Habits and automaticity (#219743)

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1) Have any data been collected for this study already?
No, no data have been collected for this study yet.

2) What's the main question being asked or hypothesis being tested in this study?
Habits, measured as insensitivity to outcome devaluation, and motor automaticity, are inversely related.

3) Describe the key dependent variable(s) specifying how they will be measured.
Number of action sequence completed toward a devalued stimulus (following outcome devaluation).
We will simply count the number across two test blocks that comes after an outcome devaluation manipulation.

4) How many and which conditions will participants be assigned to?
All participants will undergo the same procedure (no between-subject condition).
Our main task is a dual-task where a typical trial goes as follows:
1) Participants are presented with two gamble options.
2) They visit a planet where they can press a specific sequence of actions (keys) and find a gem in the color of the planet.
3) Participants need to quickly choose between the two gambles they were presented with before visiting the planet.
GAMBLES: The gambles are composed of 5 types: easy (expected value [EV] ratio [larger EV / smaller EV] > 2.34), medium (2.34 > EV ratio > 1.42), hard (1.42 > EV ratio > 1), EV ratio=1 gambles (can be thought of as the hardest; although given risk aversion it might often not be the case), and sanity check gambles (gambles where both sum and probability of one gamble are equal or larger than the other gamble, which means there is one clear better choice).
PLANETS (sequence pressing task): There are 3 different planets: red, blue and yellow. Yellow never yield a reward. Blue and red yield a blue/red gem (respectively) 50% of the times. After a substantial amount of training one of the gems is devalued (can no longer be exchanged for gold, which is worth real bonus money). This devalued gem type is counterbalanced across participants.

5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.
We will first quantify participants automaticity (independent variable) using the following steps:
1) We will calculate inter-press intervals (IPI) for each action sequence for each stimulus type (except the yellow one for which participants should not press the sequence). We will then calculate an automaticity score for each trial as the sum of the absolute differences between each interval and the same interval in the previous trial (as done by Banca et al., 2024).
2) We will smooth automaticity data using a 5-trial moving window.
3) We will then fit an exponential decay function to each participant's automaticity data (during training, i.e., before outcome devaluation) to model the development of motor automaticity throughout the task.
4) We will then extract the predicted automaticity at the end of training (i.e., the value of the fitted exponential decay curve on the last training trial).
In our main analysis, we will use this automaticity measure as the independent variable in a linear regression analysis, with the number of sequences completed toward the devalued outcome as the dependent measure.

6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.
We will exclude:
1) Participants who will press the gamble choice keys more than 50 times during the sequence action part (visiting a planet) in one block, and/or at least one gamble choice key press during the sequence action part in more than 50% trials of a block, and/or respond in less than 200ms when the gambles are presented for choice in more than 50% of the trials of a block, will be excluded. [reason: not really doing the dual-task; gambles are just randomly chosen]
2) Participants who overall have less than 60% of trials with sequence actions completed (in the red and blue planets) and/or less than 60% of trials where they made gamble choices. [reason: lack of engagement]
3) Participants who complete sequences toward the yellow planet in more than 40% of these trials. [reason: not fully understand the task, specifically, the idea that not responding could sometimes be the optimal behavior]

7) How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.
We will collect data from 300 participants.
We conducted power analyses based on previous data with different training durations. Taking those results into account, alongside practical considerations, we determined that this sample size will provide sufficient power to robustly detect the effects of interest.

8) Anything else you would like to pre-register? (e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)
Additional analyses in the context of automaticity:
We will test how outcome devaluation affects automaticity. We hypothesize that habitual responses will show less automaticity than non-habitual ones. This will be tested by comparing automaticity before and after outcome devaluation for devalued and still-valued stimuli. This will be tested using a mixed models linear regression with the trial automaticity score as the dependent variable, time (the block before vs. the two blocks after outcome devaluation) and stimulus type (devalued vs. still-valued) as independent variables with a random intercept for participants. We will use the following formula in lmer syntax: trial automaticity ~ time * stim_condition + (1| participant).

To focus on the immediate change following outcome devaluation, we will also take a modeling approach based on the one used for training, expanding it to include a potential change after outcome devaluation.
decay(t)=asymp+improvement*e^(-rate*t) [Decay function to model training trajectory]
switch(t)=1/(1+e^(−transition_steepness*(t−t_{devaluation}))) [Switch function (transition point around devaluation)]
growth(t)=asymp+change*switch(t) [Growth function (post-devaluation change)]
Automaticity(t)=(1−switch(t))*decay(t)+switch(t)*growth(t) [Automaticity over time]
Actual change=change−(Automaticity at t_{devaluation} - asymp) [This is what we are interested in]
This time we will run this on each stimulus separately to capture the difference between them.
We will then use a mixed-models linear regression specified as follows:
actual_jump ~ stim_condition + (1| participant)

Other notes:
- All hypotheses and analyses in this pre-registration are based on a previous sample of approximately 200 participants, divided into short and extensive training groups. In this version, we will run a single group with intermediate training duration.
- In this version, as opposed to the one we already collected, we also added a third block after outcome devaluation where the time to press the action sequence is much shorter. This will not be considered for the analyses mentioned here.