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Study Information

1. Title (required)
   Pause for thought: Effects of pauses in play on risky decision-making

2. Authors (required)
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3. Description (optional)
   In two previous experiments (Exp 1, N = 47 and Exp 2, N = 55; not pre-registered), we observed that participants became more sensitive to EV ratios in their risky decisions after taking a pause of 3 seconds compared to no pause. However, in a pre-registered experiment (Exp 3, N = 100), we failed to replicate this effect. Experiment 3 differed from Experiments 1 and 2 in several aspects (a. In Experiment 3 we used a long pause of 3000 ms and a short pause of 300 ms, while in Experiments 1 and 2 we used a long pause of 3000 ms versus no pause; b. In Experiment 3, we distributed the catch trials in both the long and short pause conditions, while in Experiments 1 and 2, the catch trials were all in the no-pause condition. c. The catch trials in Experiment 3 included some 0-outcome options, see following). One difference is that some options in the catch trials in Experiment 3 included a 0 outcome (e.g. one option offered a 60% chance of winning 0 cents and a 40% chance of getting nothing, which is equivalent to 100% chance of getting 0 cents). Such 0-outcome options may have increased participants' overall attention to the task, especially to the amount information. As a result, participants in Experiment 3 were overall much more sensitive to the expected values in their choices, leaving little room for pauses to exert any influence. Experiment 4 aims to test this idea, by using the same procedure from Experiment 3 (i.e., with the changes a and b as mentioned above), but with the catch trials from Experiment 2 that do not include such 0-outcome options.

4. Hypotheses (required)

   We expect to replicate the result of Experiment 2. In other words, we expect the EV ratio * pause interaction effect on choices to be statistically reliable, such that participants will become more sensitive to EV ratios after a long compared to a short pause.

Design Plan

5. Study type (required)
   Experiment

6. Blinding (required)
   No blinding is involved in this study. We will use a within-subject design. Participants will experience all experimental conditions.

7. Is there any additional blinding in this study?
   No.

8. Study design (required)
   Participants will alternate between two games, a guess game in which they need to guess the eventual color of a blue-yellow wheel, and a choice game in which they need to choose which option to play with (i.e., the Vancouver Gambling task). We will use a 2 (outcome of a guess game, win vs. loss) by 2 (pause, 300 vs. 3000 ms) within-subject design. The 10 trials from the Vancouver Gambling task will be presented in each cell twice (to counterbalance the left vs. right position of the high-probability option), resulting in 80 experimental pairs.

   Six catch trials will be presented once in each cell, resulting in 24 catch pairs. The left vs. right position of the high-probability option in the catch pairs will be counterbalanced. The table below shows the catch trials that we are going to use. HP stands for the high-probability option, and LP stands for the low-probability option. Note that these catch trials are the same with the ones from Experiment 2.

HP Prob	HP Amount	HP EV	LP Prob	LP Amount	LP EV	Optimal
0.8	40	32	0.2	20	4	HP
0.7	30	21	0.3	10	3	HP
0.8	50	40	0.2	30	6	HP
0.6	10	6	0.5	50	25	LP
0.7	10	7	0.6	50	30	LP
0.8	10	8	0.7	50	35	LP

9. Randomization (optional)
   Not applicable. We will use a within-subject design.

Sampling Plan

10. Existing data (required)
    Registration prior to creation of data: As of the date of submission of this research plan for preregistration, the data have not yet been collected, created, or realized.

11. Explanation of existing data (optional)
    Not applicable.

12. Data collection procedures (required)
    Participants will be recruited from Prolific.co, with the following criteria: (1) between 18 and 55 years old; (2) having an approval rate of at least 85% on Prolific.co; (3) being fluent in English; and (4) having no issues seeing colors; (5) not having participated in the previous experiments in this project. Participants will be paid 3.75 British pounds for their time (estimated to be around 25 minutes; 9 pounds per hour), plus any extra bonus they may win from the task (between 0 and 1 British pound).

13. Sample size (required)
    We will recruit 130 participants, after potential exclusions (see Sections 22 and 23).

14. Sample size rationale (optional)
    Assuming the effect size observed in Experiment 2 was the true effect size, a power simulation showed that with 100 participants, we have around 83% power to detect the EV ratio * pause interaction effect on choices (see the power simulation in the pre-registration for Experiment 3 for more details). Experiment 3 therefore recruited 100 participants in the final sample. However, another 31 participants finished Experiment 3, but were excluded from further analyses. The majority of these participants (29) were excluded as they failed to pass the LP-optimal catch trials. In the current experiment, we do not plan to a priori exclude participants based on their performance on the LP-optimal catch trials (see below). We will therefore recruit 130 participants, comparable to the initial sample size in Experiment 3 (i.e., including the excluded participants). This sample size will also leave some room for exclusions, when we adopt different inclusion criteria for the performance on the LP-optimal catch trials in further exploratory analyses. That is, when adopting a similar inclusion criteria as in previous experiments, we expect to have around 100 participants left in the sample for exploratory analyses.

15. Stopping rule (optional)
Not applicable.

Variables

16. Manipulated variables (optional)
We will manipulate the outcome in a guess game (win vs. loss), and the duration of the pause between a guess game and a choice game (300 vs. 3000 milliseconds). Furthermore, for the experimental pairs we will use the 10 trials from the Vancouver Gambling task (the choice game). The EV ratios of the trials will also be used in the analysis of the choices.

17. Measured variables (required)
The main measured variables include: (1) how quickly participants start a choice game (start RT, in milliseconds); (2) whether participants choose the high-probability option or not in a choice game; and (3) how quickly participants pick an option in a choice game (choice RT, in milliseconds).

18. Indices (optional)
For each choice game, following previous work, we will compute an expected value ratio. More concretely, the expected value of each option will be computed as the win amount times the win probability. The EV ratio will then be:

EV ratio = (EV of the HP - EV of the LP)/[(EV of the HP + EV of the LP)/2]

HP stands for the high-probability option, and LP stands for the low-probability option.

Analysis Plan

19. Statistical models (required)
We will use Bayesian hierarchical models, with the brms package in R.

For the main analysis on choices in the VGT, we will use hierarchical logistic regressions, with the following coding of variables.

Choice = whether participants choose the HP option or not. Choose the HP = 1, choose the LP = 0.
Prev_outcome = outcome of the preceding guess game, loss = 0.5, win = -0.5.
Pause = the duration of the pause, long pause = 0.5, short pause = -0.5.

EV ratio = EV ratio of the two options, computed based on the equation in Section 18.

Pseudo-code for the brms model in R:

```
brm(Choice ~ Prev_outcome * Pause * EV ratio +
                (Prev_outcome * Pause * EV ratio | subject),
        family = bernoulli(link = "logit"),
        prior = c(prior(normal(0, 2), class = Intercept),
                  prior(normal(0, 1), class = b),
                  prior(normal(0, 1), class = sd),
                  prior(lkj(2), class = cor)
                  )
        )
```

For the models on reaction times (start RT and choice RT), we will use hierarchical linear regressions, with the following coding of variables.

log_RT = reaction time, using a logarithm transformation (see Section 20 below).
Prev_outcome = outcome of the preceding guess game, loss = 0.5, win = -0.5.
Pause = the duration of the pause, long pause = 0.5, short pause = -0.5.

Pseudo-code for the brms model in R:

```
brm(log_RT| trunc(ub = log(5001))  ~ Prev_outcome * Pause +
                (Prev_outcome * Pause | subject),
        family = student(),
        prior = c(
            prior(normal(6.5, 1.5), class = Intercept),
            prior(normal(0, 1), class = b),
            prior(normal(0, 1), class = sd),
            prior(normal(0, 1), class = sigma),
            prior(gamma(2, 0.1), class = nu),
            prior(lkj(2), class = cor)
           )
        )
```

20. Transformations (optional)

For the coding of categorical variables, see above. For both the start RT and choice RT, the same data exclusion and transformation will be used. First, RTs above 5000 milliseconds will be excluded. Next, we will add 1 millisecond to all observations. The reason for this adjustment is because in the previous experiment, we observed that on one trial the start RT was 0, which poses a problem for the model since log(0) is -infinity. We therefore add 1 to all observations to prevent this potential problem. Next, the natural

logarithm of the adjusted RT (original RT + 1) will be computed and used as the dependent variable in the model listed above.

21. Inference criteria (optional)

We will follow a parameter estimation approach, and report the point estimate and 95% credible interval for the posterior distribution of all parameters. As a decision rule, when the 95% CI does not include 0, we will infer the effect to be reliable.

22. Data exclusion (optional)

We will include 24 catch trials, 12 in which the HP option has a higher win amount than the LP option (i.e. HP-optimal trials), and 12 in which the LP option has a higher EV (i.e. LP-optimal trials). Participants will need to choose the HP option on >= 9 HP-optimal trials (75%) in order to be included in the analysis. Note that a priori, we do not have an exclusion criterion for participants' performance on the LP-optimal trials. Although the LP options have a much larger EV on the LP-optimal catch trials, participants may be so risk-averse that they may still choose the HP option. In further exploratory analyses (see below), we will adopt different cut-off values for the performance on these LP-optimal trials, to explore the stability of the effect in different subsets of participants.

Sometimes participants may restart the experiment. Any participants who restart the experiment during the experimental blocks will be excluded.

23. Missing data (optional)

Participants with more than 10% of trials missing in the experimental blocks (e.g., due to server issues or quitting the experiment early) will be excluded.

Note that all excluded participants (criteria in Sections 22 and 23 combined) will be replaced until we reach 130 participants in the sample.

24. Exploratory analysis (optional)

We will conduct several exploratory analyses. Note that although for some analyses we do have directional hypotheses, these tests are still exploratory in nature because the sample size may not provide sufficient power for between-experiment comparisons.

First, as noted above, we will adopt different cut-off values for the performance on the LP-optimal trials, and examine whether the effect remains stable in different subsets of participants.

Second, we will compare the current experiment with Experiment 3. We expect the participants in the current experiment to be overall less sensitive to EV ratios than those in Experiment 3, and the EV ratio * pause interaction effect to be stronger in the current experiment. In other words, pauses should modulate the effect of EV ratios more strongly in the current experiment.

Third, we will compare the current experiment with Experiment 2. We expect that the participants in both experiments will be similarly sensitive to EV ratios. Furthermore, the EV ratio * pause interaction effect will also be comparable between both experiments. In other words, pauses will increase participants' sensitivity towards EV ratio to a similar extent in both experiments.

Other

25. Other (Optional)

    None.