# DOCUMENTATION

# of

# CANTAB
# Cognitive Assessments

# in

# MIDUS Refresher 1
# Neuroscience Project (P5)

**University of Wisconsin ♦ Institute on Aging**

**October 2024**

## INTRODUCTION

This document is intended to provide details regarding the CANTAB (http://www.cambridgecognition.com/) cognitive assessments conducted during the Neuroscience Project's (P5) MIDUS Refresher 1 sessions and related measures.

CANTAB tests were typically performed following the psychophysiology task during day one of a participant's two-day visit, with the exception of the Cambridge Gambling Task (CGT), which was typically performed following the MRI scan on day two. Participants were given verbal instructions prior to each task. Tests were performed using a Portable SlimBook Panel Touchscreen PC and presspad, equipped with CANTAB software version 5.0. Whenever possible, tests were performed in the order listed below. This data was not collected for MIDUS 2, therefore the 1st Refresher wave represents the first instance of these measures. Partial variable names have been provided in brackets (e.g., [RA5NEPC] for ERT Percent Correct) where appropriate. For further details on variable naming, see *MR1_P5_VARIABLE_NAMES_20241015.*

In some cases, some data could not be provided due to time constraints during the day of the session, technical difficulties, or inability of participant to complete the task. In these cases, the appropriate missing value was listed.

**MOTOR SCREENING TASK (MOT)**

Task Description: In addition to being a user-friendly way of introducing CANTAB tasks and the touchscreen to the participant, the Motor Screening Task (MOT) provides a general assessment of whether sensorimotor deficits or lack of comprehension will limit the collection of valid data from the participant. Colored crosses are presented in different locations on the screen, one at a time. The participant must select the cross on the screen as quickly and accurately as possible.

Instructions to participant:

**"Here is the computer we will be using. I'm going to show you how it should be used. Are you ready?**

**You should use the tip of your forefinger of the hand you write with for it to work properly. If you touch it properly, the X will go away. You must then take your hand away and wait for the next one.**

**Now you try please. Remember to touch the X's with the tip of your forefinger when they flash."**

*Task ends after participant touches 10 X's*

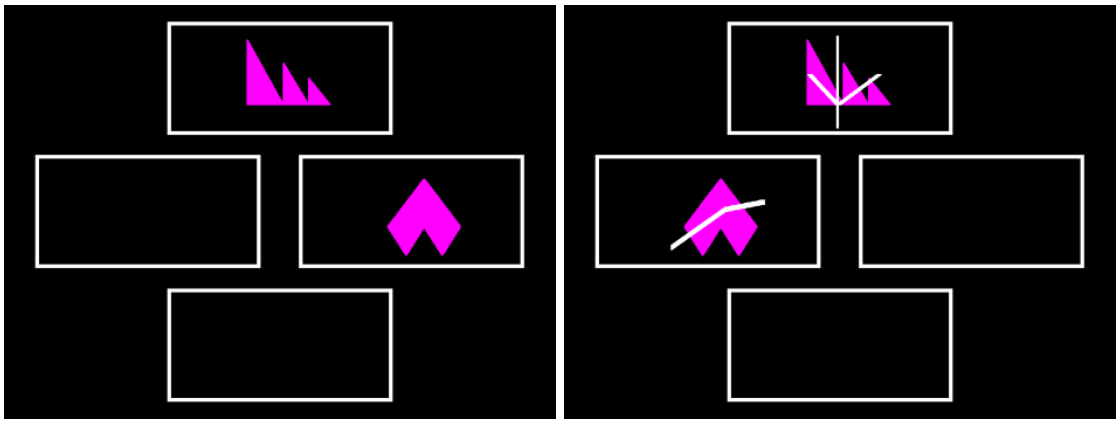
Measures:

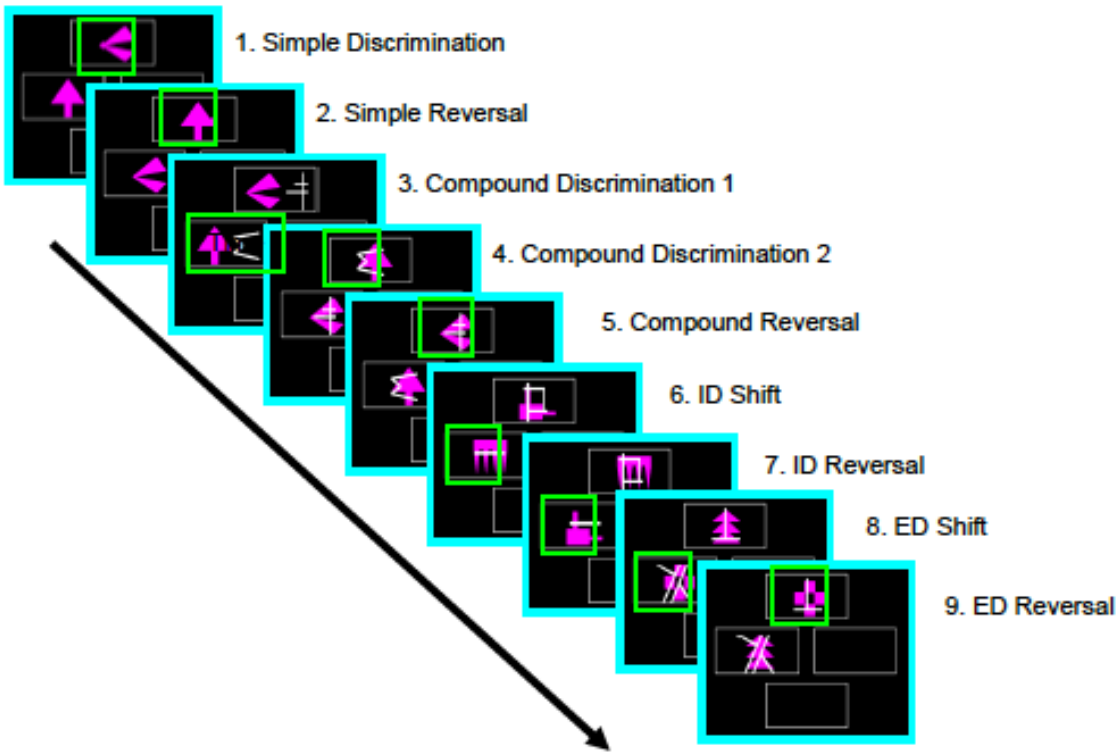
1. Mean Error **[RA5NME]**
2. Mean Latency **[RA5NML]**

## INTRA-EXTRA DIMENSIONAL SET SHIFT (IED)

Task Description: Intra-Extra Dimensional Set Shift (IED) is a test of rule acquisition and reversal. It features visual discrimination and attentional set formation maintenance, shifting, and flexibility of attention. This test is sensitive to changes to the fronto-striatal areas of the brain and is a computerized analog of the Wisconsin Card Sorting test.

Two artificial dimensions are used in the test: color-filled shapes and white lines. Simple stimuli are made up of just one of these dimensions, whereas compound stimuli are made up of both, namely white lines overlying color-filled shapes. The participant starts by seeing two simple color-filled shapes, and must learn which one is correct by selecting it. Feedback teaches the participant which stimulus is correct and, after six correct responses, the stimuli and/or rules are changed. These shifts are initially intra-dimensional (e.g., color-filled shapes remain the only relevant dimension), then later extra-dimensional (white lines become the only relevant dimension). Participants progress through the test by satisfying a set criterion of learning at each stage (six consecutive correct responses). If at any stage the participant fails to reach this criterion after 50 trials, the test terminates.






Instructions to participant:

**"Now you can see two patterns. One of the patterns is correct, and the other is wrong. What you have to do is to touch the one you think is correct. There is a rule that you can learn and follow to make sure you get it correct each time. The computer will be keeping track of how well you are doing and when it is clear that you know the rule, the computer will change it, but remember, this will not happen very often.**

**When the rule is changed, you will have to think of a different rule in order to go on**

**doing well. To begin with, there is nothing on the screen to tell you which of the two patterns is correct, so your first choice will be a simple guess. However, the computer will give a message after each attempt to tell you whether you were right or wrong.**

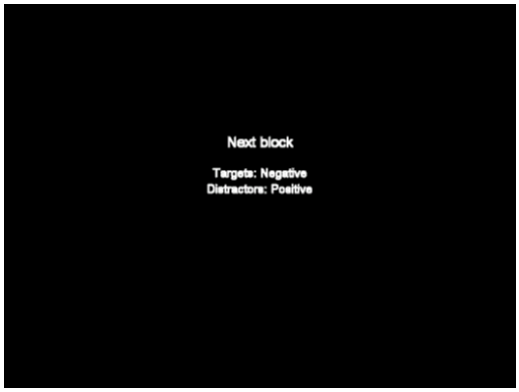
**You can start now."**

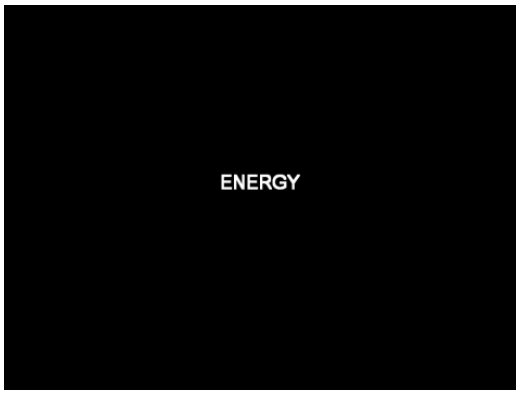
Measures:

1. Stages completed **[RA5NI01]**
2. Completed stage trials **[RA5NI02]**
3. Completed stage errors **[RA5NI03]**
4. EDS errors **[RA5NI04]**
5. Pre-ED errors **[RA5NI05]**
6. Total errors **[RA5NIT01]**
7. Total trials **[RA5NIT02]**
8. Total errors (adjusted) **[RA5NIT03]**
9. Total trials (adjusted) **[RA5NIT04]**
10. Reversal Learning [**RA5NIC01**]: Measures of reversal learning were derived from IED errors at blocks 2, 5, 7, and 9
11. Reversal Learning Scaled by Trials [**RA5NIC02]**
12. Attentional Flexibility [**RA5NIC03]**: Relative measures of attentional flexibility were derived from performance at the intradimensional shift (IED errors block 6) taken together with performance at the extradimensional shift (IED errors block 8).
13. Attentional Flexibility Scaled by Trials [**RA5NIC04]**

**AFFECTIVE GO/NO-GO (AGN)**

Task Description: Affective Go/No-Go (AGN) assesses information processing biases for positive and negative stimuli. The test consists of several blocks, each of which presents a series of words from two of three different affective categories: Positive (for example, joyful); Negative (for example, hopeless); Neutral (for example, element). Prior to each block, the participant is given a target category and a distractor category and is asked to respond with a button press only when words matching the target category are shown.




Instructions to participant:

**"In this test, a series of words will appear very quickly on the screen. A third of these words are positive, or happy words. A third of them are negative, or sad words. A third of them are neutral words, which are neither happy nor sad. However, each block of words will consist of only 2 types of words.**

**All you have to do is press the bottom button as fast as you can as soon as you see a (*target valence*) word. Remember to respond as fast as you can while trying not to make any mistakes."**

Measures:

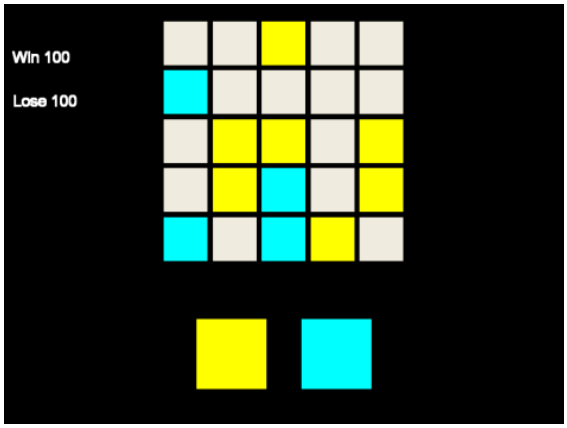
1. Mean correct latency (separate measures by valence, shift vs. non-shift blocks) **[RA5NAL…]**
2. Total commissions (separate measures by valence, shift vs. non-shift blocks) **[RA5NATM…]**
3. Total omissions (separate measures by valence, shift vs. non-shift blocks) **[RA5NATO…]**

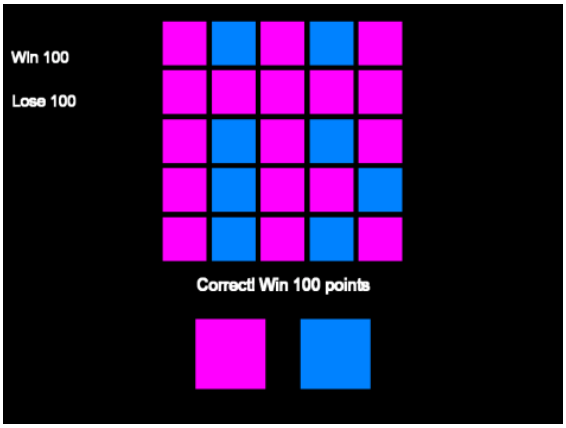
4. Mean affective response bias **[RA5NAR]**

## INFORMATION SAMPLING TASK (IST)

Task Description: The Information Sampling Task (IST) tests impulsivity and decision-making. The participant is presented with a 5x5 array of gray boxes on the screen and two larger colored panels below these boxes. The participant is instructed that they are playing a game for points, which they can win by making a correct decision about which color is in the majority under the gray boxes. They must select the gray boxes one at a time; these then open up to reveal one of the two colors shown at the bottom of the screen. Once a box has been selected, it remains open. When the participant has made their decision about which color is in the majority, they must select the panel of that color at the bottom of the screen to indicate their choice. After the participant has indicated their choice, all the remaining gray boxes on the screen reveal their colors and a message is displayed to state whether or not they were correct.

The colors change from trial to trial. At the end of a trial, the gray boxes are displayed on the screen again. The speed at which they are displayed depends on how fast the trial was completed, so that there is always at least 30 seconds between trials. There are two conditions – the fixed win condition, in which the subject is awarded 100 points for a correct decision regardless of the number of boxes opened, and the decreasing win condition, in which the number of points that can be won for a correct decision starts at 250 and decreases by 10 points for every box selected. In both conditions, an incorrect decision costs 100 points.



Instructions to participant:

*Practice Trial*

"**You are about to play a game in which you can win points. The game will take about 10 minutes to complete. It consists of a short practice and then two main parts. On each main part, there will be 10 turns. On every turn, you will see 25 boxes on the screen.**

**To start with, all the boxes will be grey, like they are at the moment. When you touch a box, it opens and shows one of two colors. You have to decide whether there are more blue boxes or yellow boxes, and then touch the panel of that color at the bottom of the screen.**

**If you make a correct decision, you win 100 points, and if you make a wrong decision, you lose 100 points. You will start with 100 points. Try to win as many points as you can.**

**Try touching one of these boxes now.**
**And another box."**

*Fixed win assessed stage:*

**"Now we'll try playing for some more points. It will be just the same as the practice part, and there will be different colors for every turn. Again, you will start with 100 points, and you have to decide whether are more boxes of (color 1) or (color 2).**

**You will win 100 points if you choose the correct color, regardless of how many boxes you open, and you can open as many boxes as you wish. You will lose 100 points if you it wrong. Try to win as many points as you can."**

*Decreasing win assessed stage:*

**"Now we'll try playing for some more points. The way you win points this time is slightly different.**

**Again, you'll start with 100 points. However, on each of these turns, the amount you can win starts at 250 points and will go down with <u>every box you open</u>, so the earlier you make you decision, the more points you will win, if you get it right.**
**You will lose 100 points if you get it wrong, regardless of when you make your decision. Try to win as many points as you can."**

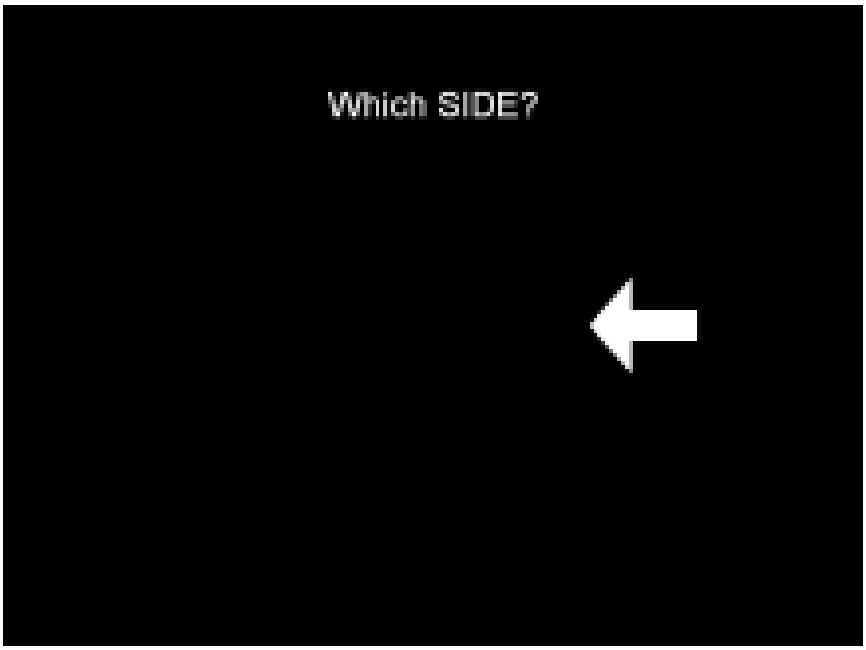
<u>Measures:</u>

1. Discrimination errors (separated by win condition) **[RA5NS…]:** This is the number of trials where the subject chose a color that was not in the majority at the point of decision, for the specified win condition.
2. Sampling errors (separated by win condition) **[RA5NS…]:** This is the number of trails where the subject chose a color that was not in the overall majority but was in the majority at the point of decision, for the specified win condition.
3. Mean opening box latency (separated by win condition **[RA5NS…]**
4. Mean number of boxes opened (separated by win condition) **[RA5NS…]**
5. Mean P(Correct) (separated by win condition) **[RA5NS…]:** This is the mean of per-trial probability value over all trials with the specified win condition. The value is the probability that the color chosen by the subject at the point of decision would be correct, based only on the evidence available to the subject at that time, and assuming each box had a 0.5 probability of assuming a particular color.

## ATTENTION SWITCHING TASK (AST)

<u>Task Description:</u> A paradigm requiring participants to switch between performing multiple different individual tasks. The Attention Switching Task (AST) is a test of the participant's ability to switch attention between the direction or location of an arrow on screen. This test is a sensitive measure of frontal lobe and 'executive' dysfunction. The test begins with an arrow in the center of the screen which points either to the left or to the right. The participant is introduced to two buttons, one on the left and one on the right, and is asked to press a button corresponding to the direction in which the arrow is pointing. After this initial training, the participant is then told that the arrow might appear on the left or the right side of the screen and, depending on the cue given at the top of the screen, the participant must either press the left or right button to indicate on which side

of the screen the arrow is displayed, or else press the button corresponding to the direction in which the arrow is pointing.




Instructions to participant:

*Prior to first block ("Which Direction?")*

**"In this task an arrow will appear on the screen pointing either to the left or to the right.**

**Before each problem, you will see the instruction, "Which DIRECTION?"**

**When you see the arrow pointing to the left, press the left button. When you see the arrow pointing to the right, press the right button. Press the buttons as quickly as you can while trying to avoid making mistakes. Are you ready?"**

*Prior to second block ("Which Direction?")*

**"This time the arrows will appear in different places on the screen. Ignore where the arrow appears and continue to press the left button when the arrow points left, and the right button when the arrow points right. Are you ready?"**

*Prior to third block ("Which Side?")*

**"This time you will see that the screen now says "Which SIDE?". You now need to ignore which way the arrow is pointing. Instead press the button on the *side of the screen* that the arrow appears on.**

**Press the left button when the arrow is on the left side of the screen, and the right button when the arrow is on the right side of the screen. Are you ready?"**

*Prior to remaining blocks (Both "Which Direction?" and "Which Side?")*

**"For this next part, you should either press the button on the same SIDE of the screen as the arrow, or press according to the DIRECTION the arrow is pointing.**

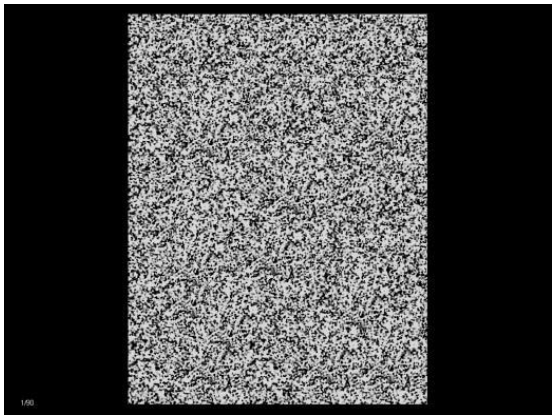
**You will see the words "Which SIDE" or "Which DIRECTION" before each arrow, to tell you which rule to follow.** "

Measures:

1. Total correct trials **[RA5NTT…]**
2. Total incorrect trials **[RA5NTT…]**
3. Total commission errors **[RA5NTT…]**
4. Total omission errors **[RA5NTT…]**
5. Congruency cost (mean) **[RA5NTCC…]**
6. Percent commission trials **[RA5NTP…]**
7. Percent correct trials **[RA5NTP…]**
8. Percent incorrect trials **[RA5NTP…]**
9. Percent omission trials **[RA5NTP…]**
10. Mean latency **[RA5NTL…]**
11. Switch cost (mean) **[RA5NTCS…]**

**EMOTION RECOGNITION TASK (ERT)**

Task Description: The Emotion Recognition Task (ERT) measures the ability to identify six basic emotions in facial expressions along a continuum of expression magnitude. Computer-morphed images derived from the facial features of real individuals, each showing a specific emotion, are displayed on the screen, one at a time. Each face is displayed for 200 ms and then immediately covered up to prevent residual processing of the image. The participant must select which emotion the face displayed from 6 options (sadness, happiness, fear, anger, disgust, or surprise).




Instructions to participant:

**"Before we start, I will give you some instructions about how to do this test. Please**

**listen carefully to the instructions as there will be no practice tries.**

**In this task you will be required to identify emotions from facial expressions. First there will be a white cross on the screen. Please look at the cross, so you are ready for the face which will be shown.**

**A face will appear on the screen for a very short time, so you must watch carefully.**

**Then the face will be covered up quickly, and you will see six boxes, which describe different emotions. These are: Anger, Happiness, Fear, Surprise, Sadness, and Disgust.**

**Touch the button that you think best describes the emotion on the face that you saw.**

**You may not always find it easy to decide which emotion has just been shown. Choose the one you think is correct, and please work as quickly as you can.**

**After you choose an emotion, the white cross will be displayed again, ready for the next problem.**

**Do you have any questions before we start?"**

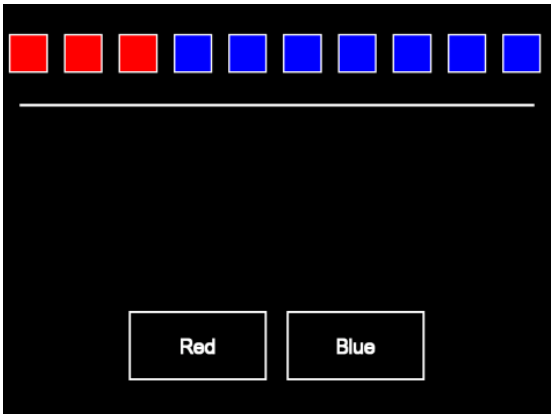
Measures:

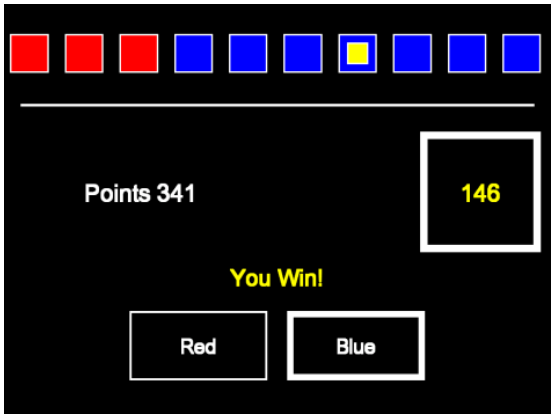
1. Percent correct (overall and by condition) **[RA5NEPC…]**
2. Total number correct **[RA5NETC]**
3. Total number incorrect **[RA5NETI]**
4. Mean overall response latency (overall and by condition) **[RA5NEL…]**

**CAMBRIDGE GAMBLING TASK (CGT)***

*Note that while other CANTAB tasks are typically collected on day one of a participant's two-day visit, CGT is typically collected on day two, following the MRI scan.

Task Description: The Cambridge Gambling Task (CGT) assesses decision-making and risk-taking behavior outside a learning context. Unlike other 'gambling' tasks, CGT dissociates risk-taking from impulsivity because in the ascending bet condition the participant who wants to make a risky bet has to wait patiently for it to appear. On each trial, the participant is presented with a row of ten boxes across the top of the screen, some of which are red and some of which are blue. At the bottom of the screen are rectangles containing the words 'Red' and 'Blue'. The participant must guess whether a yellow token is hidden in a red box or a blue box. In the gambling stages, participants start with a number of points, displayed on the screen, and can select a proportion of these points, displayed in either rising or falling order, in a second box on the screen to gamble on their confidence in this judgment. A stake box on the screen displays the current amount of the bet. The participant must try to accumulate as many points as possible.




Instructions to participant:

*Ascending Bet Condition-Practice*

**"You can see a row of boxes across the top of the screen. At the moment, there are "*X*" red boxes and "*Y*" blue boxes. The computer has hidden a yellow token under**

**one of the boxes. All you have to do is decide whether you think it is hidden under a red or blue box and touch the "Red" or "Blue" square at the bottom of the screen. This time I think it is in a Blue box, so I will touch the "Blue" square.**

**Now you try."**

*After participant makes guess:*

**"We are now going to give you 100 points to start with. After you choose Red or Blue, you have to bet a certain amount of points that you will win. So, first of all, I decide it is in the RED box.**

**Now you get offered bets in this square.** (*Point to stake box*)

**The first bet you are shown is SMALL, but as you wait, the bet gets larger, so you can choose the size of your bet. To make your bet, just touch the number, like this. If you win, your bet gets added to your score, and if you lose, it gets taken away. That time I bet** *"X"* **points, and won/lost a total of** *"X"* **points. The idea is to build up as many points as you can. Try not to let your score get as low as one point, because then you will lose the game. Now you try. You get 3 turns to practice with the bets."**

*Ascending Bet Condition-Trial*

**"Now we're going to do some more problems like that. Try to make as much as you can."**

*Descending Bet Condition-Practice*

**"This time, the way you select your bets is slightly different, so the first bet you are offered will be LARGE, and then they will gradually get smaller. You can begin the practice."**

*Descending Bet Condition-Trial*

**"Now we will do some more problems like that. Try to make as much as you can."**

Measures:

1. Quality of decision-making (overall and by condition) **[RA5NGQ…]:** This measure is the proportion of the trials on which the subject chose to gamble on the more likely outcome.
2. Deliberation time (overall and by condition) **[RA5NGD…]:** The mean latency from presentation of the colored boxes to the subject's choice of which color to bet on.
3. Risk taking (overall and by condition) **[RA5NGR…]:** This measure reports the mean proportion of the current points total (the nominal percentage, between 5% - 95%, which is used to calculate the stake displayed in the stake box) that the subject chose to risk on gamble test trials for which they had chosen the more likely outcome.
4. Risk adjustment (overall and by condition) **[RA5NGJ…]:** This measure reflects the tendency to bet a higher proportion of points on trials when the large majority of the boxes are the color chosen than when a smaller majority of the boxes are the color chosen.
5. Delay aversion **[RA5NGA]:** This measure reflects the tendency to bet larger amounts when the possible bet amounts are presented in descending order than when the amounts are presented in ascending order. It is calculated by subtracting the Risk Taking measure, calculated for ascending gamble trials, from the Risk Taking measure, calculated for descending trials.
6. Proportion bet (overall and by condition) **[RA5NGP…]:** This measure reports the average proportion of the current points total (using the nominal percentage, between 5%-95%) that the subject chose to risk on each gamble test trial, including trials on which they bet on the less likely outcome, and trials on which both outcomes were equally likely.