

# Naval Submarine Medical Research Laboratory

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## **Standard Operating Procedures for the Defense Automated Neurobehavioral Assessment (DANA™)**

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## Standard Operating Procedures for the Defense Automated Neurobehavioral Assessment (DANA)

Authors:

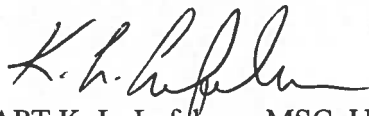
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## **I. INTRODUCTION**

The Defense Automated Neurobehavioral Assessment (DANA™) is a computerized neuropsychological assessment tool created to test an individual's cognition and level of functioning. This tool can be used to determine if changes in cognitive function are present in response to trauma, illness, or exposure to environmental stressors. The DANA™ software is pre-installed on a commercially-available tablet (i.e., a Samsung Galaxy Tab S2™ as of this publication date) and provides the tests in a convenient, mobile technology to ensure timely data gathering within a research setting. The DANA™ software functions on Android™ operating systems and has been tested in several different environments (Haran, Dretsch, & Bleiberg, 2016; Lathan, Spira, Bleiberg, Vice, & Tsao, 2013).

## **II. PURPOSE**

The purpose of this Standard Operating Procedure (SOP) is to supply directions on how to make use of all the functions in the DANA™ v4.1.0-SOCOM app that is installed on the Samsung Galaxy Tab S2™. These instructional procedures are for constructing, distributing, and interpreting the DANA™ neurocognitive assessments. The structure and format of this SOP is consistent with the format of the following references: the User Guide Version 1.2 for DANA™ v4.1.0-SOCOM (AnthroTronix, Inc., 2017; AnthroTronix, Inc., 2013) and Using the Defense Automated Neurobehavioral Assessment (DANA™) v1.5.3 Application on the Trimble Nomad (Lovelace, 2014). The current SOP updates and expands upon operating procedures outlined in previous manuals, utilizing feedback from technical and non-technical users to ensure greater accessibility of instructions and facilitate ease of use of the assessment tool. Specifically, this SOP provides guidance for assessment administration on an IT-hardened tablet meeting Defense Information Systems Administration (DISA) security specifications.

## **III. PERSONNEL QUALIFICATIONS**

This SOP is written for general use.

## **IV. EQUIPMENT**

The Samsung Galaxy Tab S2™ uses an Android™-based operating system. The DANA™ v4.1.0-SOCOM exclusively operates on Android™. The Samsung Galaxy Tablet S2™ is an acceptable device to support the DANA™ app. This SOP requires the DANA™ v4.1.0-SOCOM application be pre-installed on to the Samsung Galaxy Tab S2™.

## V. INSTRUCTIONAL STEPS

### A. Power On

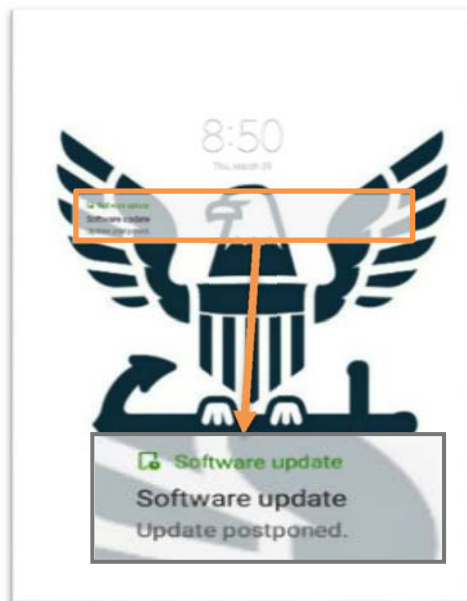
1. Turn tablet on by pressing and holding down the power button located on the top right hand side of the tablet.
2. Once powered on, a notification may appear on the lock screen stating “**Software update: Update postponed.**” This indicates a system update is needed (Figure 1).

**Note:** If a system update notification did not appear, skip to Section V.C.

### B. System Update

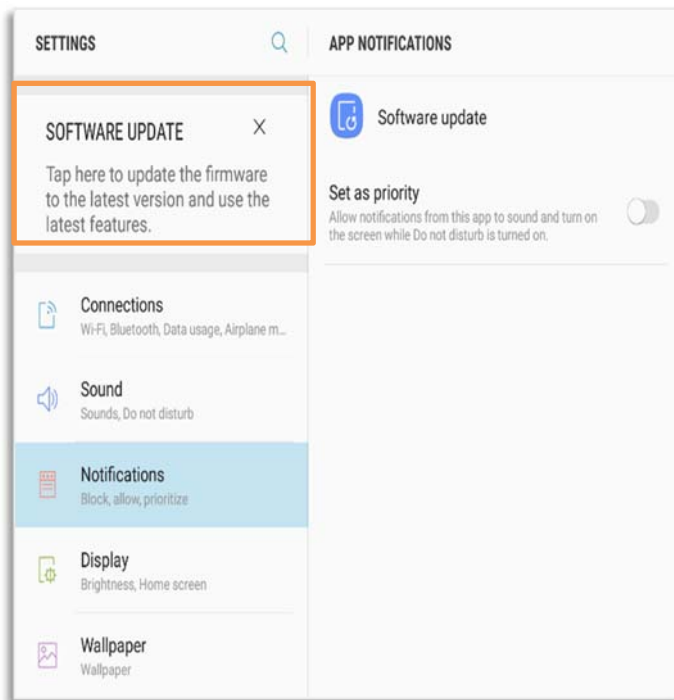
1. Select and hold the notification until the Settings screen appears (Figure 1).
2. Once the Settings screen appears select the tab labeled, “**Connections.**” Connect the tablet to the available and acceptable Wifi source.

**Caution:** The DANA™ software can be used as a tool for research or for clinical diagnosis. If personally identifiable information (PII) is stored within this application, the administrator should ensure that the Wifi source is properly secured prior to initiating a system update.

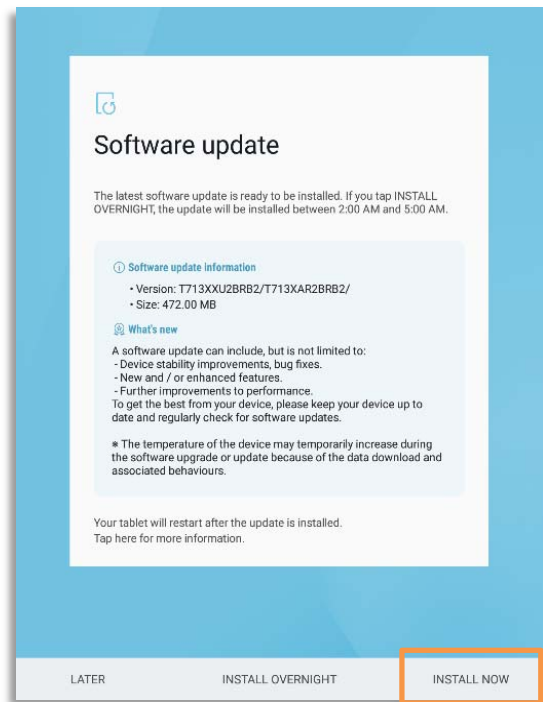


**Figure 1. Lock Screen: Software update: Update Postponed Notification**

3. Once connected to Wifi, select the tab labeled, “**Software Update.**” (Figure 2).
4. Once the next screen that appears, select the “**Install Now**” button on the bottom right hand corner to begin the update process (Figure 3).



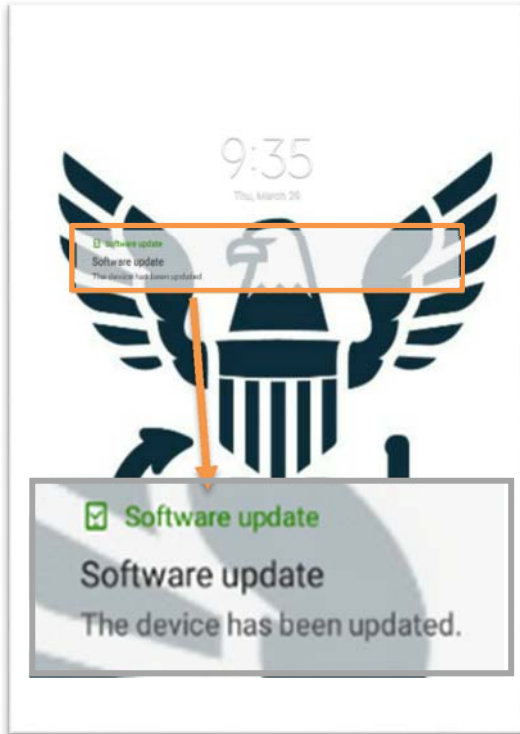
**Figure 2. Settings Page: Software Update**



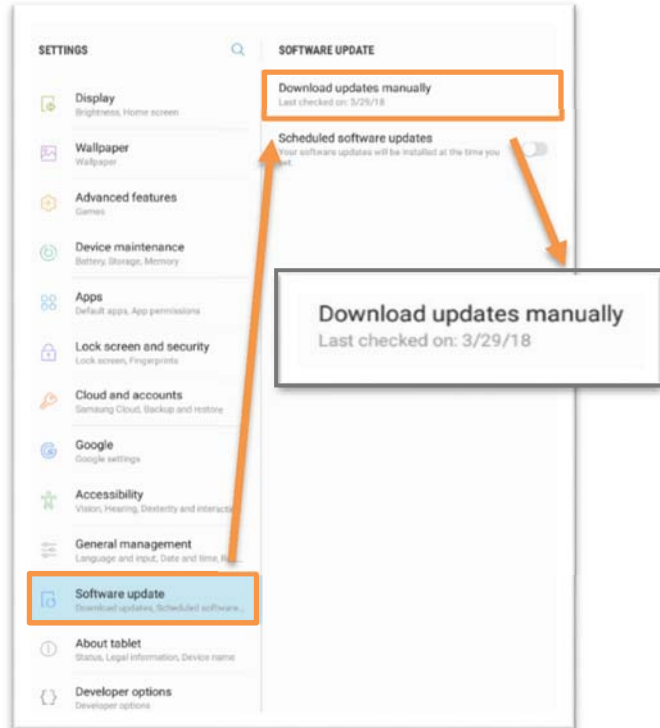
**Figure 3. Software Update: Install Now**

5. After installing the update, a notification will appear on the lock screen stating, “**Software update: The device has been updated.**” Select and hold the notification until the Settings screen appears (Figure 4).
6. Scroll down and select the tab labeled, “**Software update.**” Then, under the tab labeled, “**Download updates manually,**” the current date will be displayed (Figure 5). Once the date is verified, press the “recent” button (☐) on the bottom left hand side of the tablet and close out the Settings window.

**Note:** Disconnect from the internet after the software update has been completed. This is a security precaution to ensure data is not uploaded to any other outside source and to limit potential interruptions while tests are occurring.



**Figure 4. Lock Screen: Software Update: The device has been updated**



**Figure 5. Settings Page: Download Updates Manually**

### C. Open DANA™ Application

1. If the tablet is already powered on, simply press the top button on the right hand side to bring up the lock screen.
  - a) App notifications are disabled prior to shipment of tablets. However, should any app notifications appear on the screen then the notifications must be turned off prior to testing. While on the lock screen select and hold the notification until the settings page opens (following the same process as described in Section V.B.). If there are no notifications on the lock screen swipe up to unlock the tablet and skip to Step 2 of this section.
  - b) In the list of tabs on the left hand side, select the tab labeled “**Notifications.**” On the right hand side, a list of apps will appear showing the notification buttons turned on. Go through the list and turn off all the notifications by selecting the off button next to each app. Once finished, close out the Settings window previously described in Section V.B.
2. Launch DANA™ SOCOM by selecting the DANA™ APP.

- a) If launching DANA™ for first time if asked to “**Allow DANA SOCOM to access photos, media, and files on your device,**” select “**Allow!**” This will authorize the app to save exported data files to the device’s internal storage.

**Caution:** DO NOT SELECT DENY! If you select “**Deny,**” the tablet will have to be shipped back to the Naval Submarine Medical Research Laboratory to reset the option.

**Note:** Functions on the systems are limited to use of the DANA™ software only as the tablet has been IT-hardened to meet DISA specifications. Personnel will not have access to other applications and only limited access to the device settings. Settings may be accessed only when prompted for system updates, as described above in Section V.B.

#### **D. Log In Page**

1. Log in to DANA™ with the username and password provided below (the keyboard will appear after you tap on the screen):
  - Username: admin
  - Password: pass6677
  - a) The user must sign in every time the app is closed and reopened.
  - b) After signing in, if the DANA™ administration is disrupted, the application will automatically log out for data security and privacy purposes.

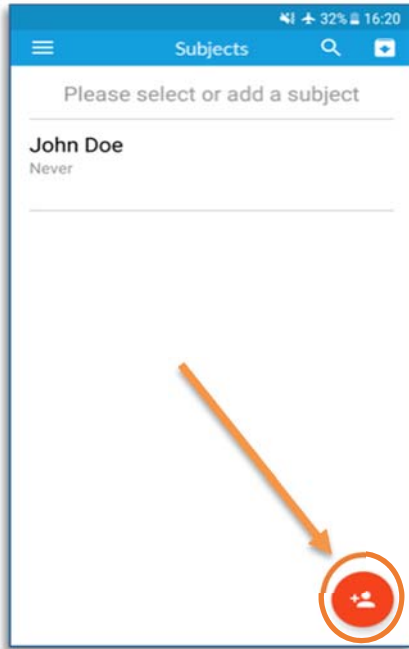
**Caution:** If a disruption occurs during a test, the subject’s data for that test will be deleted. Interruptions may include: selecting the device Home button, selecting the device Multi task button, putting the display to sleep or allowing the display to timeout, and turning the device off.

**Note:** DANA™ SOCOM is an offline application. Data is unable to be uploaded to outside servers (including virtual servers) and the tablet shall not be connected to the internet unless a software update is needed (as described above).

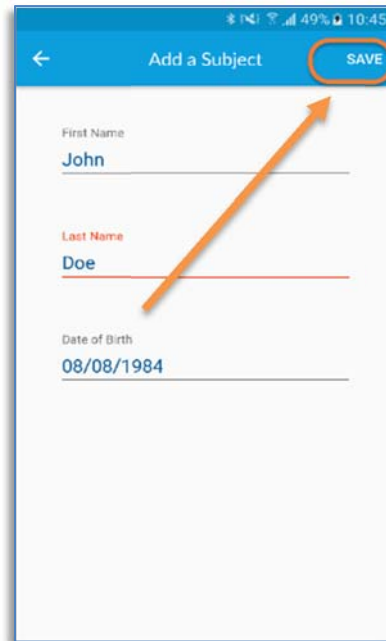
#### **E. Adding a New Subject**

1. Select the tab labeled “**Subjects.**”
2. To add a new subject, select the orange circle on the bottom right hand side of the screen (Figure 6).

3. Enter subject information (e.g., first name, last name, and date of birth) then select the “**Save**” button in the top right hand corner (Figure 7).



**Figure 6. Subject Screen:  
Adding a New Subject**

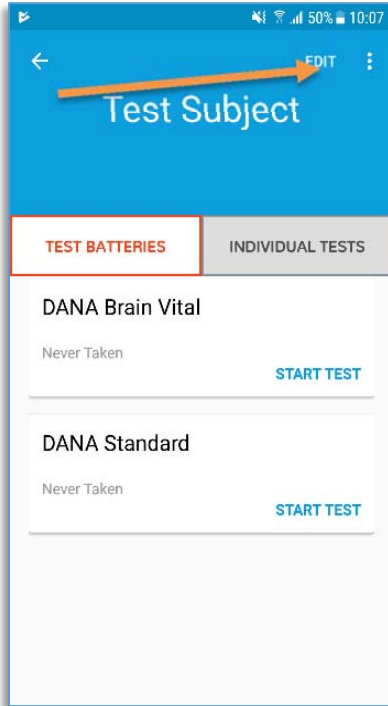


**Figure 7. Subject Screen:  
Adding Subject's Information**

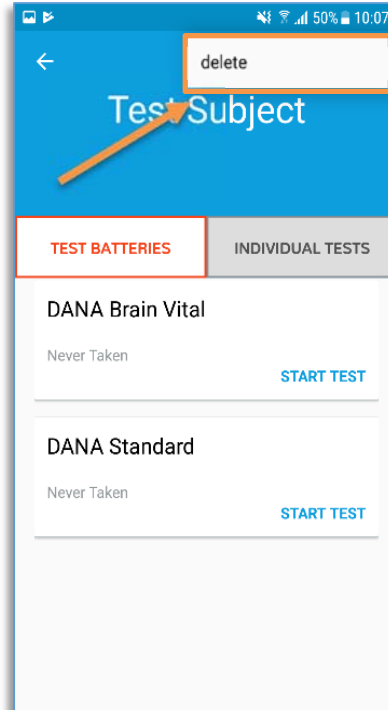
#### **F. Deleting a Subject**

1. A subject can only be deleted if the subject has not taken any tests.
2. Select the name of the subject that needs to be deleted.
3. Select the overflow menu icon (3 vertical stacked dots) next to the edit button (Figure 8).
4. Select the “**Delete**” button that will appear in the same corner as the overflow menu icon (Figure 9).
5. A menu will appear asking, “**Would you like to delete the current subject?**” Select the “**Delete**” button on the bottom right hand corner of the menu.

**Warning:** Subject records can only be deleted if there are no prior tests recorded under that subject name. If a subject has completed a test, the only way to delete the subject is by uninstalling and downloading the app or clearing the data on the app via the Android™ Settings menu, which cannot be accessed without a prompted notification. Both of these options will delete all prior subject data stored on the DANA™ app.



**Figure 8. Subject Screen:  
Menu Icon (3 dots)**



**Figure 9. Subject  
Screen: Delete Button**

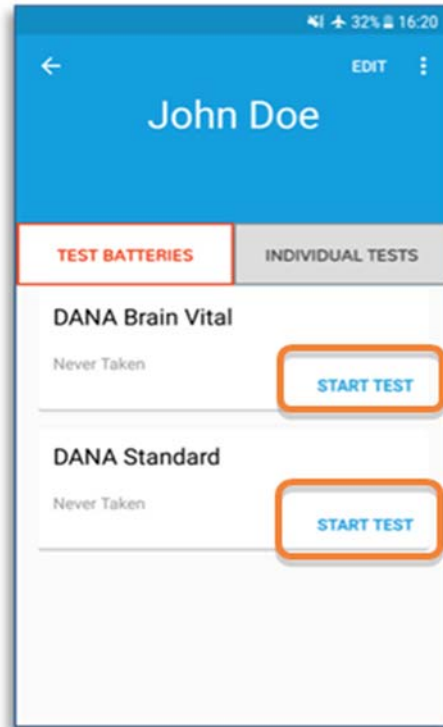
### G. Administering a Test

1. After adding a subject, select their name from the Subject screen. The search bar can also be used to search a subject's name within a long list (Figure 10).
2. After selecting the subject's name, there are two tabs to choose from: "**Test Batteries**" and "**Individual Tests.**" The tab labeled "**Test Batteries**" contains two options: "**DANA Brain Vital**" and "**DANA Standard.**" The tab labeled "**Individual Tests**" contains all the tests available on the DANA™ app. (The default Test Batteries available are listed in Section V.H. Details on each individual test are summarized in Sections VII. A-R.) Select the battery or individual test the subject will complete by selecting on the "**Start Test**" button (Figure 11).

**Warning:** It is recommended that the tablet be placed on a flat surface during administration. If deployed in an operational environment where this is not possible, ensure that the subject holds the tablet with their non-dominant hand. Subjects should be instructed not to hold the tablet in such a way that the fingers of their non-dominant hand touch the screen. The subject will use the index finger of their dominant hand to make responses. The index finger should hover a quarter of an inch away from the screen prior to making each response. If this is not followed, it could result in skewed or inaccurate data.



**Figure 10. List of Subject Names and Search Bar**



**Figure 11. Subject Screen: Start Test Button**

3. Hand the Galaxy Tablet S2™ to the subject to complete the test. The screen will provide directions for the subject. When the test is complete, the subject will be prompted to return the tablet to the examiner.

**Caution:** If the subject interrupts the test by pressing the device Home button, selecting the Multi-task button, putting the display to sleep (or allowing the display to timeout), or turning the device off, the data will be discarded for that session. The subject will have to start the test from the beginning.

4. When the subject hands the device back, select the button labeled **“Assessment Completed.”**

**Note:** Be advised, the DANA™ app may log out after this step for security reasons. If logged out, follow the steps for logging in located in Section V.D.

## **H. Default Test Batteries**

1. DANA™ Brain Vital takes approximately 5 minutes to complete and includes (shown in sequential order):
  - a) Simple Reaction Time
  - b) Procedural Reaction Time
  - c) Go/No-Go
2. DANA™ Standard takes approximately 20 minutes to complete and includes (shown in sequential order):
  - a) Simple Reaction Time
  - b) Code Substitution (Learning)
  - c) Procedural Reaction Time
  - d) Spatial Processing
  - e) Go/No-Go
  - f) Match to Sample
  - g) Memory Search (Sternberg)
  - h) Simple Reaction Time
  - i) Patient Health Questionnaire 8
  - j) Insomnia Severity Index

## **I. List of Default Individual Tests**

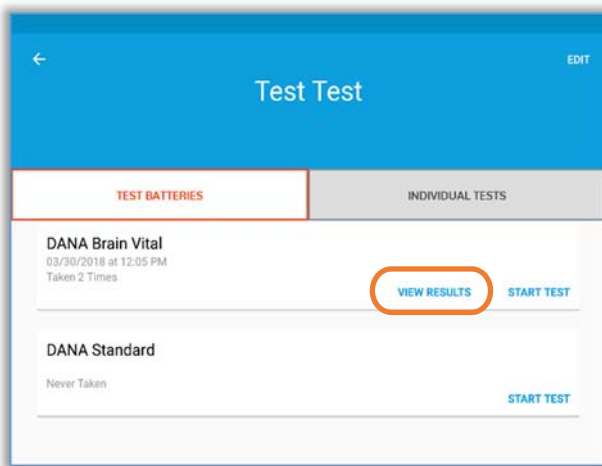
(Individual Tests are not listed in any particular order)

1. Simple Reaction Time
2. Procedural Reaction Time
3. Go/No-Go
4. Code Substitution (Learning & Recall)
5. Spatial Processing
6. Match to Sample
7. Memory Search (Sternberg)

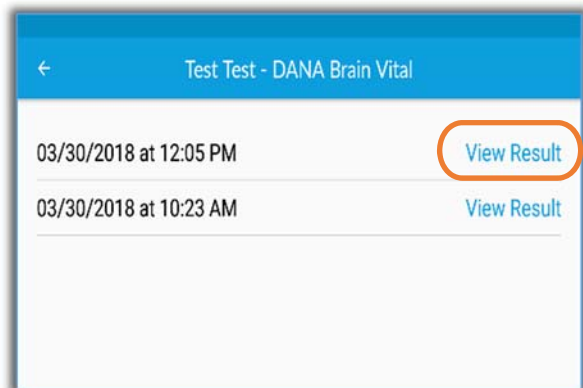
8. Patient Health Questionnaire 8
9. Insomnia Severity Index
10. PTSD- Check List- Civilian
11. PTSD- Check List- Military
12. Primary Care PTSD Screen
13. Pittsburgh Sleep Quality Index
14. Stanford Sleepiness Scale
15. Combat Exposure Scale
16. Deployment Symptom Inventory
17. Military Acute Concussion Evaluation

**J. Viewing Results on the Galaxy Tablet**

1. Log back into the DANA™ app if logged out during the previous step.
2. Select the button labeled “**Subjects.**”
3. Select the name of the subject desired. Under “**Test Batteries**” tab, select the button labeled “**View Results**” (Figure 12).
4. The next screen will display all the times and dates the subject was previously administered the chosen test battery. Select the time and date to be viewed by selecting the button labeled “**View Results**” (Figure 13).



**Figure 12. Subject Screen: View Results Button**



**Figure 13. Previous Test Administrations within a Test Battery**

- After selecting a previously administered test battery, the app gives options for inspection of the data. There are three options for viewing results: Summary, Graph (for multiple administrations), and Raw. The Graph data view and Raw data view tabs require a specific test to be chosen to view the results. Refer to the Figures 14 - 16 if needed.
- Under the Graph Tab there are different options for data visualization on the bottom of the display. These options allow visualization of reaction time (RT), cognitive efficiency scores (CE), and percent correct (PC), as well as a list option (as shown in Figure 15).

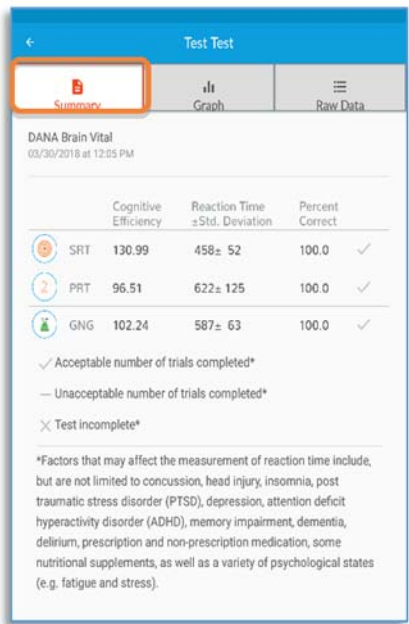


Figure 14. Summary Data

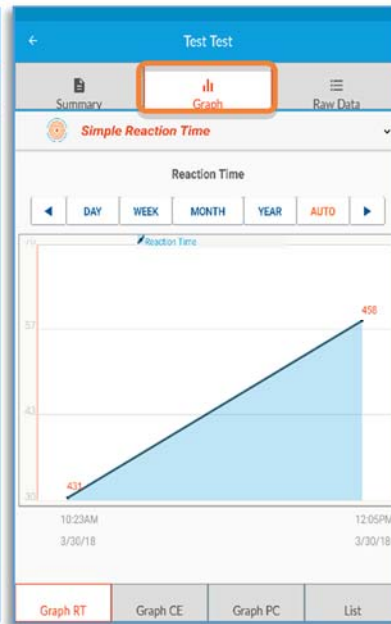


Figure 15. Graphed Data (2 or more administrations)

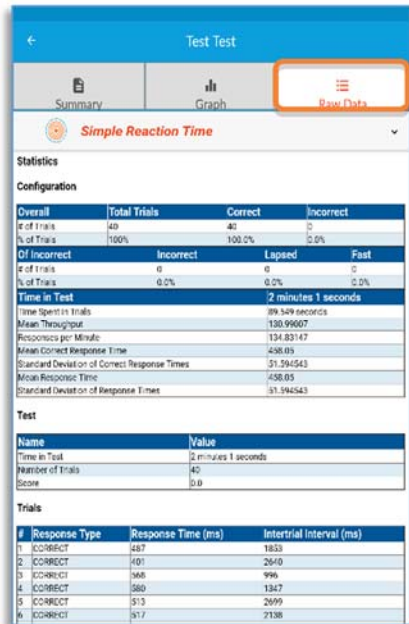


Figure 16. Raw Data

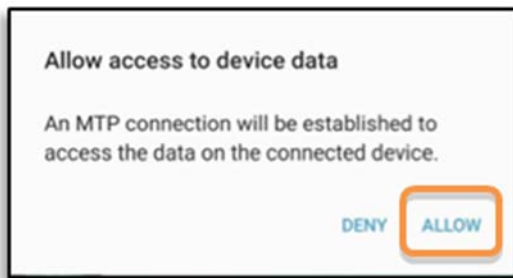
### K. How to Export Assessment Data

- Using a USB cable, connect the tablet to a personal computer (Windows PC or Mac). The USB port is located on the bottom right of the tablet.
- Once connected, a system notification will appear on the screen of the tablet asking permission to allow access to the device data. Select “Allow” (Figure 17, on next page).
- Log into the DANA™ app (if not logged in already).
- Select the button labeled “Subjects.”

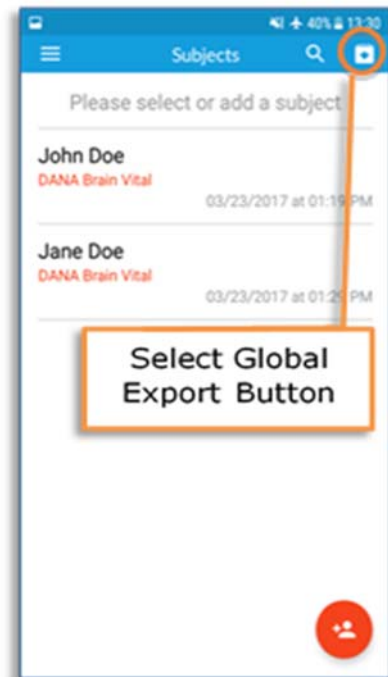
**Warning:** The next step will not provide any feedback (NO window or message will appear) after selecting the Global Export button, confirming the data was successfully exported.

5. Select the “**Global Export**” button ONCE located in the top right hand corner of the screen, to export all test results on the device in CSV format (Figure 18). Only tap the Global Export button ONCE, as multiple button presses will result in the data being exported multiple times.

**Note:** All data on the device will be saved to the “DANA > Exports” directory. The CSV files can be transferred to a personal computer (PC) or a secure HIPAA compliant computer via a wired USB connection. See Section V.L. for instructions.



**Figure 17. System Notification**

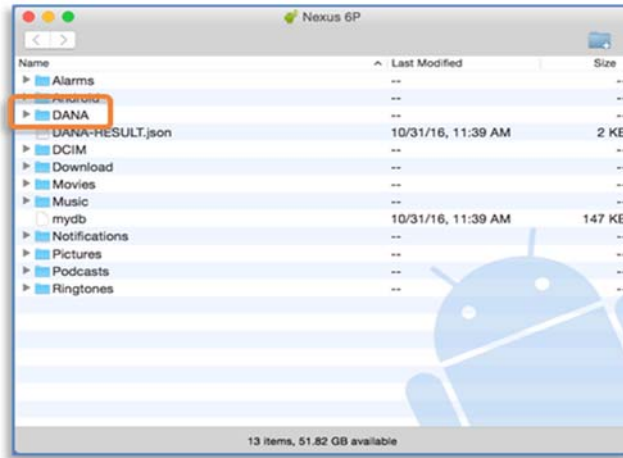


**Figure 18. Global Export Button**

#### **L. Locating Data Files on Personal Computer**

1. On the connected Windows or Mac PC, double-click on the “**File Explorer**” (Windows) or “**Finder**” (Mac). Scroll down to “**Under this PC**” and double click on “**Galaxy Tab S2**” to open.
2. After opening the device, click on the file folder labeled “**DANA**” to access exported data files (Figure 19).
3. In the DANA file, click on the “**Exports**” folder to access all the Excel-formatted files.
4. Copy all exported Excel files to the personal computer (Windows PC or Mac).

**Note:** Android File Transfer (AFT) program will need to be installed when using a Mac computer before transferring data. Connect the tablet to the Mac via USB and open the AFT program if it does not open automatically. The contents of the tablet will be located in the AFT program. If nothing transfers, disconnecting and reconnecting the tablet to the Mac may help the AFT program access the tablet.



**Figure 19. DANA™ file folder located within "Android File Transfer Program" on a Mac**

#### M. Exploring Data on Excel Files

1. After opening the Export file, there will be separate Excel files for each test administered and a zipped folder containing all the Excel files exported on that date.

**Note:** Every subject who has been administered a test on the tablet will be in the Excel file for that particular test, even if the subjects were administered the test on a different date, time, or location (“**Test Battery**” or “**Individual Test**”).

2. The name on the Excel files follows the format: dana\_data\_(Numeric value for order of test)\_(Assessment name)\_(Year)\_(Month)\_(Day)\_(Time).

For example: dana\_data\_1\_SRT\_2018\_4\_27\_095223. The numeric value (1) refers to the order of the tests, SRT refers to the name of the assessment (Simple Reaction Time), and the data was exported on April 27<sup>th</sup>, 2018 at 9:52:23.

**Note:** The date and time refers to when the data were exported off the tablet.

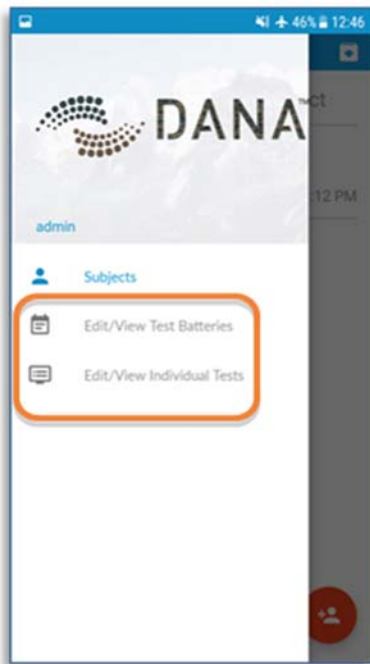
3. Click and open one of the Excel files.
4. The main columns to be concerned with are:
  - a) Column D – “Subject First Name”
  - b) Column E – “Subject Last Name”
  - c) Column G – “Date” (when the test was administered)
  - d) Column H – “Time” (when the test was initiated).

**Caution:** Be aware this is different than the time on the summary data screen on the tablet, which refers to when the subject completed the test.

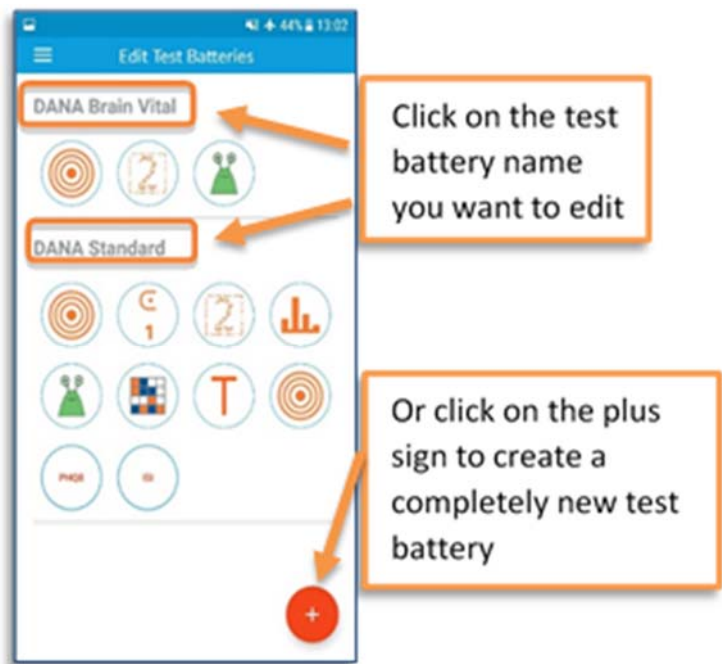
- e) Column I – “Trial number”
- f) Column J – “Response” (how the subject performed: correct, incorrect, fast, or lapsed, i.e. no response).
- g) Column K – “Response (Numeric)” (the coded value the tablet gives the subject based on their response: correct = 0, incorrect = 1, fast = 2, lapsed = 3).
- h) Column L – “Response Time” (the amount of time the subject took to answer in milliseconds).
- i) Column M – “Intertrial interval” (the amount of time (in milliseconds) between trials within the test).
- j) Column O – “Assessment Type” (where the subject took that particular test (i.e., as an individual test or part of a Test battery, such as DANA Brain Vital).

#### **N. Advanced: Editing Batteries and Individual Tests**

1. Log into DANA™ using the same credentials as described in Section V.D.
2. Select “**Edit/View Test Batteries**” or “**Edit/View Individual Tests**” buttons (Figure 20).
  - a) “**Edit/View Test Batteries**”: select a battery to edit (e.g., “DANA Brain Vital” or “DANA Standard”) or select the plus sign on the bottom right hand corner to create a new one (Figure 21).

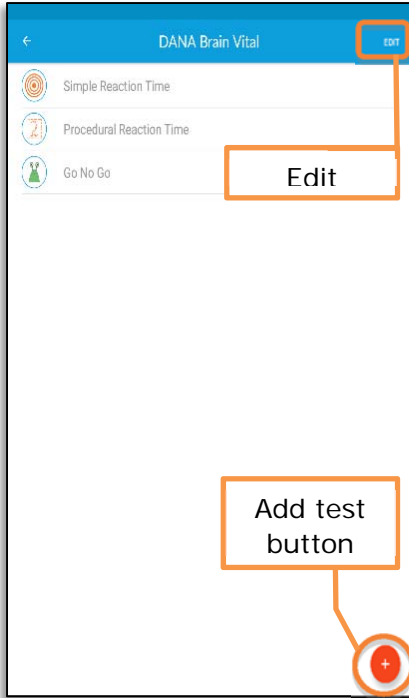


**Figure 20. Main Menu: Edit/View "Test Batteries" or Edit/View "Individual Test"**

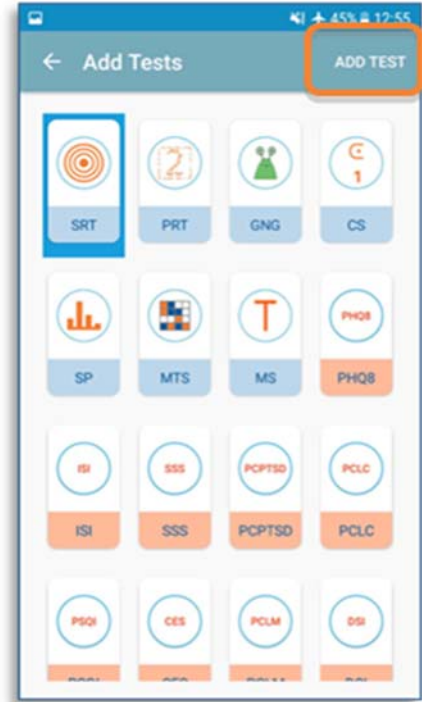


**Figure 21. Editing Test Batteries**

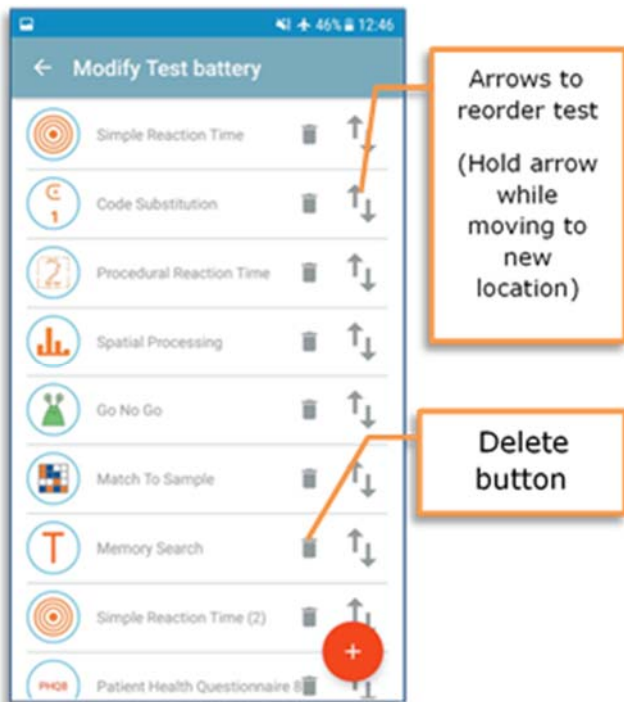
- (1) After selecting the test battery to modify, there will be a plus sign on the bottom right hand corner and an edit button on the top right hand corner of the screen (Figure 22). The plus sign button adds more tests to that specific test battery.
  - (2) Selecting the plus sign button will make a list appear to choose a test to add to the test battery. Then, select the **“Add Test”** button on the top right hand corner of the screen (Figure 23).
  - (3) Selecting the edit button allows tests to be deleted from the test battery and the ability to change the sequence of the tests as well. (Figure 24).
- b) **“Edit/View Individual Test”**: select the individual test to modify out of the list.
- (1) The next screen allows research personnel to change the parameters of a test (Figure 25). Click on the **“Save”** button in the top right hand corner when finished.



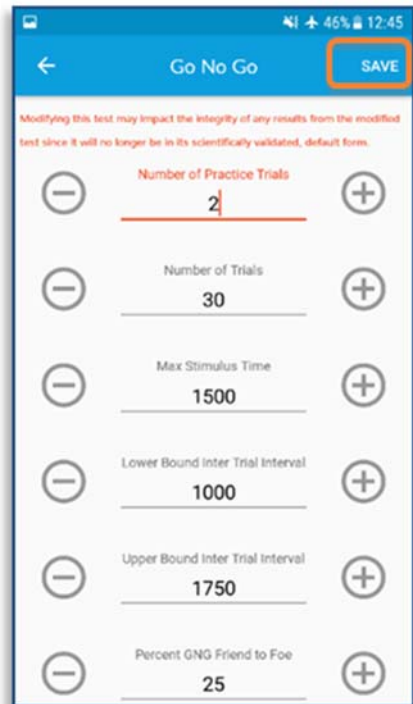
**Figure 22. Edit and Plus Sign Buttons for a Specific Test Battery**



**Figure 23. Adding Tests**



**Figure 24. Deleting or Reordering a Test Battery**



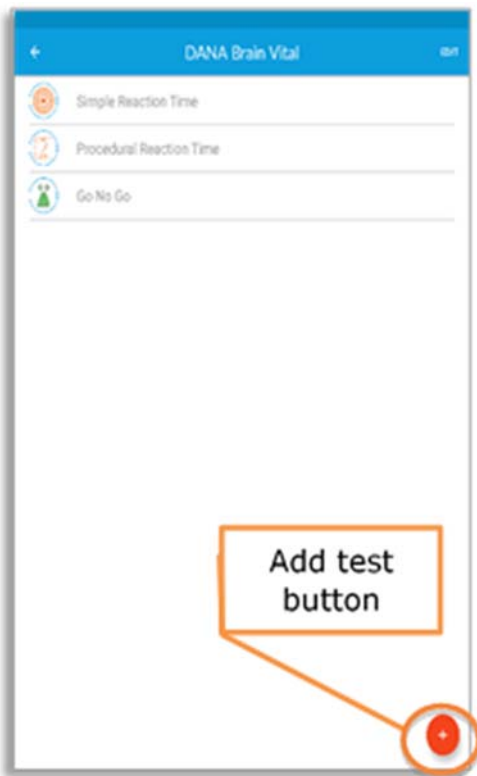
**Figure 25. Changing Individual Test Parameters**

3. Code Substitution: Learning vs. Recall Testing

The Code Substitution (also referred to as CS in the DANA™ software) has two possible tests: Code Substitution and Code Substitution (Recall). The Code Substitution test is the learning portion that teaches the subject a code set, whereas Code Substitution (Recall) tests if the subject is capable of remembering the same code set taught in the Code Substitution test.

**Warning:** A Code Substitution (Recall) test must be manually added to a test battery. The Code Substitution test contains 36 trials, but when a Code Substitution (Recall) test follows this will increase Code Substitution trials from 36 to 72. This doesn't include the 36 trials for the Code Substitution (Recall) test.

- a) To add a Recall test to a test battery select the plus sign under the test battery chosen (Figure 26).
- b) Select the “CS” test and select “Add Test” (Figure 27).

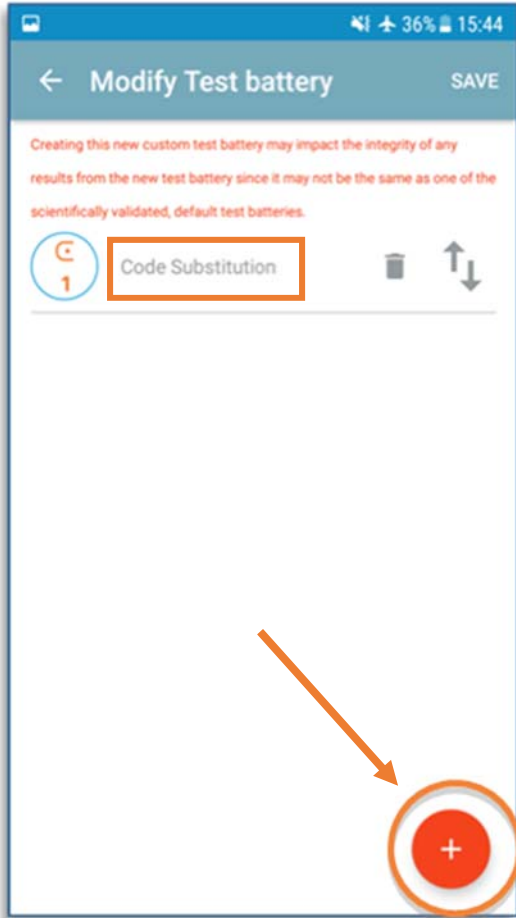


**Figure 26. Adding a Test to a Specific Test Battery**

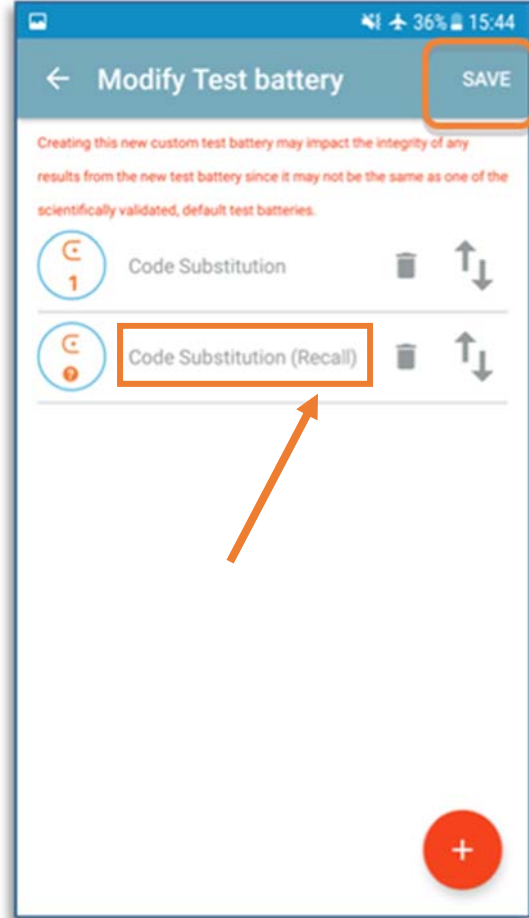


**Figure 27. Adding CS Test**

- c) On the next screen select the plus sign again (Figure 28). Select the “CS” test and select “Add Test” (Refer back to Figure 27).
- d) The following screen will show the two tests, but the second one will now say Recall. Select the “Save” button in the top right hand corner of the screen (Figure 29).



**Figure 28. Adding the Recall Test:  
Plus Sign Button**



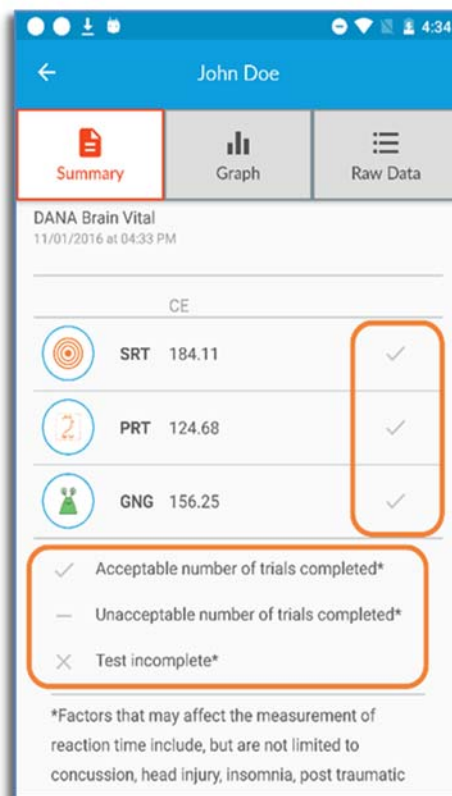
**Figure 29. Save Button**

## VI. DATA INTEGRITY

Validity determinations for each test are presented in the Summary tab. Validity indicators (✓, -, or X) are described below:

- X Test Incomplete:** In order to avoid an incomplete test the participant must correctly complete greater than or equal to 66% of the trials on the test.
- **Unacceptable number of trials completed:** In order to avoid an unacceptable mark the participant must correctly complete the minimum number of trials (dependent on the type of test) such that, if all completed trials were responded to correctly, the score would be at or above the 5<sup>th</sup> percentile.
- ✓ **Acceptable number of trials completed:** The participant does not meet the criteria for an incomplete or unacceptable mark on the test.

**Note:** When viewing a subject's summary data, the bottom of the screen lists possible reasons why an individual may perform poorly (Figure 30). Not all possible reasons are included, such as education and age. The administrators of the DANA™ will need to depend on their own experiences and judgment when interpreting data results.



**Figure 30. Explanation of Summary Screen Data**

## VII. DANA™ INDIVIDUAL DEFAULT SUBTEST DESCRIPTIONS

### A. Simple Reaction Time

The subject needs to touch the target symbol with their index finger on their dominant hand as fast as possible each time. This test targets sensory motor functioning.

Practice Trials: 5

Regular Trials: 40

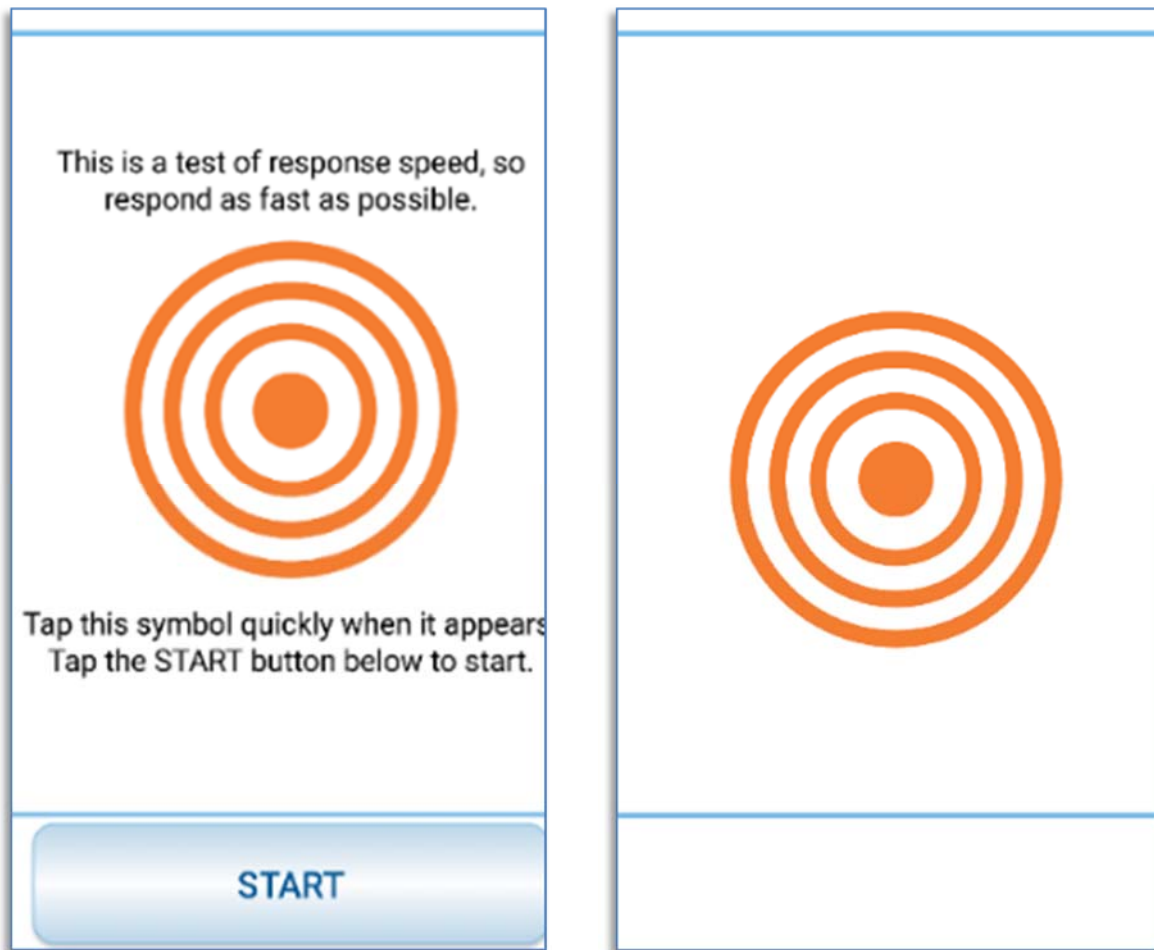


Figure 31. Instructions for Simple Reaction Time Test and Example Trial

## B. Procedural Reaction Time

A number (2 through 5) will appear for only 2 seconds. On the bottom of the screen there are two buttons: “2 or 3” on the left hand side and “4 or 5” on the right hand side. The objective is to tap the corresponding button for the number that appears on the screen. This test targets executive functioning with decision-making capabilities.

Practice Trials: 10

Regular Trials: 32

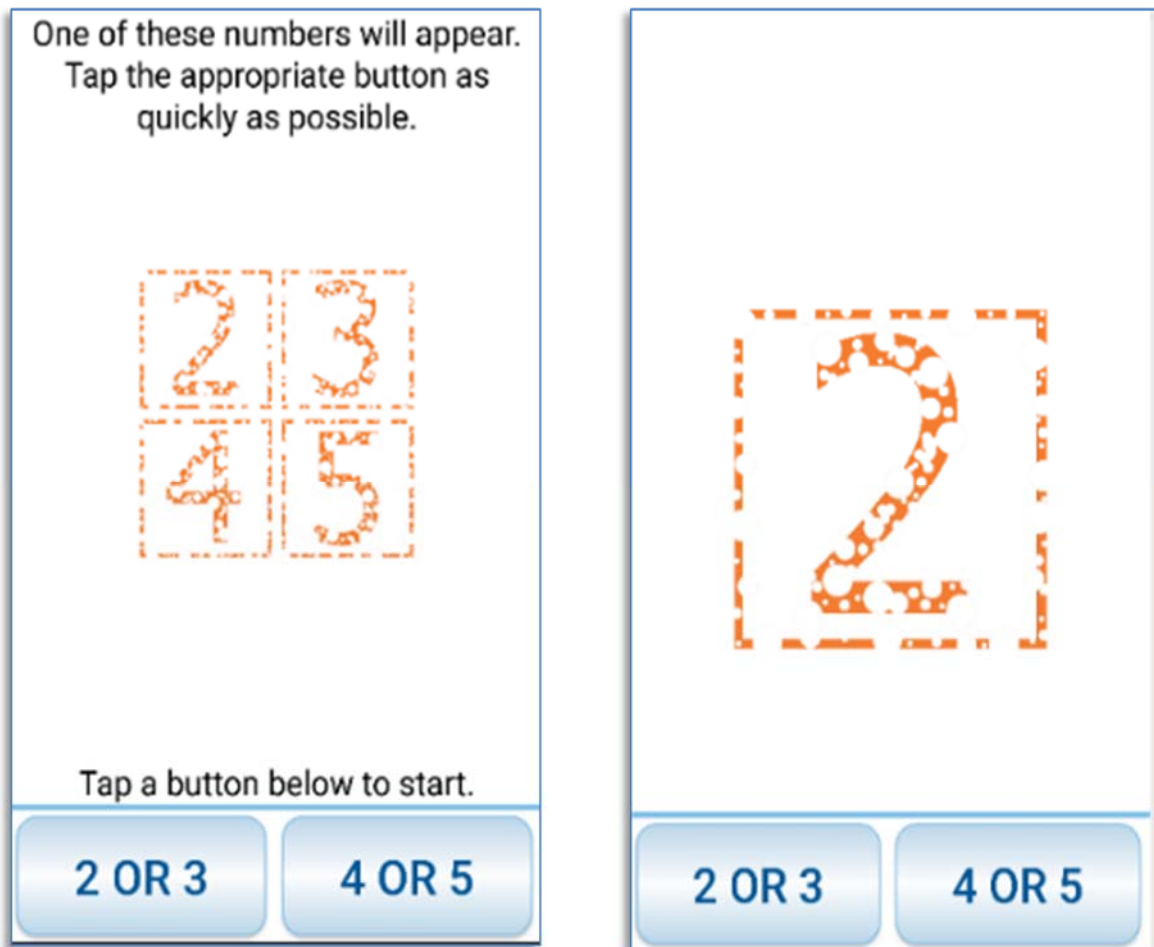


Figure 32. Instructions for Procedural Reaction Time Test and Example Trial

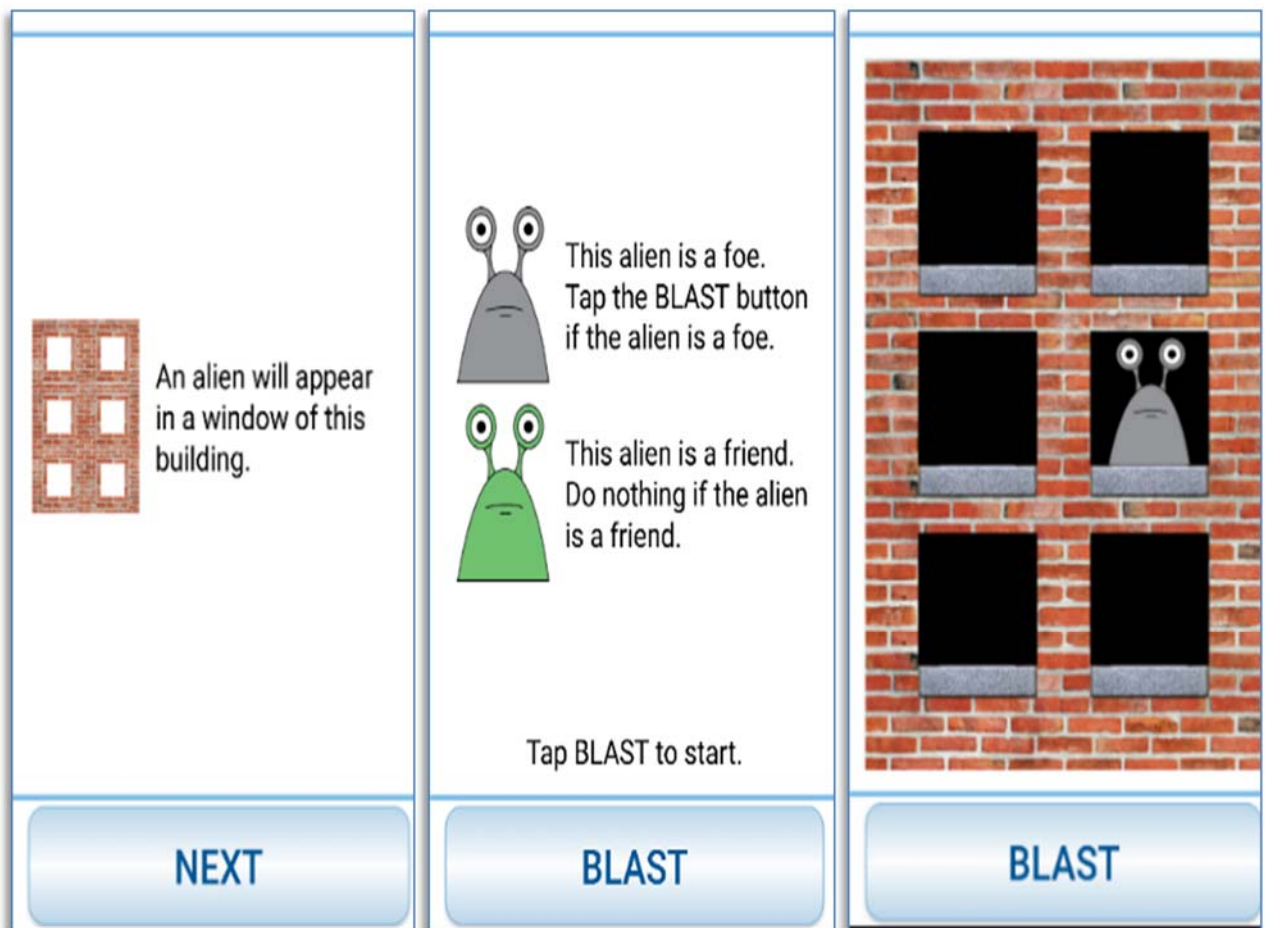
### C. Go/No-Go

The screen will display a brick house with six different windows and a “**Blast**” button on the bottom of the screen. Two different aliens will appear, grey (foe) and green (friend). The objective is to tap the “**Blast**” button only when the subject sees the grey alien. This test targets executive functioning, recording speed and accuracy of targets, omissions and commissions to derive a sensitivity metric.

**Note:** A subject with color blindness will have to be disqualified from this test.

Practice Trials: 5

Regular Trials: 30



**Figure 33. Instructions for Go/No-Go Test and Example Trial**

**D. Code Substitution (Learning Section)**

The screen will display a table containing numbers (1-9) and corresponding symbols for each number. The objective is to determine if the number and symbol that appears below the coded table matches by tapping the “Yes or No” buttons located on the bottom of the screen. This test targets executive capacity, immediate memory and attention.

Practice Trials: 4

Regular Trials: 36 or 72 (if Recall section follows)

The image shows three panels of the Code Substitution Learning Test interface. The first panel contains the instruction: "Below is a series of numbers. Each number is paired with a different symbol." Below this is a 2x9 grid of symbols and numbers. The second panel shows the same grid with the word "EXAMPLE" overlaid in blue. Below the grid is a vertical box containing a diamond symbol and the number "1". The third panel shows a 2x9 grid of symbols and numbers, with a vertical box below it containing a diamond symbol and the number "1".

Below is a series of numbers. Each number is paired with a different symbol.

⬇	⬆	⬇	⬆	⬇	⬆	⬇	⬆	⬇
1	2	3	4	5	6	7	8	9

EXAMPLE

Tap Yes if the symbol and number match the code above them.

Tap No if the symbol and number do not match the code above them.

Tap Yes or No to start.

NEXT

YES NO

⬆	⬇	⬆	⬇	⬆	⬇	⬆	⬇	⬆
1	2	3	4	5	6	7	8	9

YES NO

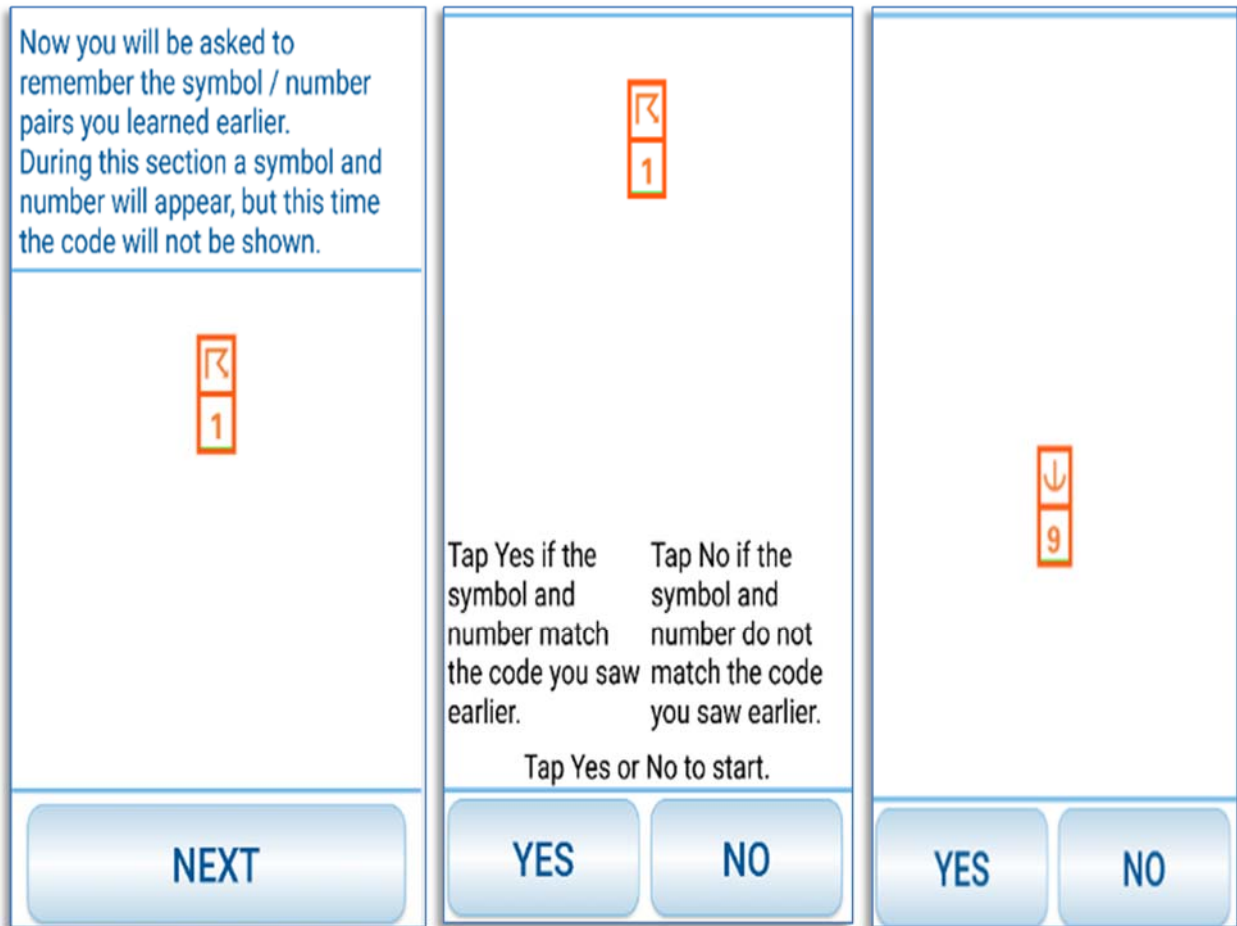
**Figure 34. Instructions for Code Substitution Learning Test and Example Trial**

**E. Code Substitution (Recall Section)**

The screen will display a number and symbol pair as seen before during the Learning section of Code Substitution. The subject will not have the coded table to reference in this test. The objective is to remember if the number and symbol pair shown corresponds to the coded table seen during the Learning phase by tapping the “**Yes or No**” buttons located on the bottom of the screen. This test targets executive capacity and long-term memory.

Practice Trials: 0

Regular Trials: 36



**Figure 35. Instructions for Code Substitution Recall Test and Example Trial**

## F. Spatial Processing

Two bar graphs will be positioned on the screen. The objective is to decide whether the bar graphs will match if one of the graphs is rotated vertically by tapping the “**Same or Different**” buttons located on the bottom of the screen. This test targets executive capacity and spatial manipulation.

Practice Trials: 10

Regular Trials: 20

The image displays the interface for the Spatial Processing Test, divided into three vertical panels. The leftmost panel contains instructions and a starting screen. The middle and right panels show two example trials.

**Instructions Panel:**

- Two bar graphs will appear on the screen.
- Tap the "Same" button if when rotated upright the graphs would be the same.
- Tap the "Different" button if when rotated upright the graphs would not be the same.

**Starting Screen:** Shows two orange bar graphs side-by-side. The left graph has four vertical bars of increasing height. The right graph has four horizontal bars of decreasing length. Below the graphs is the text: "Tap Same or Different to start." At the bottom are two buttons labeled "SAME" and "DIFFERENT".

**Example Trial 1 (Middle Panel):** Shows the same two orange bar graphs as in the starting screen. At the bottom are two buttons labeled "SAME" and "DIFFERENT".

**Example Trial 2 (Right Panel):** Shows two different orange bar graphs. The left graph has four vertical bars of varying heights. The right graph has four horizontal bars of varying lengths. At the bottom are two buttons labeled "SAME" and "DIFFERENT".

Figure 36. Instructions for Spatial Processing Test and Example Trials


### G. Match to Sample

The screen will display a grid with a specific pattern for the subject to briefly memorize. The grid will disappear for exactly 5 seconds then two different patterned grids will appear on the screen. The objective is to tap the patterned grid that matches the previous grid that was memorized. This test targets short-term memory, attention and visual-spatial discrimination.

Practice Trials: 3

Regular Trials: 20

A grid, like the one below, will appear briefly on the screen. Try to memorize it. It will disappear and the screen will go blank for a few seconds. Then two grids will appear. One is the grid you memorized and the other is not. Tap the grid that is the same as the one you memorized.



START

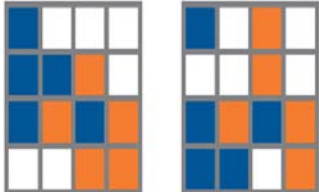



Figure 37. Instructions for Match to Sample Test and Example Trials

## H. Memory Search (Sternberg)

The subject is provided a list of five different letters to memorize before the test begins. During the test, the subject is presented a single letter at a time. The objective is to determine if the letter presented was in the list memorized by tapping the “Yes or No” buttons on the bottom of the screen. This test targets short-term memory.

Practice Trials: 0

Regular Trials: 30

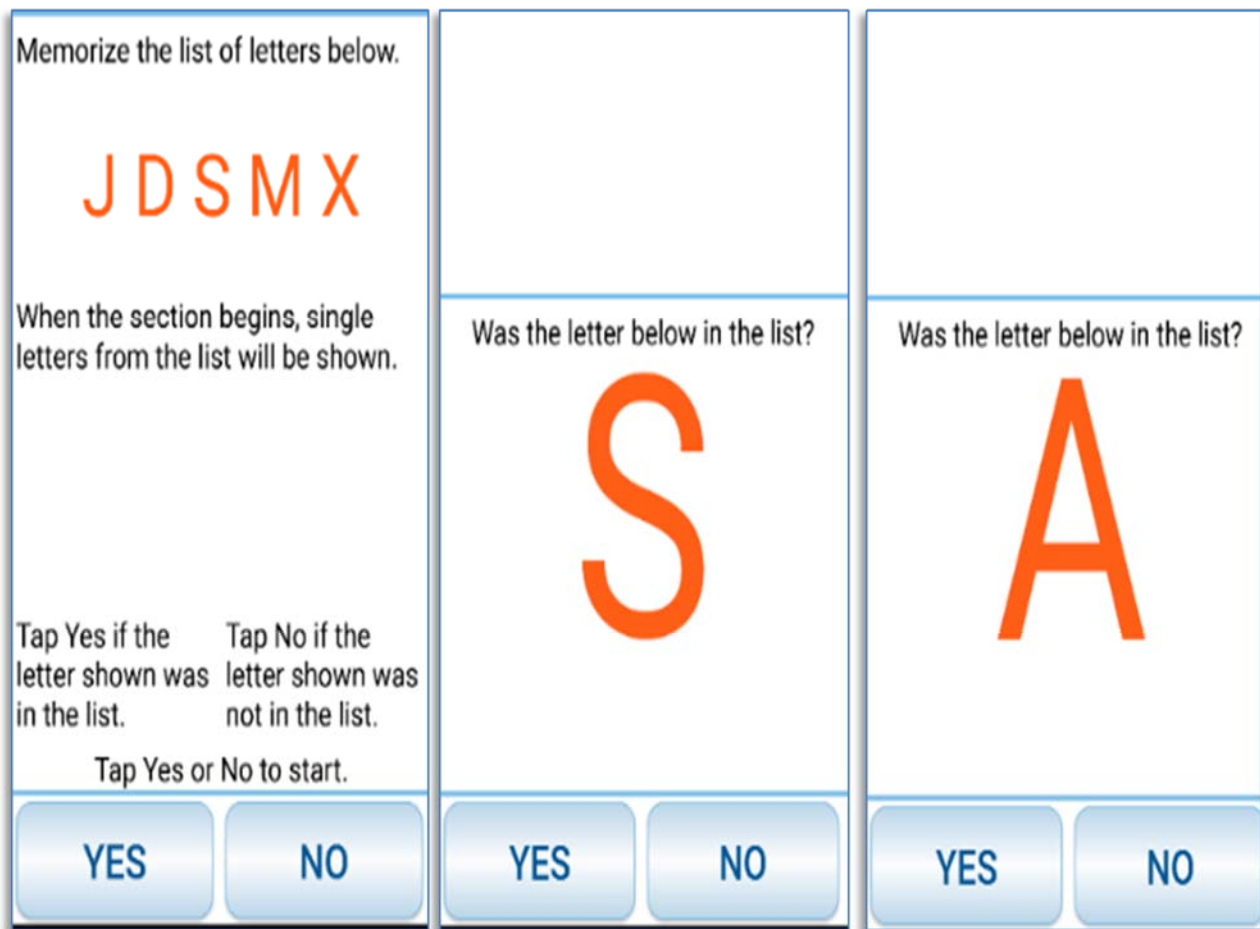


Figure 38. Instructions for Memory Search (Sternberg) Test and Example Trials

## I. Patient Health Questionnaire 8 (PHQ-8)

Purpose: Measures depression symptoms experienced within the past two weeks.

The image displays a three-column interface for the Patient Health Questionnaire 8 (PHQ-8). The first column contains a light blue box with the instruction: "In the next section you will be asked a series of questions. Please base your answers on how you have been feeling over the past two weeks." Below this is a blue "NEXT" button. The second column features a question: "Over the last 2 weeks, how often have you been bothered by any of the following problems?" followed by the sample item "Feeling down, depressed, or hopeless." Below the question is a vertical list of four response options: "Not at all", "Several days", "More than half the days", and "Nearly every day". A blue "NEXT" button is positioned at the bottom of this column. The third column features the same question and a sample item: "Little interest or pleasure in doing things." Below the question is a vertical list of the same four response options: "Not at all", "Several days", "More than half the days", and "Nearly every day". A blue "NEXT" button is positioned at the bottom of this column.

**Figure 39. Instructions for Patient Health Questionnaire 8 and Sample Items**

**J. Primary Care-PTSD Screen (PC-PTSD)**

Purpose: Initial Screen for Post-Traumatic Stress Disorder (PTSD) symptoms to be used in primary care.

The screenshot displays a three-panel interface for the Primary Care-PTSD Screen (PC-PTSD). The first panel on the left contains a grey box with the text: "The following questions relate to previous difficult experiences, and their effect on your life in the past month." Below this box is a blue button labeled "NEXT".

The second panel contains the following text: "In your life, have you ever had any experience that was so frightening, horrible, or upsetting that, in the past month, you ...". Below this is the question: "Were constantly on guard, watchful, or easily startled?". There are two input fields: the top one contains "Yes" and the bottom one contains "No". A blue button labeled "NEXT" is at the bottom.

The third panel contains the same introductory text as the second panel. Below it is the question: "Have had nightmares about it or thought about it when you did not want to?". There are two input fields: the top one contains "Yes" and the bottom one contains "No". A blue button labeled "NEXT" is at the bottom.

**Figure 40. Instructions for Primary Care-PTSD Screen and Sample Items**

**K. Insomnia Severity Index (ISI)**

Purpose: Measures severity of insomnia.

The figure displays a three-panel interface for the Insomnia Severity Index (ISI) questionnaire. The first panel on the left contains a light blue box with the following text: "The following section will ask you a series of questions about any sleep problems. Please read each one carefully, and select the appropriate response." Below this box is a blue button labeled "NEXT".

The second panel in the middle contains the instruction: "Please rate the current (i.e., in the past week) severity of your insomnia problem(s)." followed by the question: "Problem waking up too early?". Below the question is a vertical list of five response options: "None", "Mild", "Moderate", "Severe", and "Very severe". A blue button labeled "NEXT" is positioned at the bottom of this panel.

The third panel on the right contains the same instruction: "Please rate the current (i.e., in the past week) severity of your insomnia problem(s)." followed by the question: "Difficulty falling asleep?". Below the question is a vertical list of five response options: "None", "Mild", "Moderate", "Severe", and "Very severe". A blue button labeled "NEXT" is positioned at the bottom of this panel.

**Figure 41. Instructions for Insomnia Severity Index and Sample Items**

**L. Pittsburgh Sleep Quality Index (PSQI)**

Purpose: Measures quality of sleep within the past month.

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month.

During the past month, what time have you usually gone to bed?

11:00 AM PM

During the past month, how often have you had trouble sleeping because you ...  
Wake up in the middle of the night or early morning

Not during the past month

Less than once a week

Once or twice a week

Three or more times a week

**Figure 42. Instructions for Pittsburgh Sleep Quality Index and Sample Items**

**M. PTSD Check List for Civilians (PCL-C)**

Purpose: Measures PTSD-related symptoms experienced within the past month.

The screenshot displays three panels of the PCL-C interface. The first panel on the left contains instructions: "The following will present a list of problems and complaints that people sometimes have in response to stressful life experiences. Please read each one carefully, select an option to indicate how much you have been bothered by that problem in the last month." Below this is a blue "NEXT" button. The second panel in the middle asks, "In the past month, how much have you been bothered by Repeated, disturbing memories, thoughts, or images of a stressful experience from the past?" It features a vertical list of five response options: "Not at all", "A little bit", "Moderately", "Quite a bit", and "Extremely". A blue "NEXT" button is at the bottom. The third panel on the right asks, "In the past month, how much have you been bothered by Repeated, disturbing dreams of a stressful experience from the past?" It features a vertical list of five response options: "Not at all", "A little bit", "Moderately", "Quite a bit", and "Extremely". A blue "NEXT" button is at the bottom.

**Figure 43. Instructions for PTSD Check List for Civilians and Sample Items**

**N. PTSD Check List for Military (PCL-M)**

Purpose: Measures PTSD-related symptomatology for service members within the past month.

The screenshot displays the PCL-M interface with three panels. The first panel contains instructions: "The following will present a list of problems and complaints that veterans sometimes have in response to stressful military experiences. Please read each one carefully, select an option to indicate how much you have been bothered by that problem in the last month." Below the instructions is a "NEXT" button. The second panel asks, "Repeated, disturbing memories, thoughts, or images of a stressful military experience?" and provides five response options: "Not at all", "A little bit", "Moderately", "Quite a bit", and "Extremely". Below the options is a "NEXT" button. The third panel asks, "Repeated, disturbing dreams of a stressful military experience?" and provides five response options: "Not at all", "A little bit", "Moderately", "Quite a bit", and "Extremely". Below the options is a "NEXT" button.

**Figure 44. Instructions for PTSD Check List for Military and Sample Items**

**O. Deployment Symptom Inventory (DSI)**

Purpose: Broad psychological assessment tool sensitive to combat related distress.

The image displays a three-panel interface for the Deployment Symptom Inventory (DSI). The first panel on the left contains a text box with the instruction: "The following section will ask a series of questions about how often you have been having certain problems over the past 2 weeks." Below this text is a blue button labeled "NEXT". The second panel, titled "Headaches", features three vertically stacked selection boxes containing the options "Almost Never", "Sometimes", and "Often or Constantly". A blue "NEXT" button is positioned at the bottom of this panel. The third panel, titled "Pain interfering with work", also features three vertically stacked selection boxes with the same three options: "Almost Never", "Sometimes", and "Often or Constantly". A blue "NEXT" button is located at the bottom of this panel.

**Figure 45. Instructions for Deployment Symptom Inventory and Sample Items**

**P. Combat Exposure Scale (CES)**

Purpose: Assesses combat stressors experienced by service members.

<p>The following will present a series of questions about your military experiences. Please read each one carefully, and select the appropriate response.</p> <p><b>NEXT</b></p>	<p>Did you ever go on combat patrols or have other dangerous duty?</p> <p>No</p> <p>1 - 3 X</p> <p>4 - 12 X</p> <p>13 - 50 X</p> <p>51 or more times</p> <p><b>NEXT</b></p>	<p>Were you ever under enemy fire?</p> <p>Never</p> <p>&lt; 1 month</p> <p>1 - 3 months</p> <p>4 - 6 months</p> <p>7 or more months</p> <p><b>NEXT</b></p>
--	---	--

**Figure 46. Instructions for Combat Exposure Scale and Sample Items**

**Q. Stanford Sleepiness Scale (SSS)**

Purpose: Measures sleepiness

**Stanford Sleepiness Scale**

Your assessment is about to start.  
Please carefully read all instructions.

START ASSESSMENT

How sleepy do you feel today on a scale of 1 - 7?

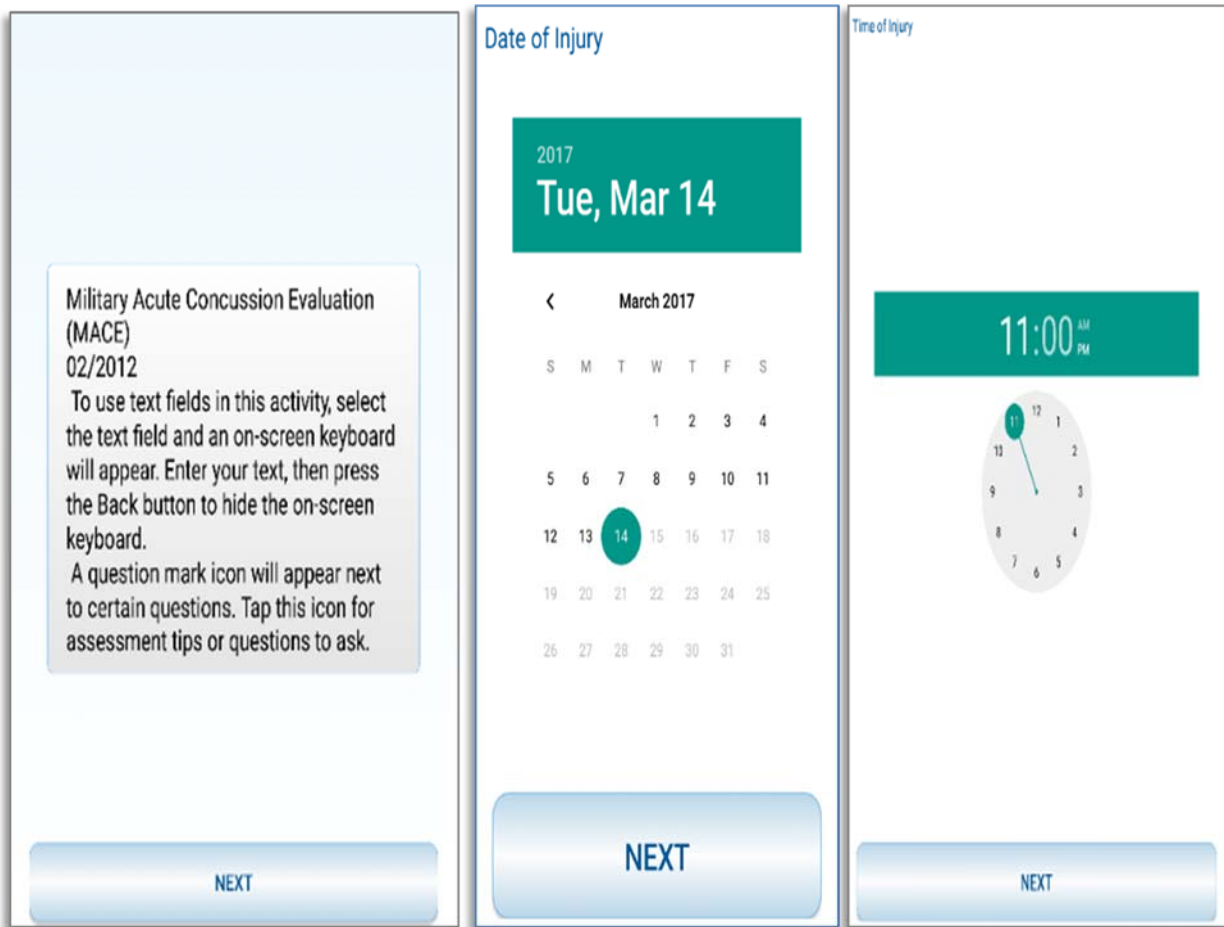
1. Feeling active, vital, alert, or wide awake
2. Functioning at high levels, but not at peak; able to concentrate
3. Awake, but relaxed; responsive but not fully alert
4. Somewhat foggy, let down
5. Foggy, losing interest in remaining awake; slowed down
6. Sleepy, woozy, fighting sleep; prefer to lie down
7. No longer fighting sleep, sleep onset soon; having dream-like thoughts

NEXT

**Figure 47. Instructions for Stanford Sleepiness Scale and Sample Item**

**R. Military Acute Concussion Evaluation (MACE)**

Purpose: Acute assessment of service members involved in a potentially concussive event.



**Figure 48. Instructions for Military Acute Concussion Evaluation and Sample Items**

## VIII. REFERENCES

- 1 Haran, F. J., Dretsch, M. N., & Bleiberg, J. (2016). Performance on the Defense Automated Neurobehavioral Assessment across controlled environmental conditions. *Applied Neuropsychology: Adult*, 23(6), 411-417.
- 2 Lathan, C., J.L., Bleiberg, J., Vice, J., & Tsao, J. W. (2013). Defense Automated Neurobehavioral Assessment (DANA)-Psychometric Properties of a New Field-Deployable Neurocognitive Assessment Tool. *Mil Med*, 178(4), 365-371.
- 3 AnthroTronix, Inc. (2017). User Guide (version 1.2) for DANA v4.1.0-SOCOM
- 4 AnthroTronix, Inc. Defense Automated Neurobehavioral Assessment (DANA) Quick reference Guide DANA v1.5.3. December 2013.
- 5 Lovelace, A. (2014). Using the Defense Automated Neurobehavioral Assessment (DANA) v1.5.3 Application on the Trimble Nomad.

## IX. APPENDICES

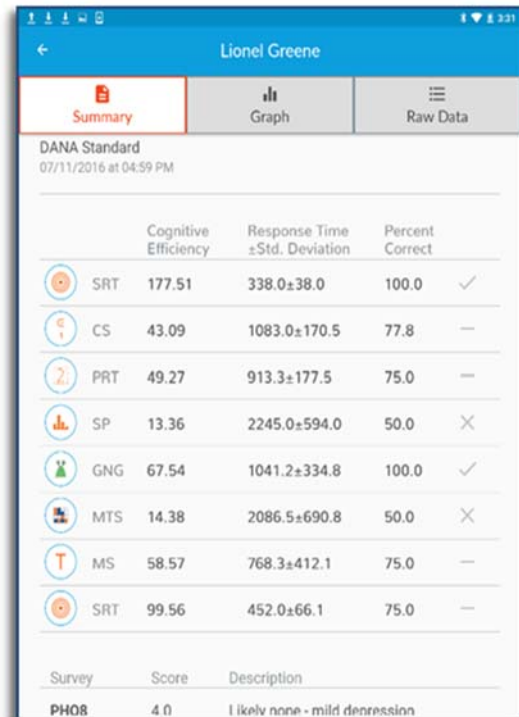
### Appendix A: Description of Normative Reference Data

The “✓,” “-,” and “X” symbols appearing on the summary screen are used to characterize the validity of each test. These designations are based on DANA™ data from a sample of 552 healthy U.S. military personnel aged between 18 and 64 (AnthroTronix, Inc., 2017). The category represented by a “-” is given to subjects whose percentage of correctly answered trials within a test fell below the 5<sup>th</sup> percentile of the normative data. The category represented by an “X” is given to subjects scoring less than 66% of the trials within a test correctly. The 5<sup>th</sup> percentile of the normative data was calculated by excluding the individuals who fell under the “X” category. The table below describes the percentage correct needed for each test on the DANA™ in the different percentile distributions.

**Table 1. Percentage Correct Categorized by Percentile Distributions and Type of Test**

Subtest	5%	25%	50%	75%	95%
SRT1	95.0	100.0	100.0	100.0	100.0
PRT	93.8	96.9	100.0	100.0	100.0
GNG	93.3	100.0	100.0	100.0	100.0
CSL	87.5	94.4	97.2	98.6	100.0
CSR	69.4	80.6	88.9	94.4	100.0
MTS	73.3	80.0	86.7	93.3	96.7
SP	80.0	90.0	95.0	95.0	100.0
MS	80.0	93.3	96.7	100.0	100.0
SRT2	92.5	97.5	100.0	100.0	100.0

**Note:** The subtest, Memory Search (MS), was collected from a sample of 124 healthy adults instead of the sample described in Appendix A.



**Figure 49. Summary Data Screen**

## Appendix B: Description of the Statistical Analysis

The DANA™ application calculates three main statistical analysis reported on the summary page: (A) Cognitive Efficiency, (B) Mean Correct Response Time (+/- 1 standard deviation), and (C) Percent Correct.

### A. Cognitive Efficiency:

Refers to the subject's total correct responses per minute to measure speed and accuracy. Units: correct responses / minute

$$CE = \left( \frac{\text{percentCorrect}}{\text{meanCorrectReactionTime}} \right) \times 60,000$$

### B. Mean Correct Response/ Reaction Time:

Refers to the subject's average reaction (response) time on all correct trials within the test. The statistical calculation for the Go/No-Go test excludes the subject's correct "No-go" trials within the test. This value is also known as Response Time or Reaction Time on the summary screen on the DANA application. Units: milliseconds (ms)

$$\text{meanCorrectRT} = \text{average}(\text{correctRT}_1, \text{correctRT}_2, \dots, \text{correctRT}_n)$$

### C. Percent Correct:

Refers to the percentage of correct trials on each test. Units: %

$$PC = \frac{\text{numberOfCorrectTrials}}{\text{totalNumberOfTrials}} \times 100\%$$

The screenshot shows a mobile application interface for 'Lionel Greene' with a 'Summary' tab selected. The data is as follows:

Survey	Score	Description
SRT	177.51	338.0±38.0
CS	43.09	1083.0±170.5
PRT	49.27	913.3±177.5
SP	13.36	2245.0±594.0
GNO	67.54	1041.2±334.8
MTS	14.38	2086.5±690.8
MS	58.57	768.3±412.1
SRT	99.56	452.0±66.1

Below the table, there is a 'PHOR' survey with a score of 4.0 and a description 'I likely none - mild depression'.

**Figure 50. Cognitive Efficiency, Response Time, and Percent Correct Calculations on Summary Screen**

### Appendix C: Normative Data

A sample of 419 healthy active-duty military were used to create these normative data tables (AnthroTronix, Inc., 2017). All the tables except Simple Reaction Time have smaller sample sizes due to excluding individuals who scored less than 66% of the trials correctly (individuals placed within the “X” or “Test Incomplete” category).

**Table 2. Normative Reference Data for Simple Reaction Time 1 Test (N=419)**

Cognitive Efficiency

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	141.15	150.97	168.83	193.72	208.92	229.25	235.71	190.28
20-24	133.94	139.06	167.21	184.28	210.19	234.09	240.11	187.21
25-29	140.36	144.50	172.50	187.80	204.65	235.83	251.70	189.78
30-34	126.89	137.34	163.69	179.04	202.72	220.62	229.85	181.88
35-44	117.00	124.08	157.00	183.35	201.48	224.41	240.50	178.40
45-54	104.57	123.18	158.51	177.33	189.88	216.55	222.55	173.14
55-64	132.23	132.97	136.24	146.25	165.25	197.21	198.88	155.04

Mean correct reaction time

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	248.72	261.73	287.21	309.73	351.23	393.45	415.13	318.82
20-24	245.61	253.99	284.65	321.12	354.15	416.12	430.90	324.25
25-29	238.39	246.54	288.93	312.09	347.42	415.25	427.51	319.75
30-34	259.97	264.98	295.98	334.98	357.95	428.63	464.45	335.40
35-44	249.48	266.70	297.80	327.25	382.19	473.58	494.02	346.18
45-54	265.47	274.00	316.10	333.32	378.53	487.15	506.64	351.86
55-64	301.73	304.32	363.42	407.83	436.31	451.25	453.80	392.91

Percent correct

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	92.50	95.62	100.00	100.00	100.00	100.00	100.00	99.27
20-24	89.00	93.75	100.00	100.00	100.00	100.00	100.00	98.87
25-29	91.45	94.88	100.00	100.00	100.00	100.00	100.00	98.88
30-34	95.00	95.50	100.00	100.00	100.00	100.00	100.00	99.23
35-44	95.20	97.50	100.00	100.00	100.00	100.00	100.00	99.41
45-54	86.10	97.50	100.00	100.00	100.00	100.00	100.00	98.52
55-64	95.90	97.25	100.00	100.00	100.00	100.00	100.00	99.50

**Table 3. Normative Reference Data for Procedural Reaction Time Test (N=418)**

Cognitive Efficiency

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	65.41	74.02	85.64	97.17	107.17	116.99	121.97	96.28
20-24	61.45	70.01	84.87	97.26	105.36	114.92	117.39	94.73
25-29	65.71	73.43	86.69	95.91	104.18	114.68	122.15	95.54
30-34	69.65	74.91	84.15	92.14	99.68	114.39	115.40	92.14
35-44	68.94	72.13	81.66	92.59	103.89	118.28	119.56	93.23
45-54	61.94	64.96	77.77	86.13	92.01	99.15	103.11	84.63
55-64	59.90	60.95	68.17	75.12	80.76	103.52	104.12	77.69

Mean correct reaction time

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	489.42	497.13	541.91	601.63	666.49	800.01	893.26	617.36
20-24	487.29	507.66	552.92	608.97	684.33	829.28	927.73	633.88
25-29	480.57	506.20	561.88	609.02	679.08	816.43	879.94	627.75
30-34	519.93	524.52	587.87	636.61	713.00	792.61	842.10	653.49
35-44	501.83	507.28	570.62	627.77	723.61	806.05	868.22	645.64
45-54	557.07	587.82	641.76	696.42	781.11	953.10	984.42	720.18
55-64	576.27	579.64	743.12	786.92	860.65	972.08	996.87	788.84

Percent correct

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	87.50	93.75	96.88	96.88	100.00	100.00	100.00	96.88
20-24	90.00	90.62	96.88	96.88	100.00	100.00	100.00	97.42
25-29	93.75	93.75	96.88	100.00	100.00	100.00	100.00	98.05
30-34	91.50	93.75	96.88	100.00	100.00	100.00	100.00	98.51
35-44	87.75	92.81	96.88	100.00	100.00	100.00	100.00	98.12
45-54	78.31	93.75	96.88	100.00	100.00	100.00	100.00	97.17
55-64	96.88	96.88	97.66	100.00	100.00	100.00	100.00	99.06

**Table 4. Normative Reference Data for Go/No-Go Test  
(N=394)**

Cognitive Efficiency

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	88.83	88.63	108.61	120.00	133.39	148.55	151.51	120.04
20-24	63.29	75.72	98.91	114.77	126.24	148.28	151.74	113.79
25-29	72.81	87.35	104.62	117.38	130.28	149.62	151.33	117.17
30-34	87.61	89.72	108.23	116.60	128.59	137.86	139.08	116.76
35-44	74.20	74.38	100.89	111.02	124.78	137.92	147.14	110.92
45-54	60.93	69.25	84.16	96.91	111.39	131.08	133.62	97.87
55-64	67.99	68.93	85.74	91.39	103.20	115.77	118.41	92.20

Mean correct reaction time

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	391.39	404.02	449.58	494.70	549.81	677.76	765.23	510.30
20-24	390.59	400.90	468.78	515.35	575.81	788.23	933.07	538.83
25-29	391.17	398.54	458.43	500.63	565.50	686.66	782.04	520.79
30-34	411.89	431.05	464.90	505.24	546.26	661.60	681.11	515.88
35-44	408.27	435.35	481.63	538.20	587.55	808.25	809.36	556.45
45-54	442.37	448.51	542.33	615.43	724.15	915.99	1164.49	658.68
55-64	479.39	499.47	581.40	656.53	699.80	859.95	878.38	664.70

Percent correct

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	49.00	93.33	97.50	100.00	100.00	100.00	100.00	96.28
20-24	42.67	50.00	96.67	100.00	100.00	100.00	100.00	93.63
25-29	50.00	86.67	96.67	100.00	100.00	100.00	100.00	96.71
30-34	50.00	58.67	96.67	100.00	100.00	100.00	100.00	95.49
35-44	86.93	92.33	96.67	100.00	100.00	100.00	100.00	97.70
45-54	50.00	50.00	96.67	100.00	100.00	100.00	100.00	90.94
55-64	57.80	69.50	97.50	100.00	100.00	100.00	100.00	94.00

**Note:** These norms were collected with the friend/foe ratio set at 50/50. The default ratio in DANA is 25/75.

**Table 5. Normative Reference Data for Code Substitution  
Simultaneous Test (N=418)**

Cognitive Efficiency

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	30.58	32.70	41.80	47.26	52.80	61.70	64.53	47.01
20-24	29.99	31.79	39.31	45.32	50.62	60.24	61.66	45.60
25-29	34.05	36.64	40.73	44.73	50.72	57.82	64.68	45.78
30-34	28.70	29.97	36.96	41.27	48.67	57.87	60.42	42.71
35-44	26.16	28.56	37.03	42.17	47.45	53.75	53.99	42.12
45-54	23.43	24.87	32.33	37.54	40.31	44.51	46.60	36.24
55-64	20.54	21.24	28.44	30.81	36.86	38.41	38.60	31.11

Mean correct reaction time

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	883.51	925.21	1086.18	1242.55	1392.27	1680.65	1768.97	1254.56
20-24	970.71	986.72	1117.90	1260.30	1476.45	1768.10	1878.34	1304.51
25-29	896.32	993.81	1148.50	1297.20	1416.05	1586.58	1657.73	1287.96
30-34	981.44	1005.18	1198.40	1418.70	1535.60	1830.70	1911.39	1395.24
35-44	1087.71	1095.14	1221.10	1366.60	1561.80	1862.29	1891.56	1409.07
45-54	1230.87	1295.34	1466.45	1588.30	1774.15	2023.83	2111.69	1620.44
55-64	1532.67	1540.41	1588.85	1754.15	1968.45	2215.34	2256.36	1811.25

Percent correct

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	83.47	86.46	93.06	97.22	98.61	100.00	100.00	95.14
20-24	84.72	87.50	94.44	97.22	98.61	100.00	100.00	95.91
25-29	87.72	90.21	94.44	97.22	98.61	100.00	100.00	96.13
30-34	84.50	90.28	94.44	97.22	98.61	100.00	100.00	95.94
35-44	84.83	87.08	94.44	97.22	98.61	100.00	100.00	95.83
45-54	65.64	80.07	91.67	97.22	98.61	100.00	100.00	93.27
55-64	77.14	78.26	88.19	93.06	98.26	98.61	98.61	91.39

**Table 6. Normative Reference Data for Code Substitution- Recall  
Test (N=364)**

Cognitive Efficiency

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	30.40	32.04	38.95	47.16	56.61	66.27	67.34	48.07
20-24	27.60	31.58	40.36	49.14	55.33	68.82	72.38	49.00
25-29	29.55	32.90	39.90	46.52	54.26	69.94	73.11	48.01
30-34	29.22	30.94	38.98	47.28	53.93	66.34	68.06	47.33
35-44	27.50	29.29	36.44	42.60	50.46	63.26	65.49	43.64
45-54	23.53	24.06	33.42	36.28	43.17	49.11	54.43	37.56
55-64	21.85	22.53	28.92	34.57	35.74	36.38	36.49	31.69

Mean correct reaction time

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	813.90	832.86	940.67	1084.45	1231.58	1398.80	1547.97	1103.66
20-24	508.83	660.02	921.95	1078.20	1195.35	1503.30	1637.98	1079.72
25-29	787.89	828.45	1001.40	1144.30	1257.85	1510.30	1564.60	1141.75
30-34	657.90	760.57	1033.70	1118.20	1313.50	1473.64	1599.33	1148.31
35-44	857.79	887.56	1060.60	1230.80	1334.50	1588.31	1710.26	1222.45
45-54	763.22	947.92	1301.40	1383.95	1706.38	2107.39	2460.56	1478.57
55-64	1233.12	1274.70	1373.80	1579.90	1708.95	2110.86	2199.74	1606.76

Percent correct

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	49.17	59.03	75.00	86.11	91.67	97.22	100.00	82.66
20-24	36.67	48.61	72.22	86.11	94.44	100.00	100.00	81.44
25-29	43.44	58.19	77.78	88.89	94.44	100.00	100.00	85.10
30-34	50.00	51.11	75.00	88.89	94.44	100.00	100.00	83.80
35-44	47.44	53.89	75.00	83.33	94.44	100.00	100.00	82.63
45-54	29.50	41.25	62.50	81.94	89.58	100.00	100.00	75.95
55-64	53.78	55.28	61.11	76.39	82.64	90.69	92.94	73.61

**Table 7. Normative Reference Data for Match to Sample Test  
(N=399)**

Cognitive Efficiency

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	23.47	24.54	30.40	35.37	39.19	45.85	48.77	35.10
20-24	20.03	21.39	28.08	33.41	38.01	47.35	51.46	33.69
25-29	25.13	25.40	30.95	35.66	39.94	49.17	57.20	36.29
30-34	21.77	22.74	29.71	33.67	38.10	46.90	52.14	34.24
35-44	22.17	22.44	28.39	31.99	35.58	45.98	50.86	32.71
45-54	20.55	21.19	26.14	29.02	33.18	39.85	40.93	30.07
55-64	18.17	19.21	22.41	31.10	34.99	49.79	54.68	31.54

Mean correct reaction time

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	1137.32	1164.32	1343.42	1529.70	1674.42	1896.62	2137.32	1538.85
20-24	1059.80	1138.40	1404.25	1555.90	1701.80	2035.35	2147.66	1576.07
25-29	985.49	1116.23	1350.52	1498.20	1666.52	1954.41	2081.51	1505.02
30-34	992.39	1150.70	1380.10	1539.70	1723.40	2089.70	2201.04	1581.01
35-44	1103.83	1171.68	1394.80	1631.40	1826.05	2089.22	2156.41	1612.05
45-54	1247.12	1329.49	1537.98	1689.90	1891.77	2300.65	2369.89	1735.39
55-64	975.10	1143.42	1503.45	1724.45	1931.55	2330.84	2442.06	1725.02

Percent correct

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	55.67	67.50	80.00	86.67	93.33	96.67	96.67	85.31
20-24	53.33	65.00	76.67	86.67	90.00	96.67	97.33	83.08
25-29	50.73	73.17	80.00	86.67	93.33	96.67	96.67	85.46
30-34	65.20	73.33	83.33	90.00	93.33	96.67	96.67	86.87
35-44	63.60	69.00	83.33	86.67	90.00	96.67	96.67	85.15
45-54	44.93	57.33	80.00	83.33	90.00	96.67	97.93	82.81
55-64	61.20	63.00	73.33	80.00	86.67	91.83	92.73	79.00

**Table 8. Normative Reference Data for Spatial Processing Test  
(N=414)**

Cognitive Efficiency

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	19.20	21.58	30.07	34.15	41.61	49.03	49.75	35.41
20-24	20.14	20.98	27.43	31.82	36.08	43.71	45.61	31.89
25-29	19.02	21.08	27.37	32.08	37.80	46.65	55.39	33.19
30-34	21.55	23.01	27.22	32.00	35.94	47.81	53.47	32.68
35-44	20.03	21.60	26.91	29.82	34.71	41.37	43.23	30.85
45-54	17.55	19.01	21.89	26.56	30.29	35.12	37.58	26.46
55-64	19.14	19.53	21.04	24.12	27.84	35.20	36.49	25.46

Mean correct reaction time

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	994.52	1051.52	1283.12	1567.05	1852.60	2424.48	2541.89	1611.50
20-24	1189.04	1268.95	1516.90	1765.70	2028.25	2467.50	2648.02	1798.31
25-29	1016.77	1117.21	1451.92	1753.10	1992.20	2529.93	2736.73	1757.44
30-34	1058.22	1139.98	1581.10	1755.50	1993.90	2364.64	2468.28	1789.27
35-44	1346.23	1384.03	1627.20	1861.50	2129.65	2521.06	2650.26	1889.47
45-54	1517.74	1547.66	1943.05	2176.40	2387.58	2692.89	2772.16	2155.48
55-64	1549.97	1585.47	1954.85	2262.15	2496.57	2809.71	2840.54	2230.61

Percent correct

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	73.50	75.00	85.00	90.00	95.00	100.00	100.00	90.06
20-24	70.00	77.50	90.00	95.00	95.00	100.00	100.00	91.65
25-29	75.00	80.00	90.00	95.00	95.00	100.00	100.00	92.00
30-34	72.80	80.00	90.00	95.00	100.00	100.00	100.00	92.46
35-44	80.00	80.00	90.00	95.00	100.00	100.00	100.00	93.73
45-54	69.30	77.75	90.00	90.00	100.00	100.00	100.00	91.09
55-64	80.90	82.25	90.00	90.00	95.00	97.75	99.10	91.00

**Table 9. Normative Reference Data for Simple Reaction Time 2  
Test (N=413)**

Cognitive Efficiency

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	120.45	125.62	157.79	180.44	205.02	226.98	237.38	179.71
20-24	117.74	123.18	152.51	172.58	200.28	226.72	236.34	174.69
25-29	111.39	125.51	159.35	177.62	196.95	237.10	243.42	179.40
30-34	141.18	143.15	159.62	177.04	192.71	222.91	226.83	178.98
35-44	106.43	119.90	158.06	178.74	195.14	222.49	242.94	174.61
45-54	132.02	140.38	159.81	180.32	197.03	209.97	215.11	173.65
55-64	127.35	135.54	170.59	179.15	187.62	213.53	214.14	177.70

Mean correct reaction time

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	252.86	264.36	292.63	331.28	375.73	468.74	485.50	340.06
20-24	253.44	264.95	298.04	338.97	384.17	447.64	462.60	347.99
25-29	246.88	253.09	299.27	333.37	368.32	450.60	261.89	338.20
30-34	260.70	268.90	311.35	330.44	372.82	404.36	415.75	337.39
35-44	247.05	269.77	307.47	332.65	379.62	477.26	497.02	351.02
45-54	279.16	289.89	304.85	339.27	381.61	471.50	545.60	358.41
55-64	276.30	277.40	313.80	334.98	346.44	427.79	444.31	339.81

Percent correct

Age band	2%	5%	25%	50%	75%	95%	98%	Mean
18-19	84.50	92.50	97.50	100.00	100.00	100.00	100.00	97.56
20-24	66.00	86.25	95.00	100.00	100.00	100.00	100.00	95.55
25-29	81.85	87.38	97.50	100.00	100.00	100.00	100.00	97.19
30-34	93.20	95.00	97.50	100.00	100.00	100.00	100.00	98.96
35-44	92.50	92.50	100.00	100.00	100.00	100.00	100.00	98.55
45-54	51.55	75.88	100.00	100.00	100.00	100.00	100.00	96.56
55-64	93.40	94.75	97.50	100.00	100.00	100.00	100.00	98.50

## **LIST OF SYMBOLS, ABBREVIATIONS AND ACRONYMS**

DANA	Defense Automated Neurobehavioral Assessment
SOP	Standard Operating Procedure