Function transformations of contingency components via stimulus-stimulus relations

Martin Finn, Matthias Raemaekers & Jan De Houwer

Ghent University

Preregistration

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Background

Arbitrarily applicable relational responses can alter the functions of the stimuli being related (Hayes et al., 2001). For instance, if we learn that one stimulus is cold and that a second stimulus is the opposite to this, we can expect the second stimulus to be hot. Unlike this simple example however, stimuli in the natural environment have multiple properties (e.g., size, texture, valence etc.) and can be related to other stimuli in several ways (e.g., same as, more than, less than, opposite to etc.). Relational responses are thus said to occur under two kinds of contextual control; Crel control which specifies how the stimuli are related, and Cfunc control which specifies the function that transforms according to the foregoing relation. Crels and Cfuncs exert control over how the functions of a stimulus change in any instance of relational responding.

Recent research (Finn & De Houwer, 2021) detailed the establishment of Cfuncs that selected which of the stimulus properties of speed and direction were transformed in accordance with relations of same and opposite. The current research is an attempt to extend this work by producing Cfuncs that select the transformation of the stimulus properties of number of bubbles and number of points. The core of the current procedure is a series of bubble clicking tasks. Participants earn points by successfully clicking all the moving bubbles in a bubble task in a fixed time window. Each trial begins by presenting information about a so called source bubble task, and information about how a number task options differ from this source task option in terms of the number of bubbles to be clicked and points the tasks offer. The latter information is provided by symbols that act as Crels and Cfuncs that specify transformations of number and points properties via the relations of more than and less than.

Insofar as points are contingent upon a certain number of responses being emitted within an interval, each bubble clicking task engenders a differential reinforcement of high rates (DRH) schedule. Throughout the procedure the tasks differ with respect to the rate at which bubbles must be clicked, and the magnitude of the point-based reward for doing so. The kind of reinforcement schedule does not change throughout the bubbles task, but the precise values defining the schedule do. These

differences between schedules are specified by Crels and Cfuncs. In the bubble task therefore, components of contingencies undergo transformations of functions.

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 have been exposed to 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, or failing to complete any trial during the calibration.

IVs.

1. Crel and Cfunc function:

   ◗ = more points, ■ = more bubbles, ✦ = less bubbles, and ▼ = less points

   Vs

   ◗ = less bubbles, ■ = less points, ✦ = more points, and ▼ = more bubbles

DVs.

1. Response accuracy
2. Response time

Procedure

The procedure is designed to establish Crel and Cfunc functions for four stimuli, and assess the efficacy of these stimuli for specifying derived transformations of functions. The procedure centers on the bubbles task that is illustrated in Figure 1. The bubbles task involves a series of trials, across which participants earn points by choosing between bubble-clicking tasks on selection screens (Figure 1a and 1c) and then

attempting to complete the bubble-clicking task they have selected (Figure 1d). Each of the bubble clicking tasks involves clicking a number of moving bubbles in a limited time window for a number of points. Time elapsed within this task is illustrated by a timer bar that is initially green but becomes red in greater proportion with each passing second. The number of seconds remaining are indicated by a small white integer within the timer bar. Failure to click all of the bubbles within the time window results in no points being gained. Each trial ends with a feedback screen displaying the proportion of bubbles clicked, points earned in that trial, and the running points total. The goal is to earn as many points as possible. Critically, participants are provided with information about the task options. Participants are shown a miniature version of the source task (Figure 1b) as well as symbols that appear between the source and the task options (see Figure 1a and 1c). Each of the four symbols presented (i.e., ◗, ■, ✦, and ▼) covary with a particular difference between the miniature source task and the bubble-clicking task to which they lead. Specifically, each symbol indicates that the task option differs from the source task in one of four ways; the task involves more bubbles, or less bubbles, or offers more points, or less points for successful completion. Across trials the covariation of each symbol and a particular difference between the source task and the selected task ought to generate Crel and Cfunc functions for these symbols.

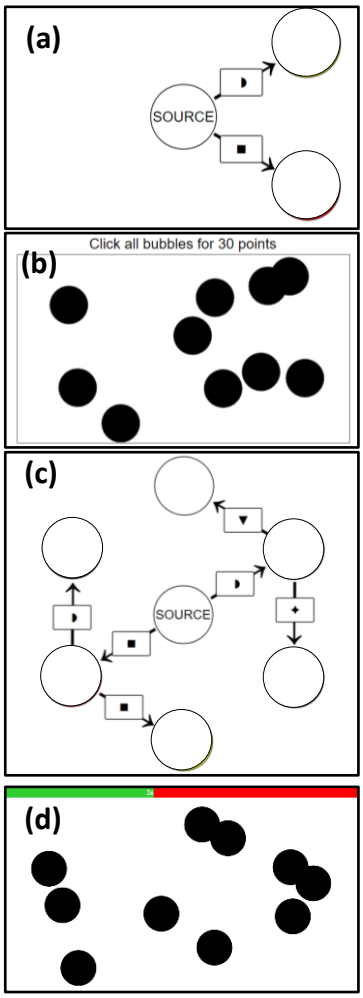

Figure 1. *Two example choice screens and a task screen from the bubbles task.*

The procedure begins by presenting study guidelines, and collecting demographic data of age and gender. The bubbles task consists of three phases; phase 1) walkthrough and calibration of bubble-clicking tasks to the participant; phase 2) establishing Crels and Cfuncs; phase 3) testing the established Crels and Cfuncs.

Phase 1: Walkthrough and calibration of bubble-clicking tasks. The bubbles task begins with a walkthrough that describes the task to participants.

Participants are informed they will complete a series of trials involving choices between tasks, and completion of the chosen tasks. They are shown an example selection screen the various elements of which are illustrated; the source, the miniature source task, the task options and the angles and positions they may occupy relative to the source, the presence of symbols that indicate how the task options compare to the SOURCE. The symbols for which Crel and Cfunc functions will be established are not presented in the walkthrough.

The calibration phase begins immediately after the walkthrough. The purpose of calibration is to ensure that changes in the number of bubbles within the task bear upon the likelihood of earning points. During calibration participants complete a series of seven trials in which the source task in the only available option. The first trial presents eight bubbles must be clicked within the five second time window. Participants are provided up to 10 opportunities to complete the first trial. Each subsequent trial increases the number of bubbles to be clicked within this time window by two. The sequence terminates when the participant has fails to complete a trial. The number of bubbles a participant clicks in the final successful trial is the numeric set point for that participant. This set point can be 8, 10, 12, 14, 16, 18, or 20.

Phase 2: Establishing Crels and Cfuncs. In this part of the task participants are provided with choices between two tasks that differ along task relevant dimensions (i.e., number of bubbles, number of points; Figure 1a). On each trial participants first view the miniature source task that displays a number of moving bubbles (i.e., the calibrated set point ± 1) and a message indicating the number of points on offer (i.e., 30 points ± 5 points). Participants cannot select the source task option, but must select one of the two other task options that displayed on each selection screen. The task options are presented at an equal distance from the source task, and can appear at 30˚, 90˚, 150˚, 210˚, 270˚, and 330˚ angles relative to the source task. The precise location of each option, and its angle relative to the source task is counterbalanced across trials. The manner in which the properties of each task differ from the source task are specified by Crels and Cfuncs. On each trial there is an optimal choice. To ensure this is the case participants are offered choices between the following

pairs; more points or less points, more points or more bubbles, less bubbles or less points, and less bubbles or more bubbles. Note that the first option in each pair is deemed the optimal choice. Upon selecting a task option participants are exposed to a bubbles task with the specified properties. Specifically, relative to the source, less bubbles means a 50% decrease in bubbles, more bubbles means a 50% increase the number of bubbles, more points increases the number of points by 10, and less points decreases the number of points by 10. These differences are relative to the values illustrated in the miniature source task in that trial. Responses in each trial are deemed correct when participants select the optimal choice and successfully complete the selected bubble task. A trial is deemed incorrect if a participant fails to fulfill either of these criteria. This phase comprises five 30 trial blocks, and terminates either upon completion of these five blocks, or upon reaching the training criterion of 17 or more correct trials across the previous 20 trials within a block.

Phase 3: Testing the established Crels and Cfuncs. In this part of the task participants complete trials involving task options multiple steps from the source. The format of the selection screen in these trials is illustrated in Figure 1c. The source is always presented in the center of the screen. The task options one step removed from the source appear at opposite sides of the source at 90˚ and 270˚, 30˚ and 210˚, and 150˚ and 330˚ angles relative to the source respectively. The task options two steps removed from the source appear at angles relative to these task options such that all task options appear equidistant from the source. The exact locations, and symbols appearing between the task options are counterbalanced across trials. As in phase 2, there is an optimal choice on each trial in phase 3. The optimal choice is always two-steps removed from the source and involves either 20 more points, 25% fewer bubbles, or 10 more points and 50% fewer bubbles. Responses are deemed correct when the optimal choice has been selected and the related task is successfully completed. Phase 3 involves two 30 trial blocks, and terminates upon completion of these trials. After phase 3 participants are asked to indicate what they think each of the Crel and Cfunc symbols mean. The experiment concludes with debriefing and payment.

Measures

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

Statistics of interest

1. Number of optimal choices selected in training
2. Number of bubbles tasks successfully completed in training
3. Number of trials to complete Cfunc training
4. Number of participants successfully completing training
5. Number of optimal choices selected during testing
6. Number of bubbles tasks successfully completed during testing
7. Number of participants successfully completing the test phase (i.e., selecting the optimal choice in ≥ 50/60 (i.e., 83%) of test trials)

Hypotheses

H1. This procedure will produce accurate responding in the test of established Crels and Cfuncs.

Results

Analytic strategy

Data processing and exclusions. Data will be processed and analyzed in R.

Hypothesis test.

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 Crel and Cfunc test provides six response options. Thus, 16.7% accuracy is chance level responding. However, this represents a low bar for demonstrating stimulus control via Cfuncs, and so we adopt a higher null.

References

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