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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 a recent pre-registered experiment (N = 131), we observed a strong numerical trend that after a pause of 3000 milliseconds (compared to a short pause of 300 milliseconds), participants became more sensitive to EV ratios in their risky decisions. However, the 95% credible interval of the posterior distribution for the key EV ratio * pause interaction just includes 0, so strictly speaking we cannot declare the effect to be 'statistically reliable'. We decided to add another 50 participants, and explore whether the effect would remain stable and become 'statistically reliable' after the addition of new participants. This amendment aims to make this plan of additional sampling transparent. We will use the same exclusion and data analysis plans as in the previous experiment (for the sake of completeness, this preregistration repeats these plans from the previous preregistration).

4. Hypotheses (required)

   We expect that after adding 50 more participants, the EV ratio * pause interaction effect on choices will become statistically reliable (i.e., the estimate will be positive, and the 95% credible interval will exclude 0).

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)
Note that we will collect data from 50 participants. Data from these 50 participants will be added to the data from the 131 participants who already participated in the experiment, and those data have already been analyzed.

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 50 participants, after potential exclusions (see Sections 22 and 23). Data from these 50 participants will be added to the data from the 131 participants who already participated, resulting in 181 participants in total.

14. Sample size rationale (optional)

We did not conduct any formal ‘power analysis’ to determine the sample size. Rather, the sample size of 50 additional participants is based on “resource constraints” - namely, the amount of funding that we are willing to invest further in this experiment (Lakens, 2022). If the effect is still not statistically reliable after adding 50 more participants, the effect size is probably rather small. Instead of adding more participants to this experiment, we would then modify the experimental procedure to potentially increase the effect size in follow-up studies.

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. Note that in all analyses in the current pre-registration, we will combine data from the 131 participants who already participated, and data from the 50 participants that we are going to recruit.

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 50 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)

References

Lakens, D. (2022). Sample size justification. *Collabra: Psychology*, *8*(1), 33267.