# Supplemental Materials

**Table S1**

Experiment 1 Participant Demographics (N=151)

|  |  |  |  |
| --- | --- | --- | --- |
| Measure | *M* (*SD)* | *n* | Percent of Sample |
| **Age** | 38.34 (11.15) |  |  |
| **Gender** |  |  |  |
| Man |  | 68 | 44.74 |
| Woman |  | 83 | 54.61 |
| Genderqueer, nonbinary, genderfluid |  | 1 | 0.66 |
| **Race/Ethnicity** |  |  |  |
| White |  | 106 | 69.74 |
| Black/African American |  | 19 | 12.50 |
| Asian |  | 15 | 9.87 |
| Hispanic/Latino (of any race) |  | 9 | 5.92 |
| Native American/Alaska Native |  | 1 | 0.66 |
| Native Hawaiian/Pacific Islander |  | 1 | 0.66 |
| Other |  | 1 | 0.66 |
| **Color Blindness** |  | 1 | 0.66 |
| Red-green |  | 1 | 0.66 |

*Note. M=*Mean; *SD*=Standard deviation. We did not exclude participants with color blindness due to redundant cues arranged between responses and during reinforcer deliveries.

**Table S2**

Experiment 2 Participant Demographics (N=153)

|  |  |  |  |
| --- | --- | --- | --- |
| Measure | *M* (*SD)* | *n* | Percent of Sample |
| **Age** | 38.62 (11.18) |  |  |
| **Gender** |  |  |  |
| Man |  | 55 | 37.16 |
| Woman |  | 86 | 58.11 |
| Genderqueer, nonbinary, genderfluid |  | 6 | 4.05 |
| Prefer not to answer |  | 1 | 0.68 |
| **Race/Ethnicity** |  |  |  |
| White |  | 95 | 64.19 |
| Black/African American |  | 25 | 16.89 |
| Asian |  | 16 | 10.81 |
| Hispanic/Latino (of any race) |  | 7 | 4.73 |
| Indigenous |  | 1 | 0.68 |
| Native American/Alaska Native |  | 1 | 0.68 |
| Other |  | 3 | 2.03 |
| **Color Blindness** |  | 1 | 0.68 |
| Red-green |  | 1 | 0.68 |

*Note. M=*Mean; *SD*=Standard deviation. We did not exclude participants with color blindness due to redundant cues arranged between responses and during reinforcer deliveries.

**Table S3**

Experiment 3 Participant Demographics (N=148)

|  |  |  |  |
| --- | --- | --- | --- |
| Measure | *M* (*SD)* | *n* | Percent of Sample |
| **Age** | 37.28 (13.38) |  |  |
| **Gender** |  |  |  |
| Man |  | 75 | 49.02 |
| Woman |  | 73 | 47.71 |
| Genderqueer, nonbinary, genderfluid |  | 4 | 2.61 |
| Prefer not to answer |  | 1 | 0.66 |
| **Race/Ethnicity** |  |  |  |
| White |  | 101 | 66.01 |
| Black/African American |  | 23 | 15.03 |
| Asian |  | 17 | 11.11 |
| Hispanic/Latino (of any race) |  | 6 | 3.92 |
| Native American/Alaska Native |  | 1 | 0.66 |
| Other |  | 5 | 3.27 |
| **Color Blindness** |  | 3 | 1.98 |
| Blue-yellow |  | 1 | 0.66 |
| Red-green |  | 1 | 0.66 |
| Unknown |  | 1 | 0.66 |

*Note. M=*Mean; *SD*=Standard deviation. We did not exclude participants with color blindness due to redundant cues arranged between responses and during reinforcer deliveries.

**Table S4**

*Exclusions by Group and Criterion for all experiments.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Criteria (*n*) | | | |
|  | 1 | 2 | 3 | 4 |
| **Experiment 1** |  |  |  |  |
| ABCDA | 0 | 0 | 17 | 0 |
| ABBBA | 0 | 0 | 13 | 1 |
| ABBB | 0 | 0 | 13 | 1 |
| Total | 0 | 0 | 43 | 2 |
|  |  |  |  |  |
| **Experiment 2** |  |  |  |  |
| ABCDE | 0 | 0 | 17 | 0 |
| ABBBE | 0 | 0 | 10 | 1 |
| ABBBB | 0 | 0 | 15 | 0 |
| Total | 0 | 0 | 42 | 1 |
|  |  |  |  |  |
| **Experiment 3** |  |  |  |  |
| ABCDA | 1 | 1 | 10 | 0 |
| ABCDE | 0 | 2 | 17 | 1 |
| ABBBB | 0 | 0 | 12 | 1 |
| Total | 1 | 3 | 39 | 2 |

*Note*. Criterion 1 = > 5 responses per second; Criterion 2 = no responses in the last 2 min in Phase 1 or Phase 2; Criterion 3 = target responding did not decrease below 50% of Phase-1 levels; Criterion 4 = Did not complete experiment, survey, or did not engage with consummatory response.

# APPENDIX A

Page Instructions

Play an easy button-pressing game for academic research. You will earn base pay = $4.00. Bonus pay from in-game points could earn you even more for more optimal performances. A simple survey follows about your participation. Click the link below to begin. To access the study, use the password: XXXXXX.

Task Instructions

Page 1: Hello and thank you for choosing this task! IMPORTANT: Please read the following

instructions before beginning!  
1. Payment for participating requires you stay on this tab of your web browser for the entire duration of the task. Please close any other tabs that you have open that could distract you. We use server-side coding so we will know if and how long you leave the task page. You WILL NOT BE PAID for participation if you violate this rule – no exceptions.  
2. Do not press the back page button or refresh button at any time during the task. Doing so will end the task and your opportunity for payment.  
3. Only do this task on a laptop or desktop computer – do NOT USE a phone or tablet.  
4. Use one of the following web browsers: Google Chrome, Mozilla Firefox, or Microsoft Edge. 5. When the task is over, a unique payment code will be displayed. Enter this code for payment. Press this button when ready to continue:  
Page 2: After pressing the PROCEED button below, you will play a game to earn as many points as you can. A new page will appear and you will see one or more buttons. Pressing buttons could sometimes increase or decrease your points. Points will be tracked by a bar on the screen.  
The game will take approximately 15-20 minutes to complete. If you complete the game, you will be paid for completing the task and every point earned will be worth US$0.00012.  
Failing to begin engaging with the game within 30 seconds after proceeding will terminate the opportunity to participate in this task and the opportunity for payment. Therefore, do not proceed unless you are ready to begin and complete the game.  
Press the PROCEED button when ready to continue and please begin the game as soon as the interface appears.

Survey Questions

1) On a scale of 1 (definitely no) to 100 (definitely yes), how sure are you there was a button

with a RED HEART at some point during the GAME?  
2) On a scale of 1 (definitely no) to 100 (definitely yes), how sure are you there was a button with a BLACK SPADE at some point during the GAME?  
3) On a scale of 1 (definitely no) to 100 (definitely yes), how sure are you there was a button with a RED DIAMOND at some point during the GAME?  
4) On a scale of 1 (definitely no) to 100 (definitely yes), how sure are you there was a button with a BLACK CLUB at some point during the GAME?  
5) On a scale of 1 (not effective) to 100 (very effective), how sure are you the button with a RED HEART was effective for earning points at some point during the GAME?  
6) On a scale of 1 (not effective) to 100 (very effective), how sure are you the button with a BLACK SPADE was effective for earning points at some point during the GAME?  
7) On a scale of 1 (not effective) to 100 (very effective), how sure are you the button with a RED DIAMOND was effective for earning points at some point during the GAME?  
8) On a scale of 1 (not effective) to 100 (very effective), how sure are you the button with a BLACK CLUB was effective for earning points at some point during the GAME?

9) On a scale of 1 (definitely no) to 100 (definitely yes), how sure are you there was a BEACH in the background during the game?;

10) On a scale of 1 (definitely no) to 100 (definitely yes), how sure are you there was a SNOW SCENE in the background during the game?;

11) On a scale of 1 (definitely no) to 100 (definitely yes), how sure are you there was a FOREST in the background during the game;

12) On a scale of 1 (definitely no) to 100 (definitely yes), how sure are you there was a LAKE in the background during the game;

13) On a scale of 1 (definitely no) to 100 (definitely yes), how sure are you there was a MOUNTAIN in the background during the game?;

14) On a scale of 1 (definitely no) to 100 (definitely yes), how sure are you there was a DESERT in the background during the game?;

15) What do you think was the overall purpose of the study you just completed? If you do not know, please feel free to respond, I don’t know. Leave the question blank if you prefer not to answer.;

16) Did you have a certain way you tried to get points through the game?;

* Yes
* No
* I prefer not to answer

17) Please describe your overall strategy that you used throughout the study. If you did not have a strategy, please feel free to respond, I did not have a strategy. Leave the question blank if you prefer not to answer.;

18) Did you change the way you tried to get points during the game;

* There was not a certain way I tried to get points throughout the game
* I prefer not to answer
* I did not change the way I tried to get points during the game
* I did change the way I tried to get points

19) If there is any other information you wish to explain about your experience during the study, please describe here:;

20) How old are you?;

21) What is your gender?;

* Genderqueer, Non-binary, Genderfluid
* Prefer not to say
* Man
* Woman

22) What is your nationality?;

23) What is your race/ethnicity?;

* Asian
* Black or African American
* Hispanic or Latino (of any race)
* Indigenous
* Native American or Alaskan Native
* Native Hawaiian or Pacific Islander
* White

24) On a scale of 1 (definitely no) to 100 (definitely yes), how stressed were you during the game?;

25) Do you have any problems with seeing color?;

* No
* Unknown
* Yes, red-green color blindness
* Yes, blue-yellow color blindness
* Yes, total color blindness
* Yes, other

26) What device did you use to press buttons during the task? Please select one of the following options:

* External Computer Mouse
* Trackpad
* Computer Touchscreen
* Other

27) Please include your Prolific ID to receive your bonus payment for completing the task.

# APPENDIX B

Task Interface

A screenshot of a game

Description automatically generated

An example of objects shown on the browser during the experimental task. Each workspace shown above is 350-px by 350-px. Two buttons (each consisting of a 100 by 100-px square with a superimposed symbol) are also shown. A point counter is shown between the two workspaces and total earnings are shown to the right of the point counter.

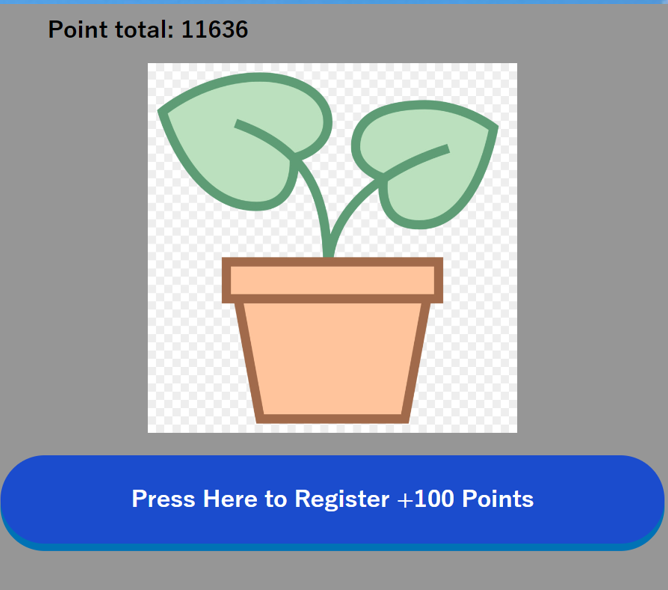
Task Interface during Reinforcement



**-1**

**R1+: VI 2 s**

**R2-: EXT**



A consummatory response including a previously selected and randomly generated image above a blue button in which pressing it resulted in reinforcer delivery.

# APPENDIX C

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table C1. |  |  |  |  |
| Results Generalized Mixed-Effects Modeling of Alternative Responding for Experiment 1 | | | | |
| Fixed Effects | β | SE | z | p-value |
| **(Intercept)** | **3.07** | **0.08** | **39.35** | **< .001** |
| **Bin** | **0.04** | **0.01** | **3.41** | **< .001** |
| **Phase (1)** | **-4.09** | **0.20** | **-20.04** | **< .001** |
| Phase (3) | 0.16 | 0.09 | 1.69 | .091 |
| Group (ABBBA) | 0.04 | 0.11 | 0.38 | .703 |
| Group (ABCDA) | -0.05 | 0.11 | -0.50 | .620 |
| **Bin\*Phase (1)** | **-0.26** | **0.02** | **-15.47** | **< .001** |
| **Bin\*Phase (3)** | **-0.04** | **0.01** | **-2.97** | **.003** |
| Bin\*Group (ABBBA) | 0.00 | 0.02 | 0.31 | .757 |
| Bin\* Group (ABCDA) | -0.01 | 0.02 | -0.77 | .442 |
| Phase (1)\*Group (ABBBA) | -0.22 | 0.29 | -0.78 | .438 |
| **Phase (3)\*Group (ABBBA)** | **-0.39** | **0.13** | **-2.89** | **.004** |
| Phase (1)\* Group (ABCDA) | -0.35 | 0.29 | -1.21 | .227 |
| Phase (3)\* Group (ABCDA) | -0.06 | 0.13 | -0.43 | .669 |
| Bin\*Phase (1)\*Group (ABBBA) | -0.02 | 0.02 | -0.71 | .475 |
| Bin\*Phase (3)\*Group (ABBBA) | 0.03 | 0.02 | 1.52 | .129 |
| Bin\*Phase (1)\* Group (ABCDA) | -0.02 | 0.02 | -0.63 | .531 |
| Bin\*Phase (3)\* Group (ABCDA) | 0.01 | 0.02 | 0.46 | .647 |

*Note.* Phase (2) and Group (ABBBB) served as the intercept. Bold values indicate a statistically significant difference.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table C2.  Results Generalized Mixed-Effects Modeling of Alternative Responding for Experiment 2 | | | | |
| Fixed Effects | β | SE | z | p-value |
| **(Intercept)** | **2.89** | **0.10** | **29.11** | **< .001** |
| **Bin** | **0.03** | **0.01** | **2.34** | **.019** |
| **Phase (1)** | **-4.12** | **0.23** | **-17.83** | **< .001** |
| Phase (3) | 0.02 | 0.11 | 0.17 | .862 |
| Group (ABBBE) | 0.06 | 0.14 | 0.45 | .651 |
| Group (ABCDE) | 0.09 | 0.14 | 0.63 | .528 |
| **Bin\*Phase (1)** | **-0.26** | **0.02** | **-13.99** | **< .001** |
| Bin\*Phase (3) | -0.02 | 0.02 | -1.15 | .249 |
| Bin\*Group (ABBBE) | 0.03 | 0.02 | 1.75 | .081 |
| Bin\*Group (ABCDE) | 0.01 | 0.02 | 0.85 | .393 |
| Phase (1)\*Group (ABBBE) | -0.44 | 0.33 | -1.32 | .188 |
| Phase (3)\*Group (ABBBE) | -0.07 | 0.16 | -0.46 | .647 |
| Phase (1)\*Group (ABCDE) | -0.03 | 0.33 | -0.10 | .923 |
| Phase (3)\*Group (ABCDE) | 0.20 | 0.16 | 1.30 | .192 |
| Bin\*Phase (1)\*Group (ABBBE) | -0.05 | 0.03 | -1.85 | .065 |
| Bin\*Phase (3)\*Group (ABBBE) | -0.04 | 0.02 | -1.70 | .088 |
| Bin\*Phase (1)\*Group (ABCDE) | 0.00 | 0.03 | -0.04 | .967 |
| Bin\*Phase (3)\*Group (ABCDE) | -0.04 | 0.02 | -1.77 | .077 |

*Note.* Phase (2) and Group (ABBBB) served as the intercept. Bold values indicate a statistically significant difference.

Table C3.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Results Generalized Mixed-Effects Modeling of Alternative Responding for Experiment 3 | | | | |  |  |
| Fixed Effects | β | SE | z | p-value |
| **(Intercept)** | **3.10** | **0.09** | **32.94** | **< .001** |
| **Bin** | **0.03** | **0.01** | **2.60** | **< .001** |
| **Phase (1)** | **-3.58** | **0.21** | **-16.90** | **< .001** |
| Phase (3) | 0.09 | 0.11 | 0.85 | .398 |
| Group (ABCDA) | -0.21 | 0.13 | -1.52 | .128 |
| **Group (ABCDE)** | **-0.20** | **0.13** | **-1.47** | **< .001** |
| **Bin\*Phase (1)** | **-0.23** | **0.02** | **-13.25** | **< .001** |
| **Bin\*Phase (3)** | -0.03 | 0.01 | -1.73 | .084 |
| Bin\*Group (ABCDA) | 0.03 | 0.01 | 1.85 | .064 |
| Bin\*Group (ABCDE) | 0.03 | 0.01 | 1.95 | .052 |
| Phase (1)\*Group (ABCDA) | -0.43 | 0.31 | -1.39 | .165 |
| Phase (3)\*Group (ABCDA) | 0.11 | 0.15 | 0.72 | .470 |
| **Phase (1)\*Group (ABCDE)** | **-0.69** | **0.31** | **-2.23** | **.026** |
| Phase (3)\*Group (ABCDE) | 0.07 | 0.15 | 0.47 | .640 |
| Bin\*Phase (1)\*Group (ABCDA) | -0.05 | 0.03 | -1.94 | .052 |
| Bin\*Phase (3)\*Group (ABCDA) | -0.03 | 0.02 | -1.54 | .123 |
| **Bin\*Phase (1)\*Group (ABCDE)** | **-0.08** | **0.03** | **-3.00** | **.003** |
| Bin\*Phase (3)\*Group (ABCDE) | -0.03 | 0.02 | -1.44 | .150 |

*Note.* Phase (2) and Group (ABBBB) served as the intercept. Bold values indicate a statistically significant difference.