Human Inference of Elasticity of Control (#133857)

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Author(s)
Levi Solomyak (Hebrew University of Jerusalem) - levi.solomyak@mail.huji.ac.il
Aviv Emanuel (Hebrew University of Jerusalem) - avivemanuel@mail.tau.ac.il
Eran Eldar (Hebrew University of Jerusalem) - eran.eldar@mail.huji.ac.il

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?
The amount of control we possess over our surroundings often depends on the resources we are capable or willing to invest. In such environments, controllability is not fixed. Rather, it is elastic to invested resources. We hypothesize that people estimate the elasticity of control in their present environment, and we offer a computational model that captures how they may do so.

3) Describe the key dependent variable(s) specifying how they will be measured.
The full task description is available at https://github.com/lsolomyak/human_inference_of_elastic_control/blob/master/task_description.docx.
We designed a novel task in which participants play a treasure-hunt game, where they can attempt to travel from an initial location ('desert' or 'fountain') to a treasure (located in either the 'desert' or the 'mountain') by taking one of two actions: boarding the train or the plane each of which travels to a distinct destination. If participants fail to board their selected vehicle they walk to the nearest location. Participants can choose whether to purchase a single ticket or to invest additional resources (up to two additional tickets and a cognitive task) to board their vehicle of choice. Overall controllability is instantiated as the probability of boarding the vehicle, whereas elasticity is instantiated as the degree to which additional resources affects the likelihood of successfully boarding the participant's preferred transport.

The dependent variables are:
1) In the second half of each block (15 trials), whether subjects purchase any number of tickets in a given trial (opt-in; coded as 1, opt- out coded as 0).

2) In the second half of each block, whether subjects invest additional resources in a given trial (extra actions; 2nd and 3rd tickets; coded as 1 for two tickets, and 2 for three tickets) or not (coded as 0).

4) How many and which conditions will participants be assigned to?
Each participant will be assigned to three conditions of varying levels of elastic and inelastic control such that investing minimal resources (i.e., one ticket), investing maximal resources (i.e., three tickets), and not investing any resources are each optimal once. Furthermore, all participants will complete an initial block where no strategy is distinctly optimal (ambiguous block).

5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.
We will test two mixed regression models with participants as a random factor, and a fully specified random effects structure:
- A logistic mixed model that predicts participants' opt-in choices in the second half of each block based on elastic (β_elastic) and inelastic (β_inelastic) control. We predict that both β_elastic and β_inelastic will be significantly above 0 ($p < .05$).

- A mixed ordered probit model that predicts how many extra tickets participants purchase in the second half of each block. We predict a significant positive coefficient for β_elastic ($p<.05$).

To capture the process of learning the elasticity of control, we designed a model that explains subjects' choices of how many tickets to buy using latent beliefs about the presence of control and its degree of elasticity (elastic vs. inelastic environments) using three beta distributions, each defined by two parameters (a_control ,b_control, a_more, b_more, a_full, b_full) which accumulate the overall number of times participants successfully boarded (a_control) and did not board (b_control) their vehicle when purchasing any number of tickets, evidence as to whether successful boarding does (a_more) or does not (b_more) require additional resources (i.e. is one ticket enough) and as to whether full (a_full; three tickets) or partial (b_full; two tickets) additional investment of resources is necessary (elasticity model ;see details at https://github.com/lsolomyak/human_inference_of_elastic_control/blob/master/model_specification.docx). We will compare it to a model that learns the expected level of success given different degrees of invested resources without a latent representation of elasticity (standard controllability model). We predict that the elasticity model will outperform the standard controllability model in predicting subjects' choices.

6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.
The following participants will be excluded:
- Participants who make more than 8 mistakes on quizzes during the instruction phase
- Participants who display less than 90% accuracy in selecting the correct vehicle corresponding to its pre-learned destination.

- Participants who choose not to purchase any tickets in 90% of trials across all experimental conditions.

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 264 valid participants. We derived this sample size using a power analysis aiming to estimate with high accuracy (credible interval width < 0.1) the likelihood that participants opt-in for any combination of elastic and inelastic control (66 total combinations). We followed Kruschke's (2014) procedure for Bayesian Power Analysis. Based on pilot data (n=19), we fitted a Bayesian Beta Binomial model to the proportion of opt-ins in the ambiguous condition (a particular combination of elastic and inelastic control where behavior across subjects is expected to be most variable), and found that 12 participants were required for the credible interval of the binomial proportion parameter to be lower than 0.1. Since each participant completes 3 combinations of elastic and inelastic control, we multiplied the required sample size by 22 which results in an estimate of n=264.

To examine whether this sample size is sufficient to detect significant effects via the regression models (analyses 1, 2), we used a bootstrap procedure whereby we sampled 264 participants from the pilot data and ran the regression analyses on them. We repeated this procedure for 50 iterations, each time recording $\beta_{elastic}$, $\beta_{inelastic}$, and their p-values. For analysis 1, we found that both $\beta_{elastic}$ and $\beta_{inelastic}$ were significantly above 0 in all iterations (95 % CI= [92,100]), and for analysis 2, $\beta_{elastic}$ was significantly above 0 in all iterations (95 % CI= [92, 100]), thereby giving us >98% power to detect all of our effects of interest. Confidence intervals were derived from a binomial test in which a positive significant coefficient counted as a success.

8) Anything else you would like to pre-register? (e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)

No