos et al., 2013). Other work from intertemporal choice, or delay discounting, tasks which assess preference for immediate versus delayed rewards suggests that greater reward sensitivity in males may account for steeper discounting for real rewards (Weafer & de Wit, 2014). A recent review suggests that gender differences in intertemporal choice may critically depend on task demands (Weafer & de Wit, 2014). In particular, females discount future rewards more steeply than males in delay discounting tasks where the rewards are hypothetical (Beck & Triplett, 2009; Smith & Hantula, 2008). In contrast, when a real monetary bonus is offered, males discount more than females (Kirby & Maraković, 1995, 1996). This conclusion is consistent with other work showing that males have a tendency to maximize future rewards, while females are biased toward optimizing immediate rewards (Byrne & Worthy, 2015). Thus, males' enhanced risk-taking tendencies may be attributed to increased reward motivation for large rewards.

Perhaps one of the most widely used paradigms to assess gender differences in decision-making is the Iowa Gambling Task (IGT) in which individuals must learn the immediate and long-term payoffs of their choices by exploring different options (Bechara, Damasio, & Damasio, 2000). Several studies have demonstrated that males typically select options that yield larger long-term rewards on the IGT compared to females (Byrne & Worthy, 2016; Overman, 2004; Overman, Boettcher, Watterson, & Walsh, 2011; Reavis & Overman, 2001; van den Bos et al., 2013). Similar findings have also been found on the Soochow Gambling task, a variant of the IGT where the optimal options provide small losses on 80% of trials, but large gains on 20% of trials, leading to net positive long-term values. In contrast, the inferior options are appealing because they provide small gains on 80% of trials, but large losses on the remaining 20% of trials, leading to net negative long-term values (SGT; Chiu et al., 2008; Byrne & Worthy, 2016). In addition to overall performance differences in gambling tasks like the IGT and SGT, computational modeling findings demonstrate that males and females differ substantially in their decision-making strategies. In particular, females focus on the frequency of gains and losses, preferring options with frequent gains that provide the smallest variability between gains and losses. In contrast, males tend to place more weight on options with high expected values and large long-term gains, rather than reward frequency (Byrne & Worthy, 2016).

While this work from the IGT and SGT is consistent with the hypothesis that males are more sensitive to reward magnitude and females are more sensitive to reward frequency, it is important to note that these gambling tasks are complex and involve factors besides reward frequency and magnitude. In particular, gender differences in these tasks could be attributed to sensitivity to gains versus losses rather than sensitivity to reward frequency or magnitude. The task also involves learning the rewards associated with four different options, and participants must also learn which options are objectively better than the others. Thus, there is more to the task than simply learning which actions lead to more frequent rewards and which lead to rewards larger in magnitude, and these factors could have contributed to the observed gender differences.

In the present work, we sought to test whether gender differences in sensitivity to reward frequency and magnitude exist in a simpler intertemporal choice task, directly designed for such a purpose. To this end, we designed the Experience-Based Probabilistic Intertemporal Choice (EPIC) to measure preferences for more frequent rewards versus less frequent rewards that are larger in magnitude. On each trial of the EPIC task, participants were asked to press a button that then dispensed between 10 and 100 points. The magnitude and probability of receiving a reward (i.e. more than zero points) were determined by how long the participant waited to make a response. If participants responded faster, they had a high probability of receiving a low-magnitude reward. Thus, faster decision timing minimizes the risk of not receiving a reward at all, and should be more appealing to females if they have a stronger preference than males for frequently receiving rewards. In contrast, a slower decision time led to a low probability of receiving a large-magnitude reward, thereby increasing the uncertainty of receiving a reward, but increasing the magnitude of the reward that could be received. This inverse relationship between reward probability and magnitude as a function of decision timing serves two distinct purposes. First, this design keeps expected values for all decisions constant, which eliminates the potential confound that participants are basing decisions on expected value information, rather than sensitivity to reward frequency versus magnitude. Thus, differences in performance cannot be attributed to differences in the ability to learn which option has a higher objective value. Secondly, this task involves only gains, and no losses, thereby ruling out sensitivity to gains versus losses as a possible cause for differences in behavior.

Because the EPIC task involves an intertemporal component, we also had participants complete the delay discounting questionnaire (DDQ; Richards, Zhang, Mitchell, & de Wit, 1999; Worthy, Byrne, & Fields, 2014). The EPIC task requires each participant to determine their preferred delay, and thus level of uncertainty, in being rewarded based on experience gained throughout the task. In contrast, the DDQ assesses each participants' preferred length of rewards delay from discrete, and descriptive, choices. While the DDQ does not involve decision-making from experience because the reward amount, length of delay, and outcomes of the choices are known, both the DDQ and EPIC tasks gauge how decision-makers discount rewards as a function of the delay in receipt.

Given the previous work showing that males prefer decisions that maximize large, long-term rewards (Byrne & Worthy, 2015, 2016), we predicted that males would exhibit a slower average decision time than females on the EPIC task compared to females. Such a finding would support our assertion that males are biased toward alternatives that offer the highest possible rewards, while females are less concerned with reward magnitude and instead prefer options that provide consistent, albeit small, rewards.

2. Method

We conducted two experiments; Experiment 2 was a gender-controlled replication of Experiment 1 to ensure that the gender effects initially found were not due to unequal sample sizes. This is important as replicability and reproducibility have recently emerged as important goals in psychological science (Zwaan, Etz, Lucas, & Donnellan, in press). Replicating the study allows for increased confidence that the results are reliable and replicable. It also allows us to combine the data and analyze them together, which increases our statistical power. To ease our exposition, we present the Methods and Results of both experiments simultaneously.

2.1. Participants

In the present studies, we used data from the undergraduate student population at a large university. Partial course completion credit was given in exchange for study participation in both experiments. Overall, there were 99 total participants: 49 participants in Experiment 1 (M_{age} = 18.86; *SD* = 1.95; 33 females) and 50 in the gender-controlled Experiment 2 (M_{age} = 18.46; *SD* = 0.79; 25 females).