## Cognitive Flexibility Task- Probabilistic Reversal Learning Task

**Cognitive Flexibility**

- **Definition:** The ability to **adapt behavior** or thinking in response to changing rules, feedback, or environmental demands.

- **Key Features:**

    - Shifting between strategies or task sets.

    - Updating choices when rules change.

## For Tech team's Reference:

1. **Task Overview**

- The task includes **6 blocks × 12 rounds** each (total 72 rounds).
- Each round: participant chooses between two designs by tapping one on screen, where one is usually rewarded and the other usually punished.
- After some time, the good and bad choices swap, and players must adjust even if feedback is sometimes misleading. ( will see to it in detail).
- A choice must be made within **4 seconds.**

**Definition of Blocks and Rounds:**

- **Rounds=** one single choice or turn.
  *Example*: "Pick the gold or silver box."

- **Block =** a group of trials with the same rule.
  *Example*: 10 turns where the gold box mostly has treasure, then the rule changes accordingly to the game.

**✓So, rounds= one pick, block = a set of picks with the same rule.**

**Between-Block and Between-Rounds Break:**

- After each round and each block, display a large fixation "+" in the center for 300 ms.

**2. Inclusion of feedback in this task:**

- **We will be providing feedback to participants in the computer interface.**

**There are two types of feedback:**

## Contingent Feedback (75%)

This is the **"normal" feedback** that makes sense:

- If you **choose correctly**, you get a **reward**.
- If you **choose incorrectly**, you get a **punishment**.

Think of it like a **game with rules that usually make sense**: do the right thing, you win; do the wrong thing, you lose. Most of the time (75% of trials), this is what happens.

**Example: In our task,** 75% of 12 trials → **9 trials**.

- Correct choice → **reward feedback to participants in the computer interface.**
- Wrong choice → **punishment feedback to participants in the computer interface.**

## Non-Contingent Feedback (25%) – "Misleading Feedback"

This is where we **mix things up** to make the task a little uncertain:

- Sometimes, even if you **choose correctly**, you might **get punished** (misleading punishment).
- Sometimes, even if you **choose incorrectly**, you might **get rewarded** (misleading reward).

So, about 1 in 4 times, the feedback **doesn't match your choice**. This is done **on purpose** to encourage you to **learn flexibly** instead of just following simple rules.

**Example: In our task,** 25% of 12 trials → **3 trials**.

- Correct choice → **punishment feedback to participants in the computer interface.**

- Wrong choice → **reward feedback to participants in the computer interface.**

The tricky feedback in this task can be a mix like:

1. **All three misleading punishments** (you're punished even when correct).
2. **2 misleading punishments + 1 misleading reward**.
3. **2 misleading rewards + 1 misleading punishment**.

This is **randomized**, so participants can't predict exactly when the feedback will be misleading.

- Randomization means **mixing things up in a way that no one can predict the order**.
- **Example for a task:** If you have 12 round, you randomly decide **round trial gives misleading feedback** so participants **cannot guess the pattern**

**3. Errors that can occur in this Task:**

- **Note these errors should not be displayed for participants in the computer interface .**

**Reversal Error: ✕**

- Occurs immediately after a reward switch when the participant continues choosing the previously rewarded stimulus.
- Reflects difficulty in detecting the change in reward rule.

**Perseverative Error: □**

- Occurs when the participant continues to select the previously rewarded option across multiple rounds after the rule has changed.
- Indicates rigidity or persistence of old response patterns despite feedback.

**Final Reversal Error: □**

- The error committed on the last round of the reversal block before the participant finally switches to the new correct stimulus.
- Shows residual difficulty in adjusting to the new contingency.

**4. Inclusion of "Reversal Rule" in the task.**

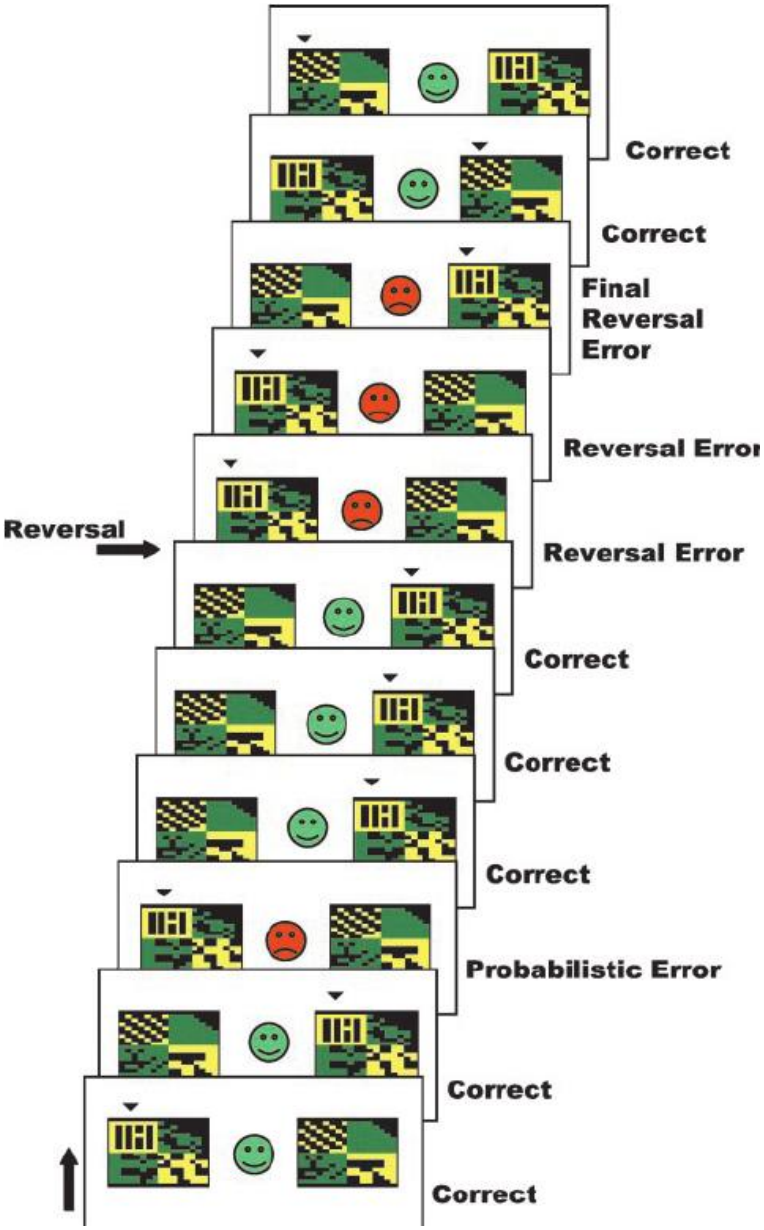
- Correct stimulus reverses after **3 consecutive correct responses**.

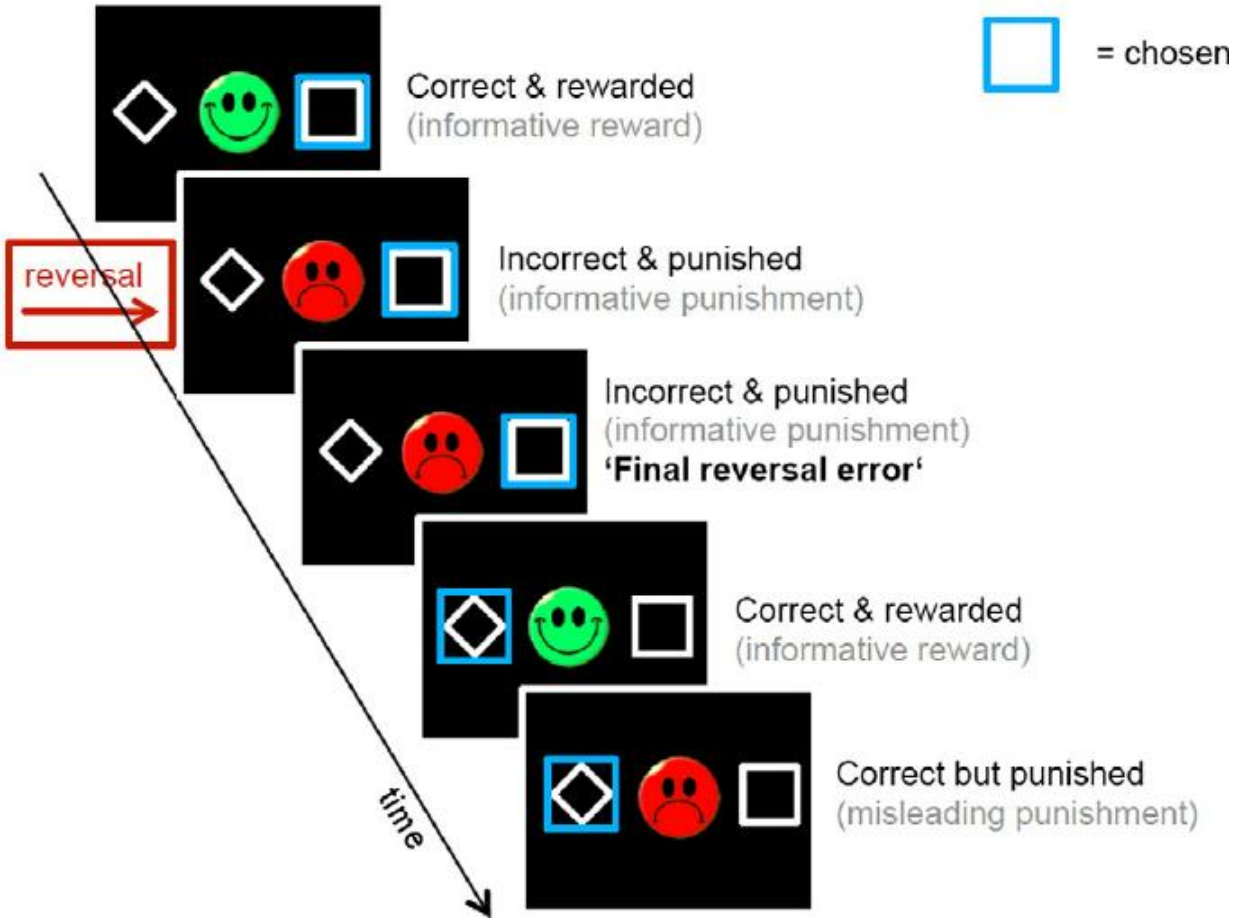
A **reversal** happens when the "correct choice" **switches to the other option**.

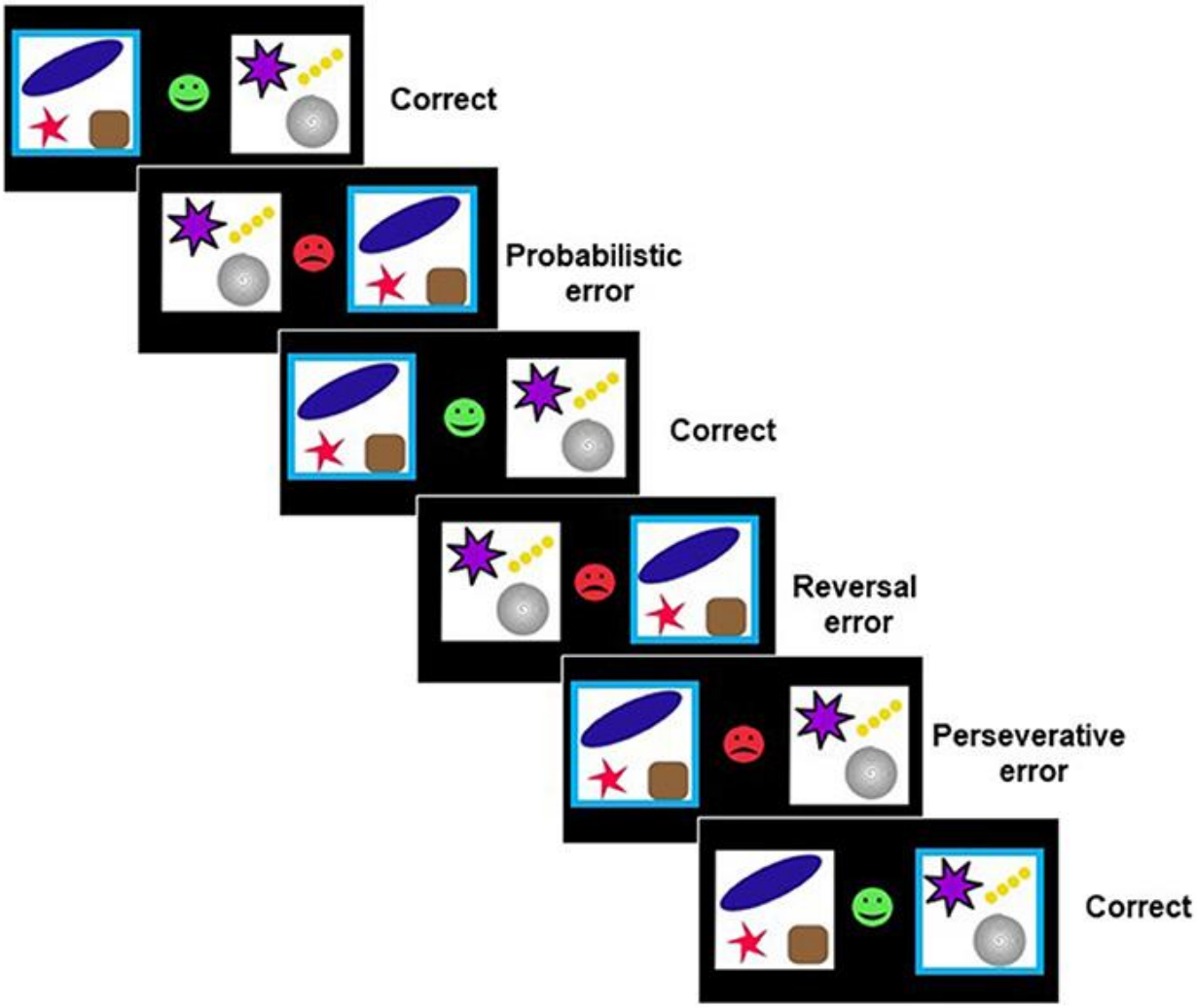
- Imagine a game with **two buttons: A and B**.
- At first, **A gives reward** and **B gives punishment**.
- If you pick the **correct one 3 times in a row**, the rules **flip**: now **B gives reward** and **A gives punishment**.

Think of it like a **"musical chairs" game** where the chair that's "safe" changes after you sit correctly 3 times.

## Visual Examples for Cognitive Flexibility Task




= chosen
Correct & rewarded
(informative reward)
reversal
Incorrect & punished
(informative punishment)
Incorrect & punished
(informative punishment)
'Final reversal error'
Correct & rewarded
(informative reward)
Correct but punished
(misleading punishment)
time




## 5. Stimulus Sets and Visual Style

| Population | Block | Stimulus to be displayed on left side | Stimulus to be displayed on right side | Feedback Visuals |
|---|---|---|---|---|
| Adolescents (14–18) | 1 and 2 | Golden Treasure Box □□ | Silver Treasure Box ○□ | Correct: Gold coin appears □ |

| | | | | |
|---|---|---|---|---|
| | 3 and 4 | Purple Pen □□ | Pink Pen □● | Incorrect: Coin disappears or cracks✕□ |
| | 5 and 6 | Yellow Key □□ | Green Key □□ | |
| Adults (18–22) | 1 and 2 | Blue Cube □ | Yellow Square □ | Correct: Green smiley □□ |
| | 3 and 4 | Yellow Star ⭑+Purple Oval □+Blue Diamond □ | Red Heart □+Green Rectangle □ | Incorrect: Red sad face □□ |
| | 5 and 6 | Horizontal black/white lines ▬▬ | Vertical black/white lines ▌▌▌ | |

**6. Rounds Flow**

**Pre-Task Instructions ( to be displayed before the task begins).**

1. The participant first reads the **Main Task Instructions.**

**Plain Language Task Instructions for Adolescents (Ages 14–18) (to be displayed before the task in the interface)**

**Welcome to the Game!**

Two pictures will appear—tap the one you think hides the **gold coins**. You have **4 seconds** to choose, or you'll see *"Time is up!"*.

- **Correct pick:** You win **110 gold coins**! ✨

- **Wrong pick:** The coin breaks, and you lose **40 gold coins** 

You start with **3,000 coins**. Your total updates after every choice—keep building your treasure!

But watch out: the winning picture can **switch** at any time. Change only when you're sure the rule has changed.

Between rounds, a **+ sign** means a short break.
You'll try a few **practice rounds** first to learn the rules.

**Good luck—collect as much gold as you can!** 

When you feel set to take on the challenge, tap **'Let's Go!'** below and the game begins!""

## Plain Language Task Instructions for Adults (Ages 18–22) (to be displayed before the task in the interface)

Welcome! You will see two shapes or designs side by side on the screen. Your task is to **tap the shape you think will reward you.**.

- You have 4 seconds to respond. If you don't respond in time, you will see "Time is up !," and the task will move on.
- After you choose, you will get feedback:
    - A green smiling face means you were right.
    - A red sad face means you were wrong.
- Sometimes, the shape that gives the reward may change without warning.
- You should only **start choosing the other shape when you are sure the rule has changed**.
- After each round, a plus sign (+) will appear for a short break before the next round begins.

Before the main task, you will have some practice trials. Tap the shape that you think will reward you within 4 seconds on each trial. You will see a happy or sad face after you choose to show if you were right or wrong.

Good luck!

When you're prepared to begin the task, press **'Let's Go!'** below to start."

2. The participant then reads the **Practice Task Instructions.**

**Adolescents (14–18):**
**Now, let's try some practice rounds. Tap the picture you think will give a reward within 4 seconds and watch the coins show if you were right or wrong.**

**Adults (18–22):**
**Now, let's start a few practice trials. Tap the shape you think will give a reward within 4 seconds and see a happy or sad face after your choice.**

3. Participants complete **12 practice trials** (same properties as main task).

**Practice Task Rounds-Level Flow**

1. **Stimulus Display**
   - Two stimuli are presented (left/right positions randomized per trial).
2. **Response Window (4 s)**
   - Participants taps a choice within 4 s.
   - If a choice is made: chosen stimulus is highlighted **instantly in blue**.
   - If no choice is made: display *"Time is up!"* for 1 second, then proceed.
3. **Feedback (1 s;** every round to be displayed to participant on computer interface)
   - Feedback appears immediately after selection.
   - Stimuli remain visible during feedback.
4. **Inter-Round Interval (0.3 s)**
   - Screen clears.
   - A fixation "+" is shown for 0.3 s.

## Practice Task Flow Table- Adolescents and Adults Version ( To be displayed in interface in same order)

| Trial | Adolescents (Left → Right) | Adults (Left → Right) | Response Time (s) |
|---|---|---|---|
| 1 | Pink Pen → Purple Pen | ⭐+□+□ → □+□ | 4 |
| 2 | Purple Pen → Pink Pen | ⭐+□+□ → □+□ | 4 |
| 3 | Purple Pen → Pink Pen | □+□ → ⭐+□+□ | 4 |
| 4 | Pink Pen → Purple Pen | ⭐+□+□ → □+□ | 4 |
| 5 | Purple Pen → Pink Pen | ⭐+□+□ → □+□ | 4 |
| 6 | Pink Pen → Purple Pen | □+□ → ⭐+□+□ | 4 |
| 7 | Purple Pen → Pink Pen | ⭐+□+□ → □+□ | 4 |
| 8 | Pink Pen → Purple Pen | □+□ → ⭐+□+□ | 4 |
| 9 | Pink Pen → Purple Pen | ⭐+□+□ → □+□ | 4 |
| 10 | Purple Pen → Pink Pen | ⭐+□+□ → □+□ | 4 |
| 11 | Pink Pen → Purple Pen | □+□ → ⭐+□+□ | 4 |

| | | | |
|---|---|---|---|
| 12 | Purple Pen → Pink Pen | ⭑+□+□ → □+□ | 4 |

**Summary for Practice Task :**

- There are 12 rounds for both adolescents and adults, with the table combining versions column-wise.
- No reversals are implemented in this practice.
- Probability feedback occurs on 25% of rounds (3 rounds), including misleading punishment or reward.
- For adolescents, the Purple Pen is the rewarded stimulus.
- For adults, the □+□ design is the rewarded stimulus.
- Response time for all rounds is 4 seconds.
- Probability feedback is randomized in location across trials for both versions.
- Remember: correct choice → reward; wrong choice → punishment. ( in terms of money gain/loss for adolescents and green smiley face/red sad face for adults, this thing should be applicable for probabilistic feedback appropriately)
- The allotment of probabilistic feedback is randomized, and it can be a mix of misleading punishment/ reward. (Either all three misleading punishments (or) **(2 Misleading Punishments + 1 Misleading Reward)** or **(2 Misleading Rewards + 1 Misleading Punishment)**

4. After practice, a **one-line instruction** appears, where participants are then directed to the main task.

**Adolescents (14–18 years)**

"Great job finishing the practice! Now get ready for the real task. Tap **'Let's Go!'** below and the game begins!""

**Adults (18–22 years)**

"Great job finishing the practice! Now get ready for the real task. Tap **'Let's Go!'** below and the game begins!""

## 5. Participants then proceed to the Main Task

Main Task Rounds Flow- same flow as the practice task.

- The main task is divided into 6 blocks.
- At the start of each block, a short instruction screen appears, explaining the specific block. (Mentioned in the Task Flow Table for Adults and Adolescents respectively)
- After reading the block instructions, participants are directed into the next block.

### Main Task Flow Table -Adolescent Version ( To be displayed in interface in same order)

| Trial | Block | Instructions | Left Stimulus | Right Stimulus | Correct Stimulus | Response Time (ms) |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 1 | **Welcome to the Game!**<br>Two pictures will appear—tap the one you think hides the **gold coins**. You have **4 seconds** to choose, or you'll see *"Time is up!"*.<br>● **Correct pick:** You win **110 gold coins**! ✨<br>● **Wrong pick:** The coin breaks, and you lose **40 gold coins** □<br><br>You start with **3,000 coins**. Your total updates after every choice—keep building your treasure!<br><br>But watch out: the winning picture can **switch** at any time. Change only when you're sure the rule has changed.<br><br>Between rounds, a **+ sign** means a short break.<br>You'll try a few **practice rounds** first to learn the rules.<br><br>**Good luck—collect as much gold as you can!** □When you feel set to take on the challenge, tap **'Let's Go!'** below and the game begins!" | Golden Treasure Box □□ | Silver Treasure Box ○□ | Golden Treasure Box □□ | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| 2 | 1 | **Golden Treasure Box will provide the reward from this block.** | Silver Treasure Box ○□ | Golden Treasure Box □□ | Golden Treasure Box □□ | 4000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | 1 | | Silver Treasure Box ○□ | Golden Treasure Box □□ | Golden Treasure Box □□ | 4000 |
| 4 | 1 | | Golden Treasure Box □□ | Silver Treasure Box ○□ | Golden Treasure Box □□ | 4000 |
| 5 | 1 | | Silver Treasure Box ○□ | Golden Treasure Box □□ | Golden Treasure Box □□ | 4000 |
| 6 | 1 | | Golden Treasure Box □□ | Silver Treasure Box ○□ | Golden Treasure Box □□ | 4000 |
| 7 | 1 | | Golden Treasure Box □□ | Silver Treasure Box ○□ | Golden Treasure Box □□ | 4000 |
| 8 | 1 | | Silver Treasure Box ○□ | Golden Treasure Box □□ | Golden Treasure Box □□ | 4000 |
| 9 | 1 | | Silver Treasure Box ○□ | Golden Treasure Box □□ | Golden Treasure Box □□ | 4000 |
| 10 | 1 | | Golden Treasure Box □□ | Silver Treasure Box ○□ | Golden Treasure Box □□ | 4000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11 | 1 | | Silver Treasure Box ○□ | Golden Treasure Box □□ | Golden Treasure Box □□ | 4000 |
| 12 | 1 | | Golden Treasure Box □□ | Silver Treasure Box ○□ | Golden Treasure Box □□ | 4000 |
| | | **Block 2- Instructions**<br><br>A new round is starting! Pay attention to which design seems to be giving a reward now. When you feel set to take on the challenge, tap **'Let's Go!'** below and the game begins! | | | | |
| 13 | 2 | | Silver Treasure Box ○□ | Golden Treasure Box □□ | Silver Treasure Box ○□ | 4000 |
| 14 | 2 | | Golden Treasure Box □□ | Silver Treasure Box ○□ | Silver Treasure Box ○□ | 4000 |
| 15 | 2 | | Silver Treasure Box ○□ | Golden Treasure Box □□ | Silver Treasure Box ○□ | 4000 |
| 16 | 2 | | Golden Treasure Box □□ | Silver Treasure Box ○□ | Silver Treasure Box ○□ | 4000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 17 | 2 | | Golden Treasure Box □□ | Silver Treasure Box ○□ | Silver Treasure Box ○□ | 4000 |
| 18 | 2 | | Silver Treasure Box ○□ | Golden Treasure Box □□ | Silver Treasure Box ○□ | 4000 |
| 19 | 2 | | Silver Treasure Box ○□ | Golden Treasure Box □□ | Silver Treasure Box ○□ | 4000 |
| 20 | 2 | | Golden Treasure Box □□ | Silver Treasure Box ○□ | Silver Treasure Box ○□ | 4000 |
| 21 | 2 | | Golden Treasure Box □□ | Silver Treasure Box ○□ | Silver Treasure Box ○□ | 4000 |
| 22 | 2 | | Silver Treasure Box ○□ | Golden Treasure Box □□ | Silver Treasure Box ○□ | 4000 |
| 23 | 2 | | Golden Treasure Box □□ | Silver Treasure Box ○□ | Silver Treasure Box ○□ | 4000 |
| 24 | 2 | | Silver Treasure Box ○□ | Golden Treasure Box □□ | Silver Treasure Box ○□ | 4000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | **Block 3- Instructions**<br><br>"A new round is starting! You'll now see a Purple Pen □□ and a Pink Pen □●. Your task is to learn which pen gives a reward. Tap carefully. Rules may change during the round." When you feel set to take on the challenge, tap **'Let's Go!'** below and the game begins! | | | | |
| 25 | 3 | **Purple Pen will provide reward for this block.** | Pink Pen □● | Purple Pen □□ | Purple Pen □□ | 4000 |
| 26 | 3 | | Purple Pen □□ | Pink Pen □● | Purple Pen □□ | 4000 |
| 27 | 3 | | Purple Pen □□ | Pink Pen □● | Purple Pen □□ | 4000 |
| 28 | 3 | | Pink Pen □● | Purple Pen □□ | Purple Pen □□ | 4000 |
| 29 | 3 | | Purple Pen □□ | Pink Pen □● | Purple Pen □□ | 4000 |
| 30 | 3 | | Pink Pen □● | Purple Pen □□ | Purple Pen □□ | 4000 |
| 31 | 3 | | Purple Pen □□ | Pink Pen □● | Purple Pen □□ | 4000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 32 | 3 | | Pink Pen □● | Purple Pen □□ | Purple Pen □□ | 4000 |
| 33 | 3 | | Pink Pen □● | Purple Pen □□ | Purple Pen □□ | 4000 |
| 34 | 3 | | Purple Pen □□ | Pink Pen □● | Purple Pen □□ | 4000 |
| 35 | 3 | | Pink Pen □● | Purple Pen □□ | Purple Pen □□ | 4000 |
| 36 | 3 | | Purple Pen □□ | Pink Pen □● | Purple Pen □□ | 4000 |
| | | **Block 4- Instructions**<br><br>A new round is starting! Pay attention to which design seems to be giving a reward now**.** When you feel set to take on the challenge, tap **'Let's Go!'** below and the game begins! | | | | |
| 37 | 4 | | Purple Pen □□ | Pink Pen □● | Pink Pen □● | 4000 |
| 38 | 4 | | Pink Pen □● | Purple Pen □□ | Pink Pen □● | 4000 |
| 39 | 4 | | Pink Pen □● | Purple Pen □□ | Pink Pen □● | 4000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 40 | 4 | | Purple Pen □□ | Pink Pen □● | Pink Pen □● | 4000 |
| 41 | 4 | | Purple Pen □□ | Pink Pen □● | Pink Pen □● | 4000 |
| 42 | 4 | | Pink Pen □● | Purple Pen □□ | Pink Pen □● | 4000 |
| 43 | 4 | | Purple Pen □□ | Pink Pen □● | Pink Pen □● | 4000 |
| 44 | 4 | | Pink Pen □● | Purple Pen □□ | Pink Pen □● | 4000 |
| 45 | 4 | | Purple Pen □□ | Pink Pen □● | Pink Pen □● | 4000 |
| 46 | 4 | | Pink Pen □● | Purple Pen □□ | Pink Pen □● | 4000 |
| 47 | 4 | | Pink Pen □□ | Purple Pen □● | Pink Pen □● | 4000 |
| 48 | 4 | | Purple Pen □● | Pink Pen □□ | Pink Pen □● | 4000 |
| | | **Block 5- Instructions**<br><br>"Welcome to the next round! You'll see a Yellow Key □□ and a Green Key □□. Your task is to learn which key gives a reward. Rules may change, so stay | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | focused!" When you feel set to take on the challenge, tap **'Let's Go!'** below and the game begins! | | | | |
| 49 | 5 | **Green Key will provide reward for this block.** | Green Key □ | Yellow Key □ | Green Key □ | 4000 |
| 50 | 5 | | Yellow Key □ | Green Key □ | Green Key □ | 4000 |
| 51 | 5 | | Green Key □ | Yellow Key □ | Green Key □ | 4000 |
| 52 | 5 | | Green Key □ | Yellow Key □ | Green Key □ | 4000 |
| 53 | 5 | | Yellow Key □ | Green Key □ | Green Key □ | 4000 |
| 54 | 5 | | Green Key □ | Yellow Key □ | Green Key □ | 4000 |
| 55 | 5 | | Yellow Key □ | Green Key □ | Green Key □ | 4000 |
| 56 | 5 | | Yellow Key □ | Green Key □ | Green Key □ | 4000 |
| 57 | 5 | | Green Key □ | Yellow Key □ | Green Key □ | 4000 |
| 58 | 5 | | Green Key □ | Yellow Key □ | Green Key □ | 4000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 59 | 5 | | Yellow Key □ | Green Key □ | Green Key □ | 4000 |
| 60 | 5 | | Green Key □ | Yellow Key □ | Green Key □ | 4000 |
| | | **Block 6- Instructions**<br><br>A new round is starting! Pay attention to which design seems to be giving a reward now. When you feel set to take on the challenge, tap **'Let's Go!'** below and the game begins! | | | | |
| 61 | 6 | | Yellow Key □ | Green Key □ | Yellow Key □ | 4000 |
| 62 | 6 | | Green Key □ | Yellow Key □ | Yellow Key □ | 4000 |
| 63 | 6 | | Yellow Key □ | Green Key □ | Yellow Key □ | 4000 |
| 64 | 6 | | Yellow Key □ | Green Key □ | Yellow Key □ | 4000 |
| 65 | 6 | | Green Key □ | Yellow Key □ | Yellow Key □ | 4000 |
| 66 | 6 | | Green Key □ | Yellow Key □ | Yellow Key □ | 4000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 67 | 6 | | Yellow Key □ | Green Key □ | Yellow Key □ | 4000 |
| 68 | 6 | | Green Key □ | Yellow Key □ | Yellow Key □ | 4000 |
| 69 | 6 | | Yellow Key □ | Green Key □ | Yellow Key □ | 4000 |
| 70 | 6 | | Green Key □ | Yellow Key □ | Yellow Key □ | 4000 |
| 71 | 6 | | Yellow Key □ | Green Key □ | Yellow Key □ | 4000 |
| 72 | 6 | | Green Key □ | Yellow Key □ | Yellow Key □ | 4000 |

## Main Task Flow Table- Adult Version ( To be displayed in interface in same order)

| Trial | Block | Instructions | Left Stimulus | Right Stimulus | Correct Stimulus | Response Time |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 1 | Welcome! You will see two shapes or designs side by side on the screen. Your task is to **tap the shape you think will reward you.**You have 4 seconds to respond. If you don't respond in time, you will see "Too Late," and the task will move on.<br>After you choose, you will get feedback: A green smiling face means you were right.<br>A red sad face means you were wrong.<br><br>Sometimes, the shape that gives the reward may change without warning. You should only **start choosing the other shape when you are sure the rule has changed**. After each round, a plus sign (+) will appear for a short break before the next round begins.<br>Before the main task, you will have some practice trials. Tap the shape that you think will reward you within 4 seconds on each trial. You will see a happy or sad face after you choose to show if you were right or wrong.<br><br>Good luck! When you're prepared to begin the task, press **'Let's Go!'** below to start." | □ Yellow Square | □ Blue Cube | □ Blue Cube | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | 1 | **Blue Cube will provide a reward for this block.** | □ Blue Cube | □ Yellow Square | □ Blue Cube | 4000 ms |
| 3 | 1 | | □ Blue Cube | □ Yellow Square | □ Blue Cube | 4000 ms |
| 4 | 1 | | □ Blue Cube | □ Yellow Square | □ Blue Cube | 4000 ms |
| 5 | 1 | | □ Yellow Square | □ Blue Cube | □ Blue Cube | 4000 ms |
| 6 | 1 | | □ Blue Cube | □ Yellow Square | □ Blue Cube | 4000 ms |
| 7 | 1 | | □ Yellow Square | □ Blue Cube | □ Blue Cube | 4000 ms |
| 8 | 1 | | □ Yellow Square | □ Blue Cube | □ Blue Cube | 4000 ms |
| 9 | 1 | | □ Blue Cube | □ Yellow Square | □ Blue Cube | 4000 ms |

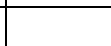
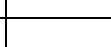
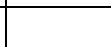
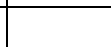
| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | 1 | | □ Blue Cube | □ Yellow Square | □ Blue Cube | 4000 ms |
| 11 | 1 | | □ Yellow Square | □ Blue Cube | □ Blue Cube | 4000 ms |
| 12 | 1 | | □ Blue Cube | □ Yellow Square | □ Blue Cube | 4000 ms |
| | | **Block 2- Instructions:**<br>"A new round starts with the same design.Pay attention and learn which one gives a reward!" When you're prepared to begin the task, press **'Let's Go!'** below to start." | | | | |
| 13 | 2 | | □ Blue Cube | □ Yellow Square | □ Yellow Square | 4000 ms |
| 14 | 2 | | □ Yellow Square | □ Blue Cube | □ Yellow Square | 4000 ms |
| 15 | 2 | | □ Yellow Square | □ Blue Cube | □ Yellow Square | 4000 ms |
| 16 | 2 | | □ Blue Cube | □ Yellow Square | □ Yellow Square | 4000 ms |

| | | | | | | |
|---|---|---|---|---|---|---|
| 17 | 2 | | □ Blue Cube | □ Yellow Square | □ Yellow Square | 4000 ms |
| 18 | 2 | | □ Yellow Square | □ Blue Cube | □ Yellow Square | 4000 ms |
| 19 | 2 | | □ Blue Cube | □ Yellow Square | □ Yellow Square | 4000 ms |
| 20 | 2 | | □ Yellow Square | □ Blue Cube | □ Yellow Square | 4000 ms |
| 21 | 2 | | □ Blue Cube | □ Yellow Square | □ Yellow Square | 4000 ms |
| 22 | 2 | | □ Yellow Square | □ Blue Cube | □ Yellow Square | 4000 ms |
| 23 | 2 | | □ Blue Cube | □ Yellow Square | □ Yellow Square | 4000 ms |
| 24 | 2 | | □ Yellow Square | □ Blue Cube | □ Yellow Square | 4000 ms |
| | | **Block 3- Instructions**<br>"A new round is starting! You'll see two sets of items: one set has a Yellow Star ⋆, Purple Oval □, and Blue Diamond □; the other set has a Red Heart □ and a Green Rectangle □. Your task is to figure out which design gives a reward. Pay attention carefully — the rules may change during the round. When you're | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | prepared to begin the task, press **'Let's Go!'** below to start." | | | | |
| 25 | 3 | **⋆+□+□will provide a reward for this block.** | ⋆+□+□ | □+□ | ⋆+□+□ | 4000 ms |
| 26 | 3 | | ⋆+□+□ | □+□ | ⋆+□+□ | 4000 ms |
| 27 | 3 | | □+□ | ⋆+□+□ | ⋆+□+□ | 4000 ms |
| 28 | 3 | | ⋆+□+□ | □+□ | ⋆+□+□ | 4000 ms |
| 29 | 3 | | ⋆+□+□ | □+□ | ⋆+□+□ | 4000 ms |
| 30 | 3 | | □+□ | ⋆+□+□ | ⋆+□+□ | 4000 ms |
| 31 | 3 | | ⋆+□+□ | □+□ | ⋆+□+□ | 4000 ms |
| 32 | 3 | | □+□ | ⋆+□+□ | ⋆+□+□ | 4000 ms |
| 33 | 3 | | ⋆+□+□ | □+□ | ⋆+□+□ | 4000 ms |
| 34 | 3 | | ⋆+□+□ | □+□ | ⋆+□+□ | 4000 ms |
| 35 | 3 | | □+□ | ⋆+□+□ | ⋆+□+□ | 4000 ms |
| 36 | 3 | | ⋆+□+□ | □+□ | ⋆+□+□ | 4000 ms |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | **Block 4- Instructions:**<br>"A new round starts with the same design.Pay attention and learn which one gives a reward! When you're prepared to begin the task, press **'Let's Go!'** below to start." | | | | |
| 37 | 4 | | □+□ | ⭐+□+□ | □+□ | 4000 ms |
| 38 | 4 | | ⭐+□+□ | □+□ | □+□ | 4000 ms |
| 39 | 4 | | ⭐+□+□ | □+□ | □+□ | 4000 ms |
| 40 | 4 | | □+□ | ⭐+□+□ | □+□ | 4000 ms |
| 41 | 4 | | ⭐+□+□ | □+□ | □+□ | 4000 ms |
| 42 | 4 | | ⭐+□+□ | □+□ | □+□ | 4000 ms |
| 43 | 4 | | □+□ | ⭐+□+□ | □+□ | 4000 ms |
| 44 | 4 | | ⭐+□+□ | □+□ | □+□ | 4000 ms |
| 45 | 4 | | □+□ | ⭐+□+□ | □+□ | 4000 ms |
| 46 | 4 | | ⭐+□+□ | □+□ | □+□ | 4000 ms |

| | | | | | | |
|---|---|---|---|---|---|---|
| 47 | 4 | | ⭑+□+□ | □+□ | □+□ | 4000 ms |
| 48 | 4 | | □+□ | ⭑+□+□ | □+□ | 4000 ms |
| | | **Block 5 Instructions:**<br><br>*"Welcome to the next round! You'll see two line patterns: Horizontal lines* ▬▬ *and Vertical lines* ▌▌▌ *. Your goal is to learn which design gives a reward Stay alert — the rule pattern may change,, so focus on the patterns you notice."* When you're prepared to begin the task, press **'Let's Go!'** below to start." | | | | |
| 49 | 5 | ▌▌▌ **will provide reward for this block.** | ▌▌▌ | ▬▬ | ▌▌▌ | 4000 ms |
| 50 | 5 | | ▬▬ | ▌▌▌ | ▌▌▌ | 4000 ms |
| 51 | 5 | | ▬▬ | ▌▌▌ | ▌▌▌ | 4000 ms |
| 52 | 5 | | ▌▌▌ | ▬▬ | ▌▌▌ | 4000 ms |
| 53 | 5 | | ▌▌▌ | ▬▬ | ▌▌▌ | 4000 ms |

| | | | | | | |
|---|---|---|---|---|---|---|
| 54 | 5 | | | | | 4000 ms |
| 55 | 5 | | | | | 4000 ms |
| 56 | 5 | | | | | 4000 ms |
| 57 | 5 | |  | | | 4000 ms |
| 58 | 5 | | |  | | 4000 ms |
| 59 | 5 | | |  | | 4000 ms |
| 60 | 5 | |  | | | 4000 ms |
| | | **Block 6- Instructions:**<br>"A new round starts with the same design.Pay attention and learn which one gives a reward! When you're prepared to begin the task, press **'Let's Go!'** below to start." | | | | |
| 61 | 6 | | | | | 4000 ms |
| 62 | 6 | |  | |  | 4000 ms |
| 63 | 6 | |  | |  | 4000 ms |

| | | | | | | |
|---|---|---|---|---|---|---|
| 64 | 6 | | | | | 4000 ms |
| 65 | 6 | | | | | 4000 ms |
| 66 | 6 | | | | | 4000 ms |
| 67 | 6 | | | | | 4000 ms |
| 68 | 6 | | | | | 4000 ms |
| 69 | 6 | | | | | 4000 ms |
| 70 | 6 | | | | | 4000 ms |
| 71 | 6 | | | | | 4000 ms |
| 72 | 6 | | | | | 4000 ms |

## 6. After the participant completes all the blocks, we would give instructions that emphasize the end of this task.

**Adolescents (14–18 years)**

*"Awesome work! You've completed this challenge — stay sharp, the next one is coming up!"*

**Adults (18–22 years)**

*"Well done! You've successfully finished this task — let's move on to the next part."*

**7. Scenarios that can occur during this task :**

## Scenario 1: Participant achieves consecutive correct responses on initial and reversed stimuli, nearing block end

- Consecutive correct criterion: 3 correct responses in a row.
- Participant selects the rewarded stimulus 3 times consecutively (e.g., Golden Treasure Box in trials 1-3).
- On meeting criteria, reversal is triggered immediately on the silver box (e.g., trials 6-8), reversal triggers again, switching repeatedly.
- Participants must now select the reversed rewarded stimulus (e.g., Silver Treasure Box).
- When a participant achieves 3 consecutive correlated stimuli.
- For any remaining trials (e.g., trials 9-12), participants chose based on the latest rewarded stimulus.
- The program must update reward contingency dynamically mid-block.
- Probabilistic feedback continues exactly per trial.
- Then, in the next block, the reversal happens. ( initially participants has to attend silver treasure boxes)

| **Trial** | **Adolescents (Left → Right)** | **Participant's Choice** | **Feedback given to participants** | **Notes** | | |
|---|---|---|---|---|---|---|
| **Block 1 – Rewarded stimulus: Golden Treasure Box** | | | | | **Response Time (s)** | **Points / Total Score** |
| 1 | Golden → Silver | Golden | ✓Correct | (1st correct in streak) | 2.3 | +110 → 3110 |
| 2 | Silver → Golden | Golden | ✓Correct | (2nd correct in streak) | 3.1 | +110 → 3220 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | Silver → Golden | Golden | ✅Correct | (3rd correct → Reversal triggered to Silver) | 2.7 | +110 → 3330 |
| 4 | Golden → Silver | Golden | ❌Incorrect | Reversal Error | 3.5 | -40 → 3290 |
| 5 | Silver → Golden | Silver | ✅Correct | (1st correct new streak) | 2.8 | +110 → 3400 |
| 6 | Golden → Silver | Silver | ❌Incorrect (Misleading Punishment) | (2nd correct in streak) | 3.2 | +110 → 3510 |
| 7 | Golden → Silver | Silver | ✅Correct | (3rd correct → Reversal triggered to Golden) | 2.9 | +110 → 3620 |
| 8 | Silver → Golden | Golden | ✅Correct | (1st correct new streak) | 2.6 | +110 → 3730 |
| 9 | Silver → Golden | Golden | ❌Incorrect (Misleading Punishment) | (counts as Correct → 2nd in streak) | 3.0 | -40 → 3690 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | Golden → Silver | Golden | ✅Correct | (3rd in streak → Reversal triggered to Silver) | 2.5 | +110 → 3800 |
| 11 | Silver → Golden | Silver | ❌Incorrect (Misleading Punishment) | (counts as Correct → 1st in streak) | 3.3 | -40 → 3760 |
| 12 | Golden → Silver | - | ❌Incorrect (Time is up) | streak disrupted, Silver remains last rewarded | 4.0 | -40 → 3720 |
| **Block Transition → Block 2 (Forced reversal to Golden, since Block 1 ended on Silver contingency)** | | | | | | |
| 1 | Silver → Golden | Golden | ✅Correct | (1st correct) | 2.7 | +110 → 3830 |
| 2 | Golden → Silver | Golden | ❌Incorrect (Misleading | (2nd correct) | 2.9 | +110 → 3940 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | Punishment) | | | |
| 3 | Silver → Golden | Golden | ✅Correct | (3rd correct → Reversal triggered to Silver) | 2.8 | +110 → 4050 |
| 4 | Golden → Silver | Silver | ✅Correct | (1st correct) | 3.0 | +110 → 4160 |
| 5 | Golden → Silver | Silver | ❌Incorrect (Misleading Punishment) | (counts as Correct → 2nd in streak) | 3.2 | -40 → 4120 |
| 6 | Silver → Golden | Silver | ✅Correct | (3rd correct → Reversal triggered to Golden) | 2.5 | +110 → 4230 |
| 7 | Silver → Golden | Golden | ✅Correct | (1st correct) | 2.6 | +110 → 4340 |
| 8 | Golden → Silver | - | ❌Incorrect (Time is up) | streak disrupted | 4.0 | -40 → 4300 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 | Golden → Silver | Golden | ✓Correct | (1st correct) | 2.9 | +110 → 4410 |
| 10 | Silver → Golden | Golden | ✓Correct | (2nd correct) | 2.7 | +110 → 4520 |
| 11 | Golden→ Silver | Golden | ✗Incorrect (Misleading Punishment) | (counts as Correct → 3rd correct → Reversal triggered to Silver) | 3.1 | -40 → 4480 |
| 12 | Silver → Golden | Silver | ✓Correct | Final correct – no errors | 2.8 | +110 → 4590 |

**Scenario 2: Participant does not learn rule; random responding without consecutive correct**

- Participant choices fluctuate without ever completing 3 consecutive correct responses.
- No reversal triggered within the block.
- Rewarded stimulus remains constant for the entire block.
- Task proceeds to the next block, which may enforce forced reversal.

**Scenario 2: Participant does not learn rule; random responding without consecutive correct**

| **Trial** | **Adolescents (Left → Right)** | **Participant's Choice** | **Feedback given to participant** | **Notes** | | |
|---|---|---|---|---|---|---|

| **Block 1 – Rewarded stimulus: Golden Treasure Box** | | | | | **Response Time (s)** | **Points / Total Score** |
|---|---|---|---|---|---|---|
| 1 | Golden → Silver | Silver | ✗Incorrect | Random choice, no streak | 2.9 | –40 → 2960 |
| 2 | Silver → Golden | Golden | ✓Correct | 1st correct | 3.0 | +110 → 3070 |
| 3 | Silver → Golden | Golden | ✗Incorrect (Misleading Punishment) | Counts as correct → 2nd correct | 2.7 | –40 → 3030 |
| 4 | Golden → Silver | Golden | ✗Incorrect | Random choice, streak broken | 3.2 | –40 → 2990 |
| 5 | Silver → Golden | Silver | ✓Correct | 1st correct | 2.8 | +110 → 3100 |
| 6 | Golden → Silver | Golden | ✗Incorrect (Misleading Punishment) | Counts as correct → 2nd correct | 3.1 | –40 → 3060 |
| 7 | Golden → Silver | Silver | ✗Incorrect | Random choice, streak broken | 2.9 | –40 → 3020 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 8 | Silver → Golden | Golden | ✓Correct | 1st correct | 3.0 | +110 → 3130 |
| 9 | Silver → Golden | Silver | ✓Correct (Misleading Reward) | Counts as correct → 2nd correct | 2.7 | +110 → 3240 |
| 10 | Golden → Silver | Silver | ✗Incorrect | Random choice, streak broken | 3.3 | -40 → 3200 |
| 11 | Silver → Golden | Golden | ✓Correct | 1st correct | 2.8 | +110 → 3310 |
| 12 | Golden → Silver | - | ✗Incorrect (Time is up) | Block ends, rewarded stimulus remains Golden | 4.0 | -40 → 3270 |
| **Block 2 – Rewarded stimulus: Silver Treasure Box (Forced Reversal)** | | | | | | |
| 1 | Silver → Golden | Silver | ✓Correct | 1st correct | 2.9 | +110 → 3380 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | Golden → Silver | Silver | ✗Incorrect (Misleading Punishment) | 2nd Correct; streak continues | 3.1 | –40 → 3340 |
| 3 | Silver → Golden | Silver | ✓Correct | 3rd correct ( Reversal Triggered: Silver is the new contingency) | 2.8 | +110 → 3450 |
| 4 | Golden → Silver | Golden | ✗Incorrect | Reversal error | 3.2 | –40 → 3410 |
| 5 | Golden → Silver | Golden | ✗Incorrect | 1st perseveratory error | 3.0 | –40 → 3370 |
| 6 | Silver → Golden | Golden | ✗Incorrect | Final Reversal Error | 3.1 | –40 → 3330 |
| 7 | Silver → Golden | Silver | ✓Correct | 1st correct in new streak (Participant finally adapts) | 2.7 | +110 → 3440 |
| 8 | Golden → Silver | Silver | ✗Incorrect (Misleading Punishment) | Counts as 2nd correct | 2.9 | –40 → 3400 |
| 9 | Golden → Silver | Silver | ✓Correct | 3rd correct, streak maintained (Reversal | 2.8 | +110 → 3510 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Triggered: Golden is the new contingency) | | |
| 10 | Silver → Golden | - | ✗Incorrect (Time is up) | Streak disrupted | 4.0 | -40 → 3470 |
| 11 | Golden→ Silver | Golden | ✓✓Correct | 1st correct | 2.9 | +110 → 3580 |
| 12 | Silver → Golden | Golden | ✓✓Correct | 2nd correct, Block ends | 2.7 | +110 → 3690 |

## Scenario 3: Participant achieves consecutive correct on initial stimulus but not on reversed stimulus nearing block end

- Participants completed 3 consecutive correct responses on initial rewarded stimulus (e.g., Golden Treasure Box in trials 1-3).
- Reversal triggered at that point; for example, from trial 4 onwards, rewarded stimulus flips to the silver box.
- The participant does not complete 3 consecutive correct responses on the silver box before the last trial (trial 12).
- Block ends with a rewarded stimulus as a silver box.
- The next block can start with  forced reversal.
- The program must log partial reversal learning and handle block transitions accordingly.

**Scenario 3: Participant achieves consecutive correct on initial stimulus but not on reversed stimulus nearing block end**

| **Trial** | **Adolescents (Left → Right)** | **Choice** | **Feedback given to participants** | **Notes** | | |
|---|---|---|---|---|---|---|

| **Block 1 – Rewarded stimulus: Golden Treasure Box** | | | | | **Response Time (s)** | **Points / Total Score** |
|---|---|---|---|---|---|---|
| 1 | Golden → Silver | Golden | ✅Correct | 1st correct | 2.8 | +110 → 3110 |
| 2 | Silver → Golden | Golden | ❌Incorrect **(Misleading Punishment)** | 2nd correct, streak continues | 2.9 | -40 → 3070 |
| 3 | Silver → Golden | Golden | ✅Correct | 3rd correct → **Reversal triggered to Silver** | 2.7 | +110 → 3180 |
| 4 | Golden → Silver | Silver | ✅Correct | 1st correct after reversal | 2.8 | +110 → 3290 |
| 5 | Silver → Golden | Golden | ✅Correct (**Misleading Reward**) | Breaks streak internally | 2.9 | +110 → 3400 |
| 6 | Golden → Silver | Silver | ✅Correct | 1st correct in new streak | 2.7 | +110 → 3510 |
| 7 | Golden → Silver | Golden | ❌Incorrect | Streak disrupted again. | 3.0 | -40 → 3470 |
| 8 | Silver → Golden | Silver | ❌Incorrect | Streak disrupted again. | 3.1 | -40 → 3430 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 | Silver → Golden | Silver | ✓Correct | 1st correct in new streak | 2.8 | +110 → 3540 |
| 10 | Golden → Silver | Silver | ✓Correct | 2nd correct | 2.9 | +110 → 3650 |
| 11 | Silver → Golden | Silver | ✓Correct (**Misleading Reward**) | Streak disrupted | 2.7 | +110 → 3760 |
| 12 | Golden → Silver | - | ✗Incorrect (**Time is up**) | Streak disrupted | 4.0 | -40 → 3720 |
| **Block 2 – Rewarded stimulus: Golden Treasure Box (Forced Reversal)** | | | | | | |
| 1 | Silver → Golden | Golden | ✓Correct | 1st correct | 2.8 | +110 → 3830 |
| 2 | Golden → Silver | Golden | ✗Incorrect (**Misleading Punishment)** | 2nd correct, streak continues | 2.9 | -40 → 3790 |
| 3 | Silver → Golden | Golden | ✓Correct | 3rd correct ( Reversal Triggered: Silver is the new contingency) | 2.7 | +110 → 3900 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | Golden → Silver | Silver | ✗Incorrect | Reversal Error | 3.0 | -40 → 3860 |
| 5 | Golden → Silver | Golden | ✓Correct (**Misleading Reward**) | Perseveratory error | 2.8 | +110 → 3970 |
| 6 | Silver → Golden | Silver | ✗Incorrect | Perseveratory error | 3.1 | -40 → 3930 |
| 7 | Silver → Golden | Silver | ✗Incorrect | Perseveratory error | 3.0 | -40 → 3890 |
| 8 | Golden → Silver | Golden | ✓Correct (**Misleading Reward**) | Perseveratory error | 2.9 | +110 → 4000 |
| 9 | Golden → Silver | Silver | ✗Incorrect | Final Reversal Error | 3.2 | -40 → 3960 |
| 10 | Silver → Golden | - | ✗Incorrect (**Time is up**) | Streak disrupted | 4.0 | -40 → 3920 |
| 11 | Golden→ Silver | Silver | ✓Correct | 1st correct | 2.8 | +110 → 4030 |
| 12 | Silver → Golden | Silver | ✓Correct | 2nd correct | 2.7 | +110 → 4140 |

## 8. Technical Implementation Notes

- **Background colour:** White

- **Device:** Tablet or phone, touch input only.
- **Response window:** 4000 ms exact, no extensions.
- **Highlight box:** blue outline appears the moment participant chooses a choice in the round.
- **Feedback distribution:** 75% contingent, 25% non-contingent randomized.
- **Reversal trigger:** after 3 consecutive responses with included misleading feedback (punishment, not reward).
- **Trial timing:**
    - Stimuli + choice: up to 4 sec response window.
    - Feedback: 1 sec with stimuli visible.
    - Fixation (+): remainder of trial to 5.3 sec total.
- After each round, break screen "+" for 300 msec.
- **Block transitions:**
- Instructions will be presented at every block to notify changes.

**9. Scoring Instructions for the tech team:**

**Scores given to participants in the computer interface (Adolescents Only)**

- Add or subtract points per trial based on feedback:
    - Correct choice: +110 points
    - Wrong choice: -40 points
- Display the current trial's score change near feedback (e.g., "+110" or "-40").
- Display total cumulative score updated every trial, visible during and after feedback.

**Errors that should be noted in Cognitive Flexibility Task (For Scoring Purposes):**

- **Note this should not be displayed for participants in the computer interface, it's for our report interpretation purposes.**

  **Recommended Data Columns for Cognitive Flexibility Task (will not be shown to participants for interpretation, for our assessment use):**
    - **Round Number:** Sequential number identifying each round.
    - **Block Number:** Indicates the current task block

- **Stimulus Presented:** Presenting which block stimuli was used.
- **Task Rule/Set:**
- **Participant Response:** Participant's actual response or choice. ( what stimulus was chosen by the participant.
- **Correct Response:** The correct or expected response based on the current rule.
- **Response Accuracy:** 1 for correct response, 0 for incorrect response.
- **Reaction Time (RT):** Time in seconds from stimulus onset to participant response, give an average estimate at the end.
- **Switch Indicator row :** indicating at what point the task requires switching the rewarding rules.
- **Feedback Given:** what feedback was given to the participant. ( in words).
- **Error Type:** If applicable, categorize errors (e.g., perseverative error, random error).

## Scoring of Errors

- When a participant gives a wrong answer immediately after the rule changes, count it as a Reversal Error, giving a total estimate in the end.
- When a participant keeps choosing the old, incorrect option repeatedly after the rule change, count each as a Perseverative Error, give a total estimate in the end.
- When a participant makes errors just before correctly adapting to the new rule, count these as Final Reversal Errors, giving a total estimate in the end.

## Scoring of Shifts

- **When a participant switches their choice after receiving a reward (win), record it as a Win-Shift.**
  Use this formula to calculate the Win-Shift Rate:
- Win-Shift Rate=Number of switches after wins/ Total number of win rounds
- **When a participant switches their choice after receiving no reward (loss), record it as a Lose-Shift.**
  Use this formula to calculate the Lose-Shift Rate:
- Lose-Shift Rate=Number of switches after losses/ Total number of lose rounds

## Additional Scoring Parameters

- **Total Rounds Answered:** Count of all rounds attempted.
- **Total Rounds not Answered:** Count of all rounds not attempted.
  - **Correct Responses:** Sum of all correct responses ( chose the stimuli that was rewarding)
  - **Incorrect Responses:** Sum of all incorrect responses (chose the stimuli that was not rewarding).
- **Accuracy of Overall Task :** Calculate the percentage of correct responses out of total rounds answered using:
- Accuracy = Number of Correct Responses/ Rounds Answered×100.

- **Reaction Time:** Calculate average RT combining correct rounds.