The selective action of cfunc control

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Preregistration

Author note

Background

The conceptual background for this experiment can be found in the preregistration document for experiment 1 (https://osf.io/zv5r6/). Further context for this experiment by the preliminary report of the results from that experiment. Briefly, 22 participants completed Cfunc training and testing in experiment 1 and 10 of these had response accuracies ≥ 83% (50/60) at test. This also means that 12 of the 22 participants did not respond with high level of accuracy at test. In experiment 2 some alterations will be made to the procedure of experiment 1. These adjustments are designed to increase the proportion of participants achieving a test accuracy of 83% or greater.

Alterations

1. In experiment 1, the procedures for establishing and testing Crel stimuli took different formats. Experiment 2 will employ the same Crel training and testing format, which has previously shown to be successful (https://osf.io/w2n9g/). The training and testing format will present a Crel stimulus before a screen displaying three circles, a sample circle and two comparison circles, only one of which is the same color as the sample circle.

2. The second adjustment will be to the Cfunc training procedure. In experiment 1 Cfuncs for speed and direction were established separately. In these phases the property of the race cars that was not being trained was held constant (e.g., when training speed both race cars went in the same direction). On the selection screen during these phases Crel and Cfunc stimuli that specified how the race cars' performances compared with the sample race car's performance along dimensions of speed and direction. So, although only one dimension and therefore one Crel and Cfunc pair was relevant to selecting the appropriate race car, two Crel and Cfunc pairs were presented on these screens. The second Crel and Cfunc pair provided information irrelevant to training the Cfunc that was the target of the procedure. In experiment 2 the irrelevant Crel and Cfunc pair has been removed, and only the relevant Crel and Cfunc pair will be presented during these phases.

3. Between training phases for each Cfunc, an instruction alerting participants to the change in phase has been inserted. This instruction reads "Phase complete! You are about to begin the next phase."

4. The maximum length of the training phases has been reduced from 5 x 30 trial blocks, to 3 x 30 trial blocks. This apples to Crel training, Cfunc for speed, Cfunc for direction, and mixed Cfunc training phases.

Method

Sample

Data collection will be conducted online via Prolific Academic. Participants will be paid at a rate of £7.50 per hour.

Planned sample size & stopping rules

Data collection will stop when 20 participants who have passed Crel training (i.e., accuracy ≤ 20/30) have been exposed to all Cfunc training and testing.

Inclusion criteria. English as a first language, between the ages of 18-65, 90% approval rating for previous studies on Prolific, no previous participation in similar studies from our research group.

Exclusion criteria. Incomplete data, responding "yes, exclude my data" on the self-exclusion question, failing to provide correct responses after 3 blocks of the Crel training phase, or failing the Crel test (i.e., accuracy ≤ 20/30).

IVs.

1. Crels: ■ = same, ▼ = different vs ▼ = same, ■ = different

2. Cfuncs: ✦ = speed, ◗ = direction vs ◗ = speed, ✦ = direction

DVs.

1. Response accuracy

2. Response time

Procedure

The procedure is designed to establish Crel and Cfunc properties for stimuli and assess their efficacy in specifying derived transformations of stimulus functions. The procedure can be decomposed into five phases: i) establishing Crels for the relations of

same and different; ii) testing Crels for the relations of same and different; iii) establishing selective action of Cfuncs for speed and direction on transformations of functions via relations of same and different; iv) testing the selective action of Crels and Cfuncs established in the previous phase; v) testing for the generalization of the experimentally established Crels and Cfuncs.

Phases 1 and 2: establishing and testing Crels. A delayed MTS procedure used in a previous study (https://osf.io/w2n9g/) will be employed to establish the symbols ■ and ▼ as Crels for the relations of same and different. Participants will receive the instruction "Select the appropriately colored circle". At the beginning of each trail a Crel will be presented for 1000ms. After an SOI of 300ms, an arrangement of three circles of equal size, two of which will be the same color, that will serve as sample and comparison stimuli (e.g., a red circle at the top of the screen, a red circle at the bottom left, and a green circle at the bottom right). They will then select a comparison stimulus for each Crel (e.g., selecting the circle that is the same color as the circle at the top of the screen after seeing the Crel for same). The locations of the stimuli will be counterbalanced across trials. Selections for the left and right comparisons will be made with the 'E' and 'I' keys. Immediately after correct selections the message "Correct!" will appear in green text at the center of the screen for 500ms. The message "Wrong!" will appear in red text in the same location for 1000ms after incorrect responses. The MTS will present up to three thirty trial blocks, and will terminate early if participants achieve an accuracy score $\geq 17/20$ across the previous 20 trials in a block. The established Crel properties will be tested in one 30 trial block presenting different colored circles and without response feedback.

Phases 3, 4 and 5: establishing and testing Cfuncs. Phases three, four and five present a series of trials in which both the speed and direction of racecar stimuli are relevant. There is a generic format common to these phases. Each trial consists of two parts, a sample racecar screen which is followed by the race screen. The layout of these components is shown in Figure 1. The sample racecar screen presents a sample racecar in the center of the screen, and allows participants to see how it performs (i.e., whether

it moves to the left or right, and does so quickly or slowly). Selection boxes are presented beneath the sample racecar. Each selection box displays the sample racecar on the left, a racecar on the right, as well as up to two Crels and two Cfuncs between the racecars. The selection boxes specify via the Crels and Cfuncs how each racecar will perform compared to the sample racecar. Within each selection box the Crels will always be located to the left of the Cfuncs, but the Cfuncs for speed and direction will be presented in the upper and lower positions within each selection box an approximately even number of times across trials. This sample racecar screen also presents a white start line, and a checkered finish line. The white start line remains in a fixed location at the center of the screen. The finish line is presented at the same location on both screens within a trial, but will appear at the left and right of the screen an approximately equal number of times across trials. This manipulation ensures that the direction of the racecars is relevant to selecting the winning racecar. This part of the study begins with a brief walkthrough that orients participants to these elements.
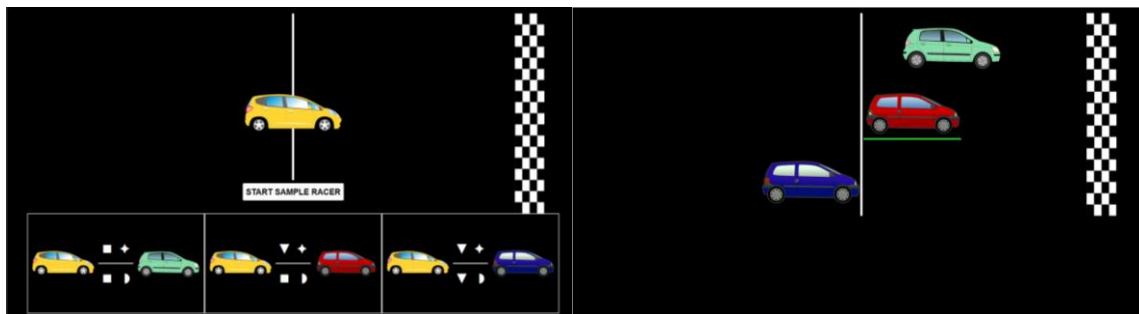

Figure 1. Screenshots of the sample racecar screen (left), and an screen shot of race from the race screen (right) from the Cfunc training task that employed in phases 3 and 4 of the experiment.

The car race task will present five different racecar stimuli are presented (four in each trial). The five racecar stimuli will appear equally often in each location throughout the study. Participants will also be instructed that "the performance of each racecar varies from one race to the next." Participants are required to select the racecar they think will win the next race. This will involve assessing the performance of the sample racecar, and how the performance of each racecar compares to the sample

racecar, which is specified by the Crels and Cfuncs in each selection box. Consistent selections of the winning racecar would imply that the chosen racecars had acquired properties of speed and direction derived from the sample racecar. When participants have made their selection participants progress to the race screen where the racecar they selected is indicated by a green line. During the race screen, the racecars move across the screen. After a race is completed participants are informed whether they selected the appropriate racecar with the message "Your racecar won!" presented in green for 500ms or "Your racecar did not win!" presented in red for 1000ms. Blocks will consist of thirty races and will terminate early if participants achieve and accuracy score ≥ 17 across the previous 20 trials within a block.

The Cfunc for direction will be established before the Cfunc for speed. In this part of the experiment only two selection boxes appear beneath the sample racecar. When establishing the Cfunc for direction, the speed of the two racecars will bear the same relation to the sample racecar. Thus, only the Cfunc for direction will differ across racecars and across trials. When establishing the Cfunc for speed, the direction of the two racecars will be related to the sample racecar in the same way, and so only the Cfunc for speed will vary across racecars and trials. Uniquely in this phase the sample racecar will always move toward the finish line. This is to avoid presenting trials in which the speed and direction of the winning racecar are different from the sample racecar but only the difference in speed is specified by the Crels and Cfuncs presented on screen. Given the salience of the direction dimension, such trials might undermine the effort to establish a Cfunc that specifies speed only. During these separate training phases aimed at establishing Cfuncs for speed and direction, only the Crel and Cfunc pair relevant to the target stimulus function will be presented. After completing each of these phases an instruction will inform them they are about to begin the next phase - "Phase complete! You are about to begin the next phase." Participants will also receive additional training trials in which the racecar stimuli vary along both Cfunc dimensions. This will involve trials in which three selection boxes appear beneath the sample racecar and both the speed and direction of these three racecars vary within and across trials.

The selective action of the experimentally established Crels and Cfuncs will be tested in two ways. The first test will take the same for as the car race with three selection boxed described above, and will simply involve the removal of the programmed consequences for 60 trials. The second test is similar to the final test employed by Stewart, Barrett, McHugh, O'Hora, & Barnes-Holmes (2013) which assessed control selection responses. We will use a based test to assess whether the established Crels and Cfuncs generalize to relations between new stimuli, pictures of a bicycle, a truck, a helicopter and a plane oriented to the left or the right. Before completing the generalization test participants will rate each stimulus in terms of their speed via six item scale from "Very slow" to "Very fast", and their direction as either "To the left" or "To the right". On a given trial in the generalization test a pair of stimuli will be presented in four selection boxes similar to those described above for Cfunc training. The four selection boxes will differ in the precise constellation of Crels and Cfuncs that appear between the vehicle stimuli (see Figure 2). Participants will be required to select the appropriate box for each pair of stimuli and arrangement of Crels and Cfuncs. The generalization test will consist of 30 trials and feedback will not be provided.
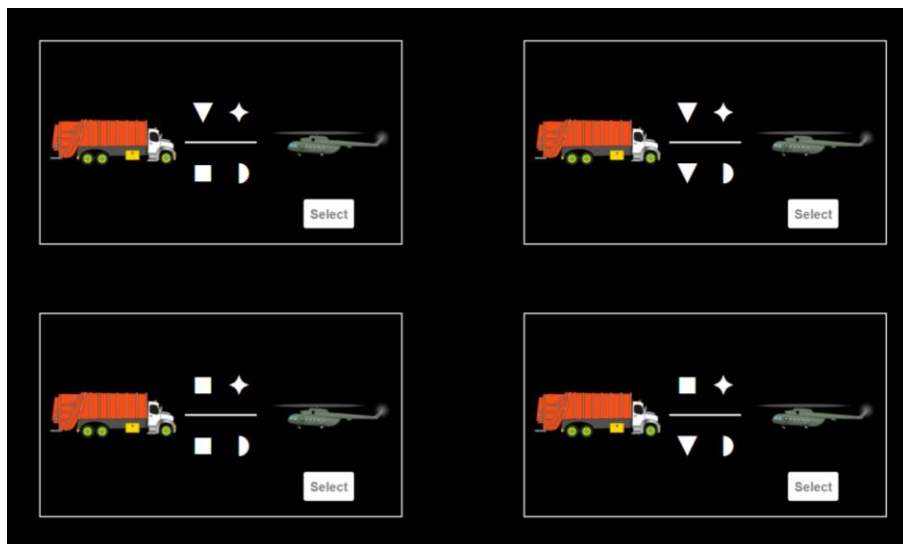

Figure 2. A screenshot of the generalization test in phase 5.

Measures

All measures implemented in lab.js (Henninger, Shevchenko, Mertens, Kieslich, & Hilbig, 2019).

Statistics of interest

1. Number of trials to complete Crel training

2. Number of correct selections in Crel test

3. Number of trials to complete Cfunc training

4. Number of correct selections in the 'racecar' Cfunc test

5. Number of correct selections in Cfunc generalization test

6. Number of participants achieving an accuracy score ≥ 85% across both Cfunc tests

Hypotheses

H1. This procedure will produce accurate responding in the 'racecar' Cfunc test.

H2. More than 45% (i.e., 10/22) participants will achieve a test accuracy of 83% or greater in the Cfunc test employing the car race format.

Results

Analytic strategy

Data processing and exclusions.

Data will be processed and analysed in R.

Hypothesis tests.

H1. The primary hypotheses will be investigated with a one sample t-test with a 50% null and a one tailed alpha of 0.05. We predict that participants responding will be at more than 50% accuracy. Note that the 'racecar' Cfunc test provides three response options. 33% accuracy is chance level responding. However, this represents a low bar for demonstrating stimulus control via Cfuncs, and so we adopt a higher null.

H2. The secondary hypothesis will be investigated using a fishers exact test.

References

Henninger, F., Shevchenko, Y., Mertens, U., Kieslich, P. J., & Hilbig, B. E. (2019). Lab.js: A free, open, online study builder.

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