**Supplemental Materials**

HIT Page Instructions

Play an easy button-pressing game for academic research. You will earn base pay = $0.50. 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. At the end of the game, you will receive a payment code. Paste the code into the box below to receive payment.

This HIT must be completed on a**WINDOWS**or **MAC COMPUTER**with one of the following browsers: **GOOGLE CHROME**, **MOZILLA FIREFOX**, or **MICROSOFT EDGE**.

**Make sure to leave this window open as you play the game.**When you complete the HIT, return to this page to paste the **PAYMENT CODE** **(NOT YOUR WORKER ID)** into the box.

Task Instructions

Page 1: Hello and thank you for choosing this HIT! 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 HIT. 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 HIT 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 HIT. Doing so will end the HIT and your opportunity for payment.

3. Only do this HIT 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 HIT is over, the HIT code will be displayed onscreen for you to enter 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 minutes to complete. If you complete the game, you will be paid for completing the HIT and every point earned will be worth US$0.00005.

Failing to begin engaging with the game within 30 seconds after proceeding will terminate the opportunity to participate in this HIT 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 HIT?
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 HIT?
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 HIT?
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 HIT?
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 HIT?
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 HIT?
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 HIT?
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 HIT?
9. 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.
10. Did you have an overall strategy that you used throughout the study?

Yes

No

I prefer not to answer.

1. 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.

I did not have a strategy.

I prefer not to answer.

My strategy did not change.

My strategy did change (If so, please describe below how your strategy changed).

1. Did your strategy change as you moved forward in the study?
2. If there is any other information you wish to explain about your experience during the study, please describe here:
3. What is your age?
4. What gender/sex do you identify with?
5. What is your nationality?
6. In what country do you live?
7. How much distress did you feel resulting from this task from 1 (no stress) to 100 (very stressful)?
8. Do you have any problems with color vision?

No.

Yes, red-green color blindness.

Yes, blue-yellow color blindness.

Yes, total color blindness.

Yes, other.

**Details of Experimental Procedures**

Reinforcement consisted of several events, including: (1) a yellow star appearing above the button, (2) a switch in the color of the point bar from gray to green for 0.4 s, (3) 100 points added to the point counter, and (4) USD $0.00005 per point added to total earnings (Figure S1).

Across all groups, each click on a button also resulted in a response cost, indicated by (1) a 0.4-s presentation of red text below the button, (2) a switch in the point-bar color from gray to red for 0.4 s, and (3) a deduction of $0.00005per point lost from total. The task was programmed such that events associated with reinforcement and response cost could occur simultaneously.

**Figure S1**

*Task Interface and Hourglass Image*

A picture containing graphical user interface

Description automatically generated

Chart, funnel chart

Description automatically generated

*Note.* In the top panel, each workspace shown above is 350-px by 350-px. The top panel shows two buttons, each consisting of a 100 by 100-px square with a superimposed symbol. A yellow star with green text (“+100”) is shown above one of the buttons, indicating reinforcement. Red text is shown below the button indicating a response cost (-1 point). A point counter is shown between the two workspaces and total earnings are shown to the right of the point counter. The bottom panel shows the hourglass image presented during brief blackouts.

**Results**

**Reinforcer Rates**

Table S1 shows obtained reinforcer rates (star deliveries per minute) in each phase. Results of separate one-way ANOVAs indicated that reinforcer rates were comparable among groups in Phase 1 [*F*(3.00, 200.00) = 0.80, *p* = .365] but there was a significant effect of Group on reinforcer rates in Phase 2 [*F*(3.00, 200.00) = 4.47, *p* = .010]. Post-hoc tests indicated that reinforcer rates were lower in Group None (*M* = 10.60, *SD* = 6.35) compared to Groups Phase (*M* = 15.01 *SD* = 6.96) and 60 s (*M* = 14.83, *SD* = 7.34; *t*s > 3.10, *p*s < .011). Comparisons among all other groups were not significant, *p*s > .296. Thus, the VI schedule was successful in controlling target-reinforcer rates in Phase 1, but it was not successful in controlling alternative-reinforcer rates in Phase 2.

**Table S1**

Reinforcer Rates: Means and Standard Deviations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Phase 1 | Phase 2 | Phase 3 |
| Experiment 1  None  12 s  60 s  Phase |  | 18.74 (4.98)  19.11 (4.73)  18.59 (5.93)  17.55 (5.66) | 10.60 (6.35)  13.06 (6.81)  14.83 (7.34)  15.01 (6.96) | --  --  --  -- |

*Note.* Values represent mean star deliveries per minute.

**Details of Mixed-Effects Modeling Approach**

We analyzed target and alternative response rates in separate linear mixed-effects models. For each analysis, we fit an initial model with all possible fixed effects based on the experimental design. The initial model included fixed effects of Bin, Phase, and Group, all possible interactions between these factors, and a random intercept of Participant. The random intercept allowed overall levels of responding to vary across individual participants.

To evaluate the random-effects structure, we compared the initial model to more complex models with upto two simultaneous random-slope effects (Bin, Phase). The random-slope effects of Bin and Phase allowed for participant-level differences in changes in responding across 12-s bins and phases, respectively. We performed model comparisons using Akaike Information Criterion (AICc) via the *MuMIn* R package (Barton, 2009) before evaluating fixed effects using Wald tests via the *car* package (Fox & Weisberg, 2019). AICc comparisons supported the use of the model with two random-slope effects. Finally, we used the *emmeans* package (Lenth, 2016) to conduct post-hoc comparisons of responding in the last bin of Phases 1 and 2 and the first bin of Phase 3.

**Alternative Responding**

Results of the mixed-effects analysis of alternative responding indicated significant fixed effects of Bin (χ2[1.00] = 58.88, *p* < .001), Phase (χ2[2.00] = 377.39, *p* < .001), a significant Phase x Group interaction (χ2[6.00] = 15.13, *p* = .019), a significant Bin x Phase interaction (χ2[2.00] = 518.78, *p* < .001), and a significant Bin x Phase x Group interaction (χ2[6.00] = 20.35, *p* = .002). The Bin x Group interaction was not significant, *p* = .289. Solid and dashed lines in the bottom panel of Figure 1 show the predictions from the final mixed-effects model.

To further examine the significant three-way interaction among Bin, Phase, and Group, we first evaluated differences in alternative responding between phases within each group. Response rates were lower in the last bin of Phase 1 compared to the last bin of Phase 2 and first bin of Phase 3 across all groups, *t*s > 8.10, *p*s < .001. Thus, both (1) arranging reinforcement only for the alternative response and (2) subsequently removing reinforcement for both responses produced higher rates of alternative responding compared to arranging reinforcement only for the target response. Response rates were also lower in the first bin of Phase 3 compared to the last bin of Phase 2 across all groups (*t*s > 3.38, *p*s < .001), indicating that alternative responding decreased when extinction was introduced for that response regardless of the arranged stimulus conditions. Finally, we observed no between-group differences in responding in the last bin of Phases 1 or 2 (*p*s > .132) or in the first bin of Phase 3 (*p*s > .110). These findings suggest that the involvement of Group in the three-way interaction between Bin, Phase, and Group was reflective of between-group differences at other timepoints (e.g., at the beginning of Phase 1, see Figure 1).

**References**

Barton, K. (2009) MuMIn: Multi-model inference. R Package Version 0.12.2/r18.

Fox, J., & Weisberg, S. (2019). *An R Companion to Applied Regression*, Third edition. Sage, Thousand Oaks CA. https://socialsciences.mcmaster.ca/jfox/Books/Companion/

Lenth, R. V. (2021). emmeans: Estimated Marginal Means, aka Least-Squares Means. R package version 1.5.4. https://CRAN.R-project.org/package=emmeans