CALCAP®

California Computerized Assessment Package™ Manual

Second Edition

1775 E. Palm Canyon Dr, Suite 110-201 • Palm Springs, California 92264 • http://www.calcaprt.com

Licensing Agreement

The CALCAP® software and manual are protected by both United States copyright law and international treaty provisions. You are permitted to make copies of the software for archival purposes only. The manual may not be reproduced in whole or in part in any form except as provided by the U.S. Copyright Law.

The CALCAP® software may be used by any number of people and may be freely moved from one computer location to another, so long as there is no possibility of it being used in two different places at the same time.

Limited Warranty

The CALCAP® software diskettes and documentation are warranted to be free of defects in materials and workmanship for a period of 60 days from the date of purchase. If these materials are found to be defective during the warranty period, the author will replace the defective disk or documentation.

All other express and implied warranties, including but not limited to implied warranties of merchantability and fitness for a particular purpose are hereby disclaimed. In no event shall the author be liable for any loss of profit or any other commercial damage, including but not limited to special, incidental, consequential or other damages.

Cover Design by E. Gordon Bing

12 June 2013

Table of Contents

INTRODUCTION

The *California Computerized Assessment Package* (CALCAP®) allows you to perform standardized assessments of reaction time and speed of information processing.

Computerized assessment techniques facilitate the application of technology and methods developed in experimental cognitive laboratories to the problems of applied clinical assessment. There are several advantages to this approach.

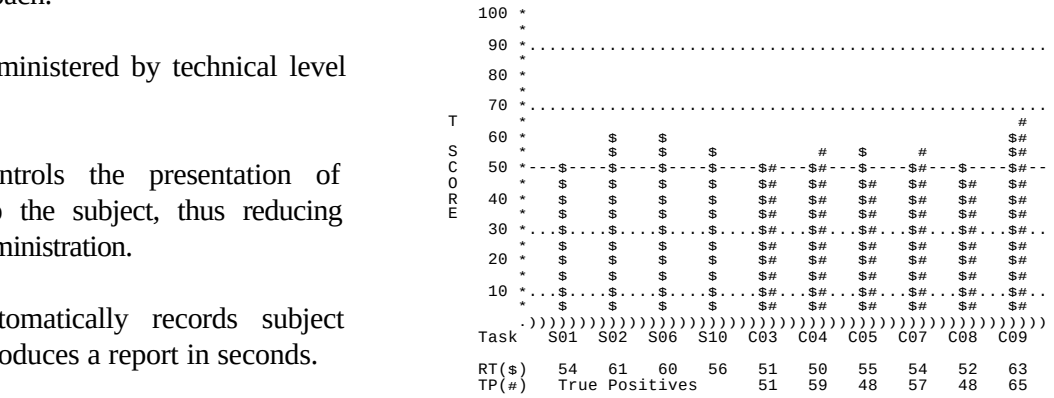
- The test can be administered by technical level personnel.
- The computer controls the presentation of complex stimuli to the subject, thus reducing variability in test administration.
- The computer automatically records subject performance and produces a report in seconds.
- Subjects find the computerized tasks stimulating, non-threatening, and often report that they enjoy the experience.

How It Works

The standard CALCAP task consists of a series of ten Simple and Choice reaction time measures administered by computer. The tasks are designed to be self-explanatory and need only minimal supervision by the examiner. The complete procedure takes approximately 20-25 minutes for administration and scoring. An abbreviated version lasting 8-10 minutes is also included. Stimulus materials are available in English, Spanish or Norwegian.

The individual reaction time measures are designed to assess a number of cognitive domains, including speed of processing (reaction time), language skills, rapid visual scanning, form discrimination, recognition memory, and divided attention.

The computer scores each task using age- and education-specific norms derived from 641 men ranging in age from 21 to 58 years, with a mean education of 16 years. Final scores are available immediately in tabular and graphical formats.



In addition to reaction time measures, level of performance on each task is assessed by evaluating the numbers of "Hits" and "False Positives." Signal detection theory provides measures of the subject's ability to discriminate between the true signal and distractor items (d') and of the degree to which the subject deviates from the optimal likelihood ratio (beta).

The standard CALCAP program classifies subjects as 'outliers' if they perform two standard deviations or lower on two or more of the tasks. Using these criteria, approximately 10% of subjects are classified as outliers. This baserate of 10% includes individuals with premorbid conditions such as prior head injury, learning disability, pre-existing neurologic conditions, as well as individuals who are simply on the low end of normal functioning.

Background

The *California Computerized Assessment Package* is modeled after the Continuous Performance Task, a measure of sustained attention and reaction time. Subjects are asked to focus on a display field and respond only to specific visual stimuli.
The CALCAP program presents a broad range of stimulus materials on a computer display, with exposure times precisely controlled by the computer program. Responses to the stimulus also are precisely measured and recorded and include:

- mean and median reaction times
- total numbers of true and false positive responses
- estimates of the signal detection parameters d' and beta.

These measures can be used to assess slowed cognition, focused and divided attention, sustained attention, and rapid visual scanning. It is ideal for longitudinal assessment of cognitive changes due to disease, medications, and cognitive rehabilitation.

Research

The CALCAP test battery is currently being used to study changes in reaction time and speed of information processing in multiple sclerosis, hyperbaric nitrogen narcosis, HIV infection, dementia, drug abuse and traumatic brain injury.

Findings to date suggest that the CALCAP is a practical and inexpensive screening tool for detecting early cognitive decline. Preliminary data suggest that the CALCAP may eventually prove more sensitive than conventional neuropsychological procedures for detecting cognitive changes over time.

The CALCAP has been used extensively with a sample of 509 HIV negative and 451 HIV positive men who are participating in a longitudinal study of the natural history of AIDS (Miller et al., 1988, 1989a, 1989b, 1991, 1992a, 1992b, 1993).

These subjects were tested using both the CALCAP and a brief conventional neuropsychological screening procedure consisting of measures of motor speed and attention (Trail-Making, Grooved Pegboard), verbal memory (Rey Auditory Verbal Learning Task), memory span (WAIS-R Digit Span), and verbal fluency.

Subjects were designated as 'outliers' on the conventional neuropsychological screen if they scored two or more standard deviations below the mean on two or more independent measures of cognitive functioning, or if they scored three standard deviations or lower on any one measure.

Using these criteria, the computer program and the conventional neuropsychological screen agreed on outlier status 85% of the time. Further, 60% of individuals identified as outliers by CALCAP at baseline were identified as having equivocal or abnormal clinical neuropsychological or neurological exams on follow-up.

Preliminary longitudinal data suggest even greater specificity and sensitivity for the computerized measures for detecting change over time. In a sample of 101 HIV seronegative and 88 HIV seropositive men, poorer performance on the computerized measures following a 6-month interval was noted in approximately twice as many seropositive (27 men, 30.7%) as seronegative subjects (15 men, 14.9%). By contrast, the conventional neuropsychological measures detected poorer performance by only 21 seropositive (23.9%) and 18 seronegative men (17.8%) after six months.

In a study of 42 patients with mild to moderate AIDS dementia, Worth et al (1993) found that patients with AIDS dementia performed significantly worse than a control group of 33 healthy subjects an all four of the reaction time measures in the Abbreviated CALCAP battery. The two measures of sequential reaction time were found to be the best tasks for discriminating between patients and controls and for discriminating among different levels of severity of dementia.

INSTALLATION

What You Need

The California Computerized Assessment Package requires an PC-compatible computer running MS-DOS® (any version) or Windows®. The program works correctly with Intel 80286 microprocessors or faster (80386, 80486, etc.), but cannot time the stimulus materials correctly on slower computers (8086, 8088). In addition, the program requires:

- 1 MB minimum memory
- Hard Disk Drive with 2 MB of free space
- 80-column color display (CGA, EGA, VGA or better) or Active Matrix (TFT) color laptop
- DOS 3.1 or greater
- Any printer (optional)

*Note: VGA adaptor cards and monitors provide improved picture quality relative to CGA and EGA monitors. The CALCAP stimulus materials were developed so that they appear almost identical across these different monitors. The visual clarity and readability of the task instructions, however, is significantly better on VGA monitors. Normative data for this program were collected using 14-inch EGA and VGA monitors. There were no differences in reaction times or signal detection parameters as a function of the type of monitor used.

Potential Conflicts with Other Software

The California Computerized Assessment Package requires full access to the microprocessor in your computer for accurate timing. The CALCAP program works correctly with most implementations of Microsoft Windows®, but only when running inside of a DOS virtual machine. The current version of the CalCAP sets up the necessary software to run within a virtual machine, so long as you always start it from the Windows "Start" menu. Note that while the CALCAP program is running, all other Windows functions (such as switching from one task to another or viewing programs within windows) will be disabled.You cannot print directly from the CalCAP program when it is running under Windows. Once you return to the Windows environment you will be able to print out the CalCAP results.

Installing the California Computerized Assessment Package (CALCAP) on Your Hard Disk

Before you use the CALCAP program you need to install it. The program and data files for the CALCAP program are in a compressed format and must be installed using one of the two procedures detailed below.

The CALCAP program requires a hard disk for proper execution. Your hard disk should have at least 2 MB of free disk space.

Windows Installation Procedures

1. Download the current Windows version of the CalCAP program from the internet.

2. Run the downloaded program file by clicking on it.

3. The installation program will transfer all of the files for the CalCAP program into a subdirectory (\CALCAP7) on Drive C. You can install a foreign language version of the CalCAP using procedures described later in this chapter.

4. To start the CalCAP program, locate the CalCAP program in the Windows Start Menu and then click on the CalCAP icon. You will see a list of all of the installed versions of the CalCAP program, and a DOS prompt (C:\>). Type the name of the program you wish to run at the DOS prompt, then press the Enter key. For more information about the different CalCAP routines, see Chapter 4: Task Administration.

5. When the CalCAP program is finished, you will be returned to the DOS prompt (C:\>). Type 'EXIT' to return to Microsoft Windows.

DOS Installation Procedures

To install the CALCAP Program:

1. Start your computer and stay in the root directory of your hard disk. The DOS prompt will probably be C:> but may differ depending on your particular computer.

2. Download the DOS version of the CalCAP software from the internet and save it on your hard drive or a floppy disk.

3. To start the installation process from a floppy disk, type:

    A:INSTALL

and then press the [Enter] key (or, use B:INSTALL if installing from Drive B).

The installation screen will suggest C:\CALCAP as the default drive and subdirectory. If you would like to install the program to a different hard disk or to a subdirectory other than CalCAP, edit the destination shown on the installation screen.

You cannot use nested subdirectories such as MYDIR\CALCAP during the initial installation, though you can copy the CALCAP files to any directory after they have been transferred to your hard disk.

4. Unless you specify otherwise, the installation program will transfer all of the files for the CALCAP program into a subdirectory (\CALCAP) on Drive C.

5. At the end of the installation procedure, the installation routine will look to see if you have an older version of the CalCAP already installed in this subdirectory. If so, it will ask some additional questions about updating your CalCAP files (see "Installing an Updated Version of the CalCAP Program" below).

6. If the installation routine does not detect an older version of the CalCAP program, it will list all currently available CalCAP routines and exit to the DOS prompt. You can then type in the name of the CalCAP routine that you would like to run (see Chapter 4: Task Administration).

Installing an Updated Version of the CalCAP Program

The CALCAP installation program automatically detects and updates earlier versions of the CALCAP software.

If the installation routine detects an old version of the CALCAP program, you will see some additional messages at the end of the installation procedure (for the DOS installation disk), or the first time that you click on the CalCAP icon (for the Win 95/98 installation). These additional messages are described below:

- An older version of CALCAP has been detected. Shall I delete the old program files? **Y**es (**N**o) [Default is Yes]

  There is no reason to keep the old program files since they cannot be used with the updated version of the CALCAP program and will not function correctly after the new CALCAP procedures have been installed.

- `Would you like to keep your customized Site Identification codes? Yes (No)` [Default is Yes]

  This question is asked only if you have customized the Site Identification codes by using the RTCONFIG program (described below). Answer 'Y' if you would like to retain any unique Site Identification codes that you may have assigned previously.

- `There are one or more batch files that need to be updated. Would you like to have these files updated so that they can be used with the new version of the CALCAP program? Yes (No)` [Default is Yes]

  This question is asked only if the installation procedure finds batch files that use the old version of the CALCAP program. Answering 'Y' will save you considerable time by editing your customized batch files and substituting the new name for the latest version of the CALCAP program.

These procedures for updating your programs work only if you have followed standard procedures for installing the CALCAP program. The updating process may fail if you have renamed any of the CALCAP files, have changed any of the CALCAP file attributes to Read-Only, or have write-protected your CALCAP files.

At the end of the installation procedure you will be in the `\CALCAP` subdirectory in Drive C. To see all available program drivers for the CALCAP program, type `'CALCAP'`. This command will list all of the CALCAP routines that are installed on your computer, as well as the DOS commands you should use to start the program.

For more information on starting the CALCAP program, refer to Chapter 4: Task Administration.

Installing Multiple Program Drivers for the CALCAP Program

All versions of the CALCAP program drivers are compatible and can reside in the same subdirectory on your hard disk. To install an additional set of program drivers, just follow the installation procedures described above. The CALCAP currently ships with the Standard, Abbreviated and Mini test batteries in English and several other languages (see below).

If you want to know which versions of the CALCAP program are installed on your hard disk, type the command `'CALCAP'` at the DOS prompt. You must already be in the `\CALCAP` subdirectory for this command to work.

Installing Foreign Language Versions of the CALCAP Program

The basic CALCAP program installs the English language version of the CALCAP. The necessary files for other languages are included on the CALCAP subdirectory in a compressed format.

Make sure that you are at the DOS prompt for the CalCAP program. Type the installation code word shown in the table below to de-compress and install the necessary program files. Then type 'CALCAP' at the DOS prompt to confirm that the routines were installed.

To install ...	Type ... and press [Enter]
Danish version*	DANISH
Flemish version	FLEMISH
French version	FRENCH
Norwegian version*	NORWAY
Spanish version	SPANISH

*See additional information below regarding Code Page adjustments for Norwegian and Danish versions of the CalCAP.

Code Page Adjustments for Norwegian and Danish Versions

If you are running Microsoft Windows, the characters ø and Ø will not display correctly in the CalCAP instructions (stimulus materials are not affected). If you are using an MS-DOS computer and these characters do not already display correctly, you can configure your computer by following the instructions shown below:

To configure your computer for an alternate MS-DOS character set:

1) Add to CONFIG.SYS:

```
country=047,865,c:\dos\country.sys
device=c:\dos\display.sys con=(,,2)
```

(Note: Country 045 is Denmark, Country 047 is Norway; Code page 865 is Nordic, Code page 850 is Multilingual)

2) Add to `AUTOEXEC.BAT:`

```
c:\dos\nlsfunc
c:\dos\mode con cp
   prep=((865,437) c:\dos\ega.cpi)
c:\dos\mode con cp select=865
```

(Note: Code page 865 is Nordic, 850 is Multilingual, 437 is U.S.)

These examples assume that you are using MS-DOS 5.0 or higher and that DOS is located in `C:\DOS.` The files `COUNTRY.SYS, DISPLAY.SYS, MODE.COM, NSLFUNC.EXE` and `EGA.CPI` must be in your DOS subdirectory. Consult your MS-DOS manual or the file `COUNTRY.TXT` supplied with MS-DOS for more information on configuring your computer for alternate character sets.

Site Identification Codes

If you are using the CALCAP program at more than one location you may want to assign unique site identification codes for each location. The RTCONFIG program allows you to enter a 28-character site identification descriptor and a 2-digit site number (01-99). To change the current defaults, type 'RTCONFIG' while in the \CALCAP subdirectory.

Note: The RTCONFIG program also lists the version numbers of the CALCAP programs and reaction time routines. These values are provided for informational purposes only. You cannot use RTCONFIG to change any of the version numbers.

Removing Old Versions of the CALCAP Program

If you are upgrading to a newer version of the CALCAP program the installation routine will automatically remove any old program files. To start the installation process, follow the instructions detailed under *Installing the California Computerized Assessment Package (CALCAP) on Your Hard Disk*.

If you are not installing a new version of the CALCAP program you can still remove the old program files without damaging the data files.

If you installed the program using Windows procedures, just choose Uninstall from the CalCAP menu found by clicking “Start” -> “Programs”.

If you installed the program using the DOS installation procedures, you can remove old program files by using the 'REMOVE' program included on your DOS distribution diskette.

For example, if your new CALCAP diskette is in Drive A and your \CALCAP subdirectory is on Drive C, you would type:

```
A:REMOVE C:\CALCAP
```

[If you need to use a different floppy disk drive or a different hard disk you would change the drive letters A and/or C shown above.]

This procedure will remove all old versions of the CALCAP program but will not remove any subject data.

Technical Notes: The 'REMOVE' program deletes most executable and batch files from the \CALCAP subdirectory. If you have installed programs other than the CALCAP routines in the \CALCAP subdirectory these programs should be moved to another subdirectory before using the 'REMOVE' program.

If you want to erase the old CALCAP program manually, you should be careful to save any subject data. *DO NOT* erase all of the files in your \CALCAP subdirectory since all of the files with a '.DAT' suffix contain subject data.

CALCAP TEST MATERIALS

The CALCAP battery is available in Standard (20-25 mins) and Abbreviated (8-10 mins) versions, or can be customized to meet specific clinical or research needs. Final scoring and intermediate feedback are available using age- and education-specific norms based on 641 men, ages 21 to 58.

Standard Edition

Test Duration: 20-25 minutes

The Standard program drivers for the CALCAP program were developed by Eric N. Miller, Ph.D. and Paul Satz, Ph.D. The stimulus materials assess a broad range of cognitive functions, including brief, sustained and divided attention, rapid visual scanning, form discrimination and language skills:

- *Simple Reaction Time.* Subjects are asked to press a key as soon as they see anything at all on the screen. This procedure provides a basal measure of reaction time. This task is given at the beginning, middle and end of the computerized procedures to allow the examiner to assess fatigue effects.

- *Choice Reaction Time for Single Digits.* Subjects are asked to press a key as soon as they see a specific number such as '7', otherwise they are to do nothing. This procedure adds a simple element of memory to the task.

- *Serial Pattern Matching (Sequential Reaction Time).* Subjects are asked to press a key only when they see two of the same number in sequence, for example, if they see the number '3' followed by a second occurrence of the number '3'. This procedure adds a more complex element of memory since the subject must keep in mind the last number that was seen.

- *Lexical Discrimination.* Subjects are asked to press a key when they see a word which fits into a specific category such as animal names (such as, 'COW' or 'HORSE'), but not when they see a word which fits into a category of non-animals (such as 'DESK' or 'FOOD'). This procedure introduces an additional level of language skills by requiring meaningful differentiation between semantic categories. The task requires rapid language processing and should be sensitive to any disruption in language skills.

- *Visual Selective Attention.* Subjects are asked to press a key as soon as they see a specific word such as 'SEVEN' in the center of the screen. An additional set of the words are displayed around the periphery of the target stimulus located in the center of the screen. These distractors require that the subject focus his or her attention much more narrowly.

- *Response Reversal and Rapid Visual Scanning.* This task is identical to task 5 described above, but the subject must ignore the stimuli presented in the middle of the screen while responding to target stimuli displayed around the periphery of the computer screen. This task taps into the subject's ability to change cognitive set from the previous task, and requires more rapid visual scanning across the entire display screen.

- *Form Discrimination.* Subjects are shown three geometric figures simultaneously and asked to press a key only when two of the figures are identical. This task requires rapid comparison of non-nameable forms, and, because of the brief exposure time, may measure the subject's ability to retain an iconic memory of the figures.

Abbreviated Version

Test Duration: 8-10 minutes

The Abbreviated version of the CALCAP provides a very brief screening battery using a subset of the most sensitive measures from the Standard edition. This test battery is ideally suited for collecting reliable information on psychomotor functioning in a brief period of time, and can be used effectively for assessing changes over time. The task entitled Serial Pattern Matching 2 is new and is designed to be even more sensitive to subtle cognitive deficits than Serial Pattern Matching 1.

- *Simple Reaction Time.* Subjects are asked to press a key as soon as they see anything at all on the screen. This procedure provides a basal measure of reaction time.

- *Choice Reaction Time for Single Digits.* Subjects are asked to press a key as soon as they see a specific number such as '7', otherwise they are to do nothing. This procedure adds a simple element of memory to the task.

- *Serial Pattern Matching 1 (Sequential Reaction Time 1).* Subjects are asked to press a key only when they see two of the same number in sequence, for example, if they see the number '3' followed by a second occurrence of the number '3'. This procedure adds a more complex element of memory since the subject must keep in mind the last number that was seen.

- *Serial Pattern Matching 2 (Sequential Reaction Time 2).* Subjects are asked to press a key only when they see two numbers in sequence (increasing order). For example, if they see the number '3' followed by the number '4', the number '6' followed by '7' and so on.

Normative data for these tasks are available using age- and education-specific norms based on 656 men between the ages of 21 and 72.

Mini Version

Test Duration: 4-5 minutes

A "Mini" version of the CALCAP was developed for clinical research protocols where testing time is extremely limited. This "Mini" version consists of the first two choice reaction time tasks from the Abbreviated reaction time task. There is no Simple Reaction Time procedure.

- *Choice Reaction Time for Single Digits.* Subjects are asked to press a key as soon as they see a specific number such as '7', otherwise they are to do nothing. This procedure adds a simple element of memory to the task.

- *Serial Pattern Matching 1 (Sequential Reaction Time 1).* Subjects are asked to press a key only when they see two of the same number in sequence, for example, if they see the number '3' followed by a second occurrence of the number '3'. This procedure adds a more complex element of memory since the subject must keep in mind the last number that was seen.

The normative data for these tasks are the same as those used for the Abbreviated test battery, and include age- and education-specific norms based on 656 men between the ages of 21 and 72.

Customized Versions

The CALCAP routines can be special ordered to include any of the simple and choice reaction time measures described above. This flexibility allows researchers and clinicians to customize the CALCAP for specific needs that may not be met by the Standard and Abbreviated versions of the CALCAP.

TASK ADMINISTRATION

Setting Up the Room

It is important that the subject be able to see the screen clearly during the task. Make sure that the back of the computer monitor is slightly elevated to reduce glare from any overhead lights. If necessary, lights should be dimmed or a glare screen should be placed over the computer screen.

Starting the CalCAP Program

From Windows: Select Start ➞ Programs ➞ CalCAP and then click on the CalCAP icon.

From DOS: Switch to the `\CALCAP` subdirectory on your hard disk, then type 'CalCAP'. For example, if CalCAP is installed on Drive C you would type:

```
C:
CD \CALCAP
CALCAP
```

For Windows or DOS: From this point on the procedures are the same regardless of whether you started from Windows or from DOS. You will see a listing of all versions of the CalCAP program that are installed on your computer.

DOS Commands

Language	Standard	Abbrev	Mini
English	`RT`	`ART`	`MINI`
Danish	`DRT`	`DART`	`DMINI`
Flemish	`FLRT`		
French	`FRRT`		
Norwegian	`NORT`	`NOART`	`NMINI`
Spanish	`SRT`	`SART`	`SMINI`

Type the appropriate 'DOS Command' for the program you want to use, then press [Enter]. The program checks to make sure it has exclusive use of the computer, then performs several brief initialization routines lasting approximately 30 seconds.

These procedures compute the speed of your computer's microprocessor so that timing can be accurately controlled for the reaction time stimulus materials.

Entering Identification Numbers and Demographic Information

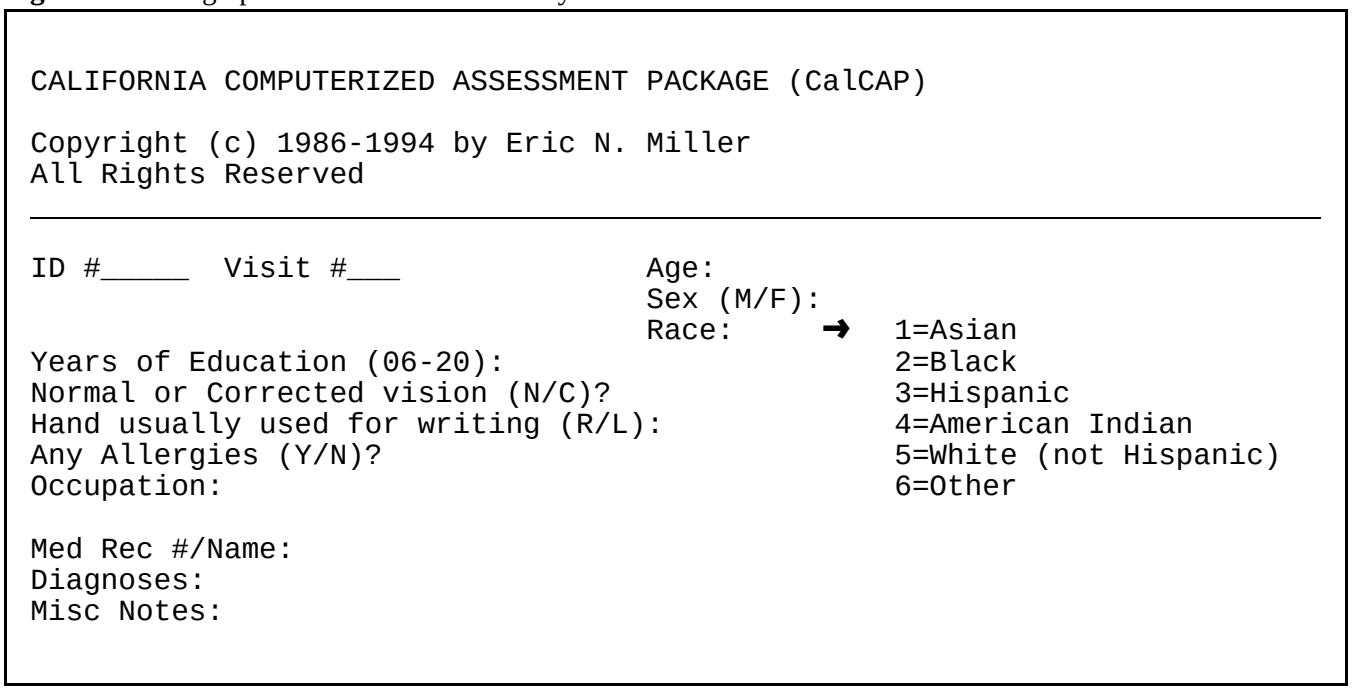
The first data entry screen prompts you for an identification number for the subject (see Figure on next page). To ensure accurate data entry, you will be asked to enter the subject number twice. Subject numbers can be composed of the letters A-Z and numbers 0-9, but cannot be longer than 5 characters.

One of the best methods for creating unique subject numbers is to use the patient's initials plus the day of the month. For example, the code for Eric N. Miller tested on November 21st would be 'ENM21'. This method will usually create unique numbers. If data have been entered during the past month using this same ID number the CalCAP program will warn you that the ID number already exists. If this happens, you should select a different ID number (perhaps by using a different day of the month).

After entering the subject number you will be prompted to enter a variety of demographic and medical information. All of this information is optional, although age and years of education are used to select appropriate normative data for evaluating the subject's responses. These data are recorded on diskette and are included in the final report of the subject's results.

Once you have entered the subject number and all necessary demographic information, press the [Esc] key to display a brief set of instructions for the subject.

Figure 1. Demographic Information Data Entry Screen



Instructions to the Subject

Seat the subject at the computer and instruct him to position himself so that he can comfortably see the screen and press the space bar on the keyboard. *The subject should be instructed to use the space bar for all responses.* Unpredictable results may be obtained if the subject presses any function key, any key on the numeric keypad, the Escape key or any of the following keys: Tab, Alt, Shift, Ctrl, Num Lock, Scroll Lock, Caps Lock.

The CALCAP program displays a brief set of instructions at the beginning of the reaction time task and at the beginning of each individual reaction time measure.

For the most part, the CALCAP program is self-paced and self-explanatory. The best way to familiarize yourself with the program is to complete the tasks yourself. The tasks are designed to be progressively more difficult.

Instructions for Subjects Who are Unable to Complete the Practice Trials

Occasionally, a task will be too difficult for the subject to complete the practice trials. For simple reaction time measures, the program will detect this problem and display a message to the subject saying that he should contact the examiner. At this point, the only way to continue with the computerized tasks is to press the [Esc] key. The program will then re-start the practice trial.

For choice reaction time measures, the program allows the subject up to 3 practice trials and then proceeds to the actual task, even when the subject fails all 3 practice trials. For all tasks, the computer suggests that the subject contact the examiner if he has any questions about the instructions.

If the subject has any questions during the testing, use the following procedures:

1. If the subject finds the instructions unclear, tell him to try the practice trial and see if he understands after completing the practice. You should monitor the subject's responses on the first task to make sure that he is pressing the space bar as soon as he sees something on the screen. Also, for the standard version of the reaction time task you should make sure that the subject is using the correct hand for the first 3 tasks. The sequence for the standard version of the reaction time task is: dominant hand (first task — practice and full task), nondominant hand (second task), dominant hand (all remaining tasks).

2. If the subject still finds the instructions unclear following the practice trial, explain the nature of the task as clearly as you can.

3. If the subject is still unable to understand the task following three practice trials, the CalCAP program will automatically move on to the full task. If necessary you can skip the task by pressing the [Esc] key followed by the [Tab] key when the computer says "Press the space bar twice to continue".

Feedback During the CalCAP Task

If feedback has been selected (as in the standard version of the CalCAP program), the computer will give the subject feedback on his performance relative to other subjects of the same age and education. It is not possible to change the feedback setting while the CalCAP program is in progress.

Feedback can be permanently enabled or disabled if necessary. See 'Special Configurations for the CalCAP Program' elsewhere in this document.

Controlling the Music

In the standard version of the CalCAP program the computer plays a brief tune at the end of each of the Choice Reaction Time measures.

You can turn off the music in the middle of the CalCAP program by pressing '0' (zero) twice when the program asks for the subject to 'Press the space bar twice to continue'. Use the '0' key at the top of the keyboard rather than on the numeric keypad. Music can be turned on by pressing '1' (one) instead of '0' (zero).

The default setting for music can be permanently enabled or disabled. See 'Special Configurations for the CalCAP Program' elsewhere in this document.

Skipping Specific Tasks

If you need to skip one specific task, you can do so by pressing the [Esc] key, then pressing the [Tab] key.

Note: If the computer is waiting for you to 'Press the space bar twice to continue' this procedure will work quickly. If you attempt to skip a task that has already started, however, you will need to wait for a beep after pressing the [Esc] key. Within simple reaction time tasks it may take several seconds for the system to respond after you press [Esc]. Within choice reaction time tasks you may need to press the [Esc] key more than once before the computer will respond.

Aborting the CalCAP Program

If you need to abort the CalCAP program for any reason, you can do so by pressing the [Esc] key and then pressing the [Backspace] key.

Note: If the computer is waiting for you to 'Press the space bar twice to continue' this procedure will work quickly. If you attempt to abort the CalCAP program from within a reaction time task, however, you will need to wait for a beep after pressing the [Esc] key. Within simple reaction time tasks it may take several seconds for the system to respond after you press [Esc]. Within choice reaction time tasks you may need to press the [Esc] key more than once before the computer will respond.

In a real emergency, you can exit from the program by pressing Ctrl-Alt-Del, or by turning the computer off. These methods have the potential for causing damage to the procedures for recording data and should be used only when the system refuses to respond to any keyboard input.

End of the CalCAP Program

At the end of the CalCAP program the keyboard appears to "freeze" so that the subject will not accidentally view the summary of exam results.

Viewing Exam Results

Following completion of the computerized tasks, a summary of the test results is immediately available. After the subject leaves the room, press the [Esc] key to move to the next screen. On slower computers it may take from 20 to 40 seconds after pressing [Esc] before the exam summary appears on the screen.

The CalCAP program provides several pages of test results: (1) a Summary of all abnormal test results; (2) a Graphical representation of Mean Reaction Times and True Positive responses; (3) Mean and

Median Reaction Times; (4) Difference Scores for deviation from baseline simple and choice reaction time tests; (5) True Positive and False Positive scores; and (6) the A' population estimate of the Signal Detection parameter d'.

You can move from one screen to the next by pressing the space bar. Most of these results include z-scores and percentile ranks based on age and education level. In addition to the information presented on the screen, additional recommendations for interpretation of exam results are printed if you request a hard copy of the results.

Printing the Results

The DOS version of the CalCAP will send results directly to a printer if you press the letter 'P' while the results are displayed.

The Windows version of the CalCAP runs in a virtual machine that cannot send information directly to your printer. Instead, the CalCAP results are automatically sent to a file (REVIEW.TXT) that can be read by the Windows Notepad program. The easiest way to open REVIEW.TXT is by choosing the 'Print Results' icon from the CalCAP folder in the Start Menu (Start -> All Programs -> CalCAP -> Print Results). Once the results are displayed in Notepad you can print them as you would with any other Windows program.

Note: The current default directory for the Windows CalCAP is C:\CalCAP7. Earlier versions, however, may have installed the program in C:\Program Files\CalCAP7 or C:\Program Files (x86)\CalCAP7. The 'Print Results' icon will search for REVIEW.TXT in all of these locations, as well as several hidden locations that are sometimes used by Windows 7 and Windows 8. If you are having difficulty finding the REVIEW.TXT file (or any of the CalCAP data files), contact Eric Miller at emiller@calcaprt.com.

Re-Starting the CALCAP Program

You can avoid the 30-second initialization process at the beginning of the CALCAP program by re-starting the program from the Results screen. Simply press the letter 'R' to restart the program.

Exiting the Program

If you want to exit from the Results screen, simply press the [Esc] key.

If you want to exit at the prompt for ID number, press Alt-X (hold down the Alt key and press X).

If you want to exit in the middle of the CALCAP program, follow the procedures for 'Aborting the CALCAP Program' described above.

All of the procedures described above will return you to the DOS command prompt. If you started the program from Windows and would like to return to Windows, type 'EXIT' then press the Enter key.

Reviewing Results at a Later Time

The CalCAP program stores a copy of all data collected during the task in a file called 'subjn-xx.DAT' where 'subjn' is the subject number entered at the beginning of the program and 'xx' is the number of times the person has been tested.

From Windows: Double-click on the Review icon in the CalCAP folder, or, from the Start Menu, select Start ➞ Programs ➞ CalCAP and then click on the Review icon. You will then need to select the appropriate subject ID from a list of all available subject data.

If you want to review the last set of test results, you can just click on the 'Print Results' icon in the CalCAP folder (Start -> Programs -> CalCAP -> Print Results).

From the DOS prompt: You can review exam results by typing 'Review' or 'Review subjn' at the system prompt. (Note: You must already be in the \CALCAP subdirectory before using this command.)

Printing Results Using the Classic (1986-1998) CalCAP Print Format DOS Version of the CalCAP Only

If you want to see the 3-page printout format that was used up through mid-1998, you can toggle between the new and old formats by pressing "C" (for Classic style) while the test results are displayed

on the screen. This alternate format can only be printed using the DOS version of the CalCAP. It cannot be stored in REVIEW.TXT for use by the Windows version of the CalCAP.

If you are using the DOS version of the CalCAP and decide that you prefer the old printout format, you can make the “Classic” style the default by switching to the CalCAP subdirectory and then typing ‘PRINTOLD’ at the DOS prompt. If you later decide that you prefer to keep the New printout style as the default, you can go back by switching to the CalCAP subdirectory and then typing ‘PRINTNEW’ at the DOS prompt.

Troubleshooting Your Printer

The Windows version of the CalCAP runs in a virtual machine that cannot send information directly to your printer. Instead, the CalCAP results are automatically sent to a file (REVIEW.TXT) that can be read by the Windows Notepad program. The easiest way to open REVIEW.TXT is by choosing the ‘Print Results’ icon from the CalCAP folder in the Start Menu (Start -> All Programs -> CalCAP -> Print Results). Once the results are displayed in Notepad you can print them as you would with any other Windows program.

Note: The current default directory for the Windows CalCAP is C:\CalCAP7. Earlier versions, however, may have installed the program in C:\Program Files\CalCAP7 or C:\Program Files (x86)\CalCAP7. The ‘Print Results’ icon will search for REVIEW.TXT in all of these locations, as well as several hidden locations that are sometimes used by Windows 7 and Windows 8. If you are having difficulty finding the REVIEW.TXT file (or any of the CalCAP data files), contact Eric Miller at emiller@calcaprt.com.

INTERPRETATION OF REACTION TIME RESULTS

Overview

At the completion of testing, the CALCAP program displays a summary of all of the exam results on a single screen, showing those tests, if any, on which the subject performed abnormally (see Figure 1).

An additional five screens of detailed test results are available by pressing the space bar to cycle through a graphical summary of the reaction times and true positive responses; a detailed summary of mean and median reaction times; difference scores; accuracy indices including true and false positive responses; and signal detection parameters.

The exam results are automatically sent to a file (REVIEW.TXT) which can be accessed for printing after you return to the Windows environment (Start –> Programs –> CalCAP –> Print Results). Additional information about test interpretation is included when you print the REVIEW.TXT file. A sample printout is shown in Appendix B.

Note: If you are using the original DOS version of the CalCAP, you can send results to a printer by pressing 'P' while the results are displayed.

How the CalCAP Selects Normative Comparison Samples

The CALCAP program compares each subject's responses with normative data matched (when possible) by age and education. The original normative sample consisted of over 600 men between the ages of 21 to 59, with a mean educational level of a college degree. Additional normative data are available, and most of these data are summarized in Appendix A. For the purposes of the CalCAP printouts, however, only the original normative sample is used to compute *z*-scores and percentile ranks. Normative data are stratified by both age (20-34, 35-44, 45+) and education (< 16 years, 16 years, > 16 years).

Subjects who are not within the age groupings of the normative sample are evaluated based on means and standard deviations for all subjects within their educational stratum. If years of education are missing, subjects are evaluated using means and standard deviations for all subjects within their age stratum. If age and education data are missing or out of range, subjects are evaluated using means and standard deviations for all subjects within the normative sample.

Sociodemographic Factors That May Influence Reaction Time

Reaction time correlates most highly with age, and, to a lesser extent, with years of education. A study of the effects of age, education and ethnicity is reprinted in Appendix F. Two small studies of gender effects on CalCAP reaction time have shown no differences between men and women on any of the CalCAP indices. Normative data from one of these studies, stratified by gender, are included in Appendix A.

Understanding the Results: A Page by Page Interpretation Guide

Each of the six pages of the CalCAP printout is described in detail below and are illustrated in the accompanying figures. A complete sample printout is shown in Appendix B. For all printouts, results that are outside of normal limits are tagged with one, two or three asterisks to represent performance 1.5, 2.0 or 3.0 SDs below the mean of the normative sample. The notation "Skipped" indicates that some or all of the subtest was skipped by the user. "Custom" indicates that the subtest is Custom-designed and cannot be compared with the original CalCAP normative data set.

Figure 1. Summary of Exam Results (Page 1 of standard printout)

```
                CALIFORNIA COMPUTERIZED ASSESSMENT PACKAGE (CalCAP)

                                    ID#: 40000
                             Date of Exam: 25 Aug 1998
                                   Gender: Male
                                      Age: 47
                                Yrs Education: 16
                                   Handedness: Right
                                       Vision: Corrected
                                         Race: White (not Hispanic)
                                   Occupation: CLERICAL
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
                        SUMMARY OF ABNORMAL CALCAP EXAM RESULTS
                     (only results 1.5 SDs below norms are marked)

                                      Reaction            Signal     Normative
## Description                          Time   Accuracy  Detection     Data
-- --------------------------  -------- --------  ---------  -----------
 1 Simple RT 1 - Dominant Hand                                 Std (a)
 2 Simple RT - Nondominant Hand                                Std (a)
 3 Choice Reaction Time - Digits                               Std (a)

 4 Sequential Reaction Time 1      *         ***       ***     Std (a)
 5 Language Discrimination                                     Std (a)
 6 Simple RT 2 - Dominant Hand                                 Std (a)

 7 Degraded Words with Distract                                Std (a)
 8 Response Reversal - Words                                   Std (a)
 9 Form Discrimination                          **             Std (a)

10 Simple RT 3 - Dominant Hand                                 Std (a)

  *One or more indices are more than 1.5 SDs outside of normal range
 **One or more indices are more than 2.0 SDs outside of normal range
***One or more indices are more than 3.0 SDs outside of normal range
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
                                  Normative Sample(s)
   (a) Norms are based on 25 U.S. males ages 45 - 54 with education level
       = 16 years. Normative Sample = NORM0292/509.
```

Page 1 - Summary of Results

(see Figure 1)

Results that are outside of normal limits are tagged with one, two or three asterisks to represent performance 1.5, 2.0 or 3.0 SDs below the mean of the normative sample. The notation "Skipped" indicates that some or all of the subtest was skipped by the user. "Custom" indicates that the subtest is Custom-designed and cannot be compared with the original CalCAP normative data set.

Reaction Time: Indicates whether mean computed reaction time falls outside of normal limits. Additional information on mean reaction times is included on Page 3 of the printout, which also includes information about the Range of reaction times and Median reaction times. Only Mean reaction time is used to evaluate whether or not a score was within normal limits.

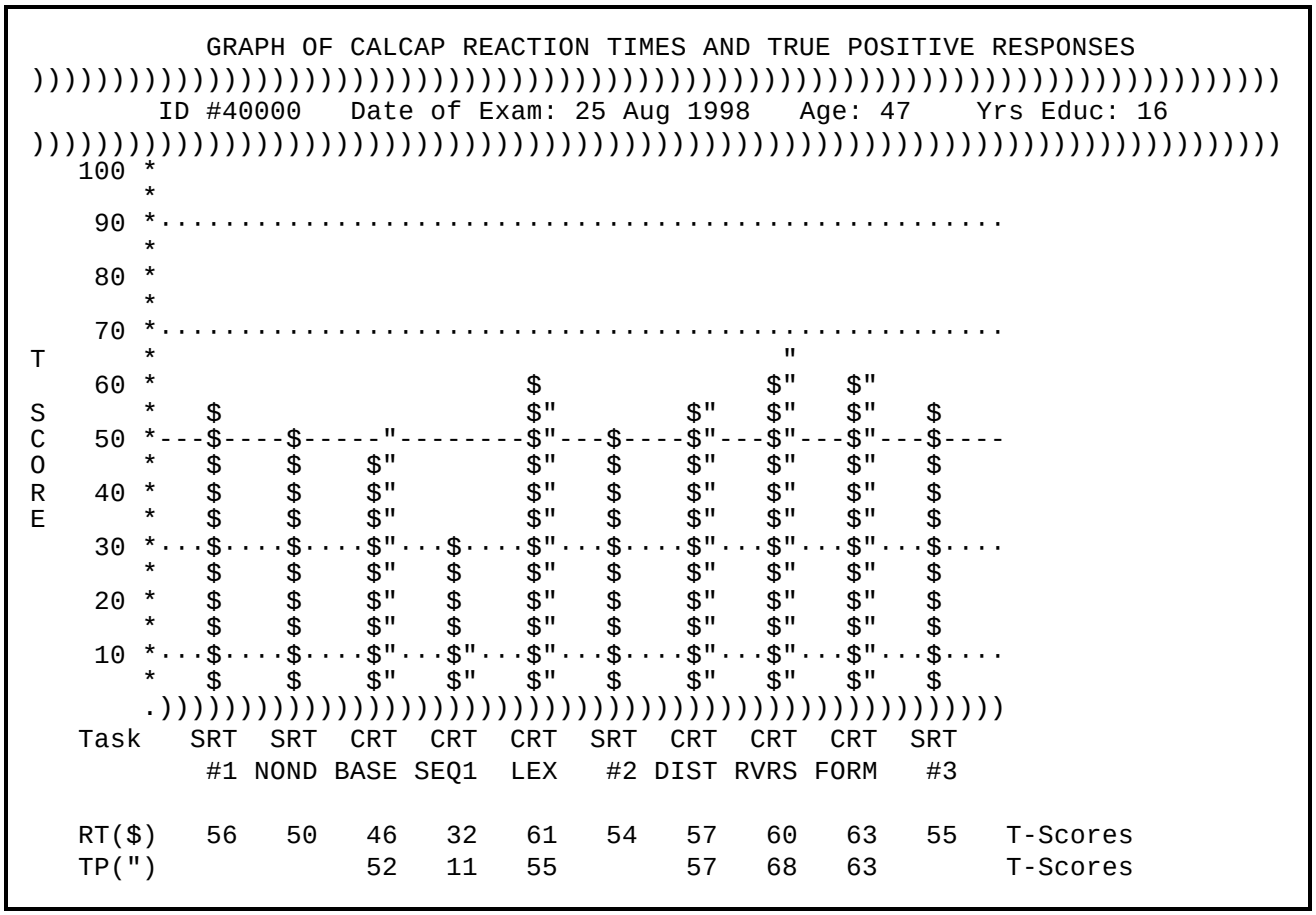
Accuracy: Indicates whether True Positive and/or False Positive indices of response accuracy all outside of normal limits. For a more detailed breakdown of raw scores, z-scores and percentile ranks for these indices, see Page 4 of the printouts (Figure 4 in this Interpretation Guide).

Signal Detection: Indicates whether the signal detection parameter A' (a population estimate of d') falls outside of normal limits. Addition information about this signal detection parameter is shown on Page 6 of the printout (Figure 6 in this Interpretation Guide).

Normative Data: Std Norms or Std (a) indicates that the original CalCAP normative data set was used as a comparison group for this test protocol. "Skipped" indicates that some or all of the subtest was skipped by the user. "Custom" indicates that the subtest is Custom-designed and cannot be compared with the original CalCAP normative data set.

The *"Normative Sample(s)"* footer provides additional information about the age and education range of the normal control subjects that were used as a comparison group for this test protocol.

Figure 2. Graphical Printout (Page 2 of standard printout)



Page 2 - Graphical Printout
(see Figure 2)

The graphical representation of exam results is presented using T-score (standard score) values where a score of 50 is average. The standard deviation for a T-score is 10. Higher T-scores correspond to better performance, lower T-scores correspond to poorer performance.

The CALCAP program displays the age- and education-adjusted reaction time T-scores for all of the simple and choice measures. In addition, the program displays the age- and education-adjusted T-scores for the number of true positive responses on each choice reaction time measure.

The following codes are used:

- RT = Age & education adjusted T-score for Mean Computed Reaction Time
- TP = Age & education adjusted T-score for # of True Positive responses

Task Codes:

- SRT #1 = Simple RT, Dominant Hand (1st iteration)
- SRT NOND = Simple RT, Nondominant Hand
- SRT #2 = Simple RT, Dominant Hand (2nd iteration)
- SRT #3 = Simple RT, Dominant Hand (3rd iteration)
- CRT BASE = Choice RT, Basic Go-No Go Paradigm
- CRT SEQ1 = Choice RT, Serial Pattern Matching (Repetition of Numbers)
- CRT LEX = Choice RT, Word Discrimination
- CRT DIST = Choice RT, Go-No Go Paradigm with Distraction
- CRT RVRS = Choice RT, Rapid Visual Scanning/Response Reversal
- CRT FORM = Choice RT, Form Discrimination
- CRT SEQ2 = Choice RT, Serial Pattern Matching (Numbers in Sequence)
- MEMORY = Recognition Memory

Figure 3. Mean and Median Reaction Time Indices (Page 3 of standard printout).

CALCAP REACTION TIMES

ID #40000 Date of Exam: 25 Aug 1998 Age: 47 Yrs Educ: 16

##	Description	Range	Median	Mean Reaction Time (RT) RT	z-score	%ile
1	Simple RT 1 - Dominant Hand	283- 352	333	332	0.64	74%
2	Simple RT - Nondominant Hand	295- 428	343	351	0.03	51%
3	Choice Reaction Time - Digits	375- 502	427	426	-0.36	36%
4	Sequential Reaction Time 1	437- 853	853	712*	-1.78	4%
5	Language Discrimination	382- 552	482	488	1.15	87%
6	Simple RT 2 - Dominant Hand	338- 868**	354	385	0.40	65%
7	Degraded Words with Distract	431- 669	515	503	0.68	75%
8	Response Reversal - Words	407- 757	613	601	1.05	85%
9	Form Discrimination	435-1133	607	613	1.27	90%
10	Simple RT 3 - Dominant Hand	298- 458	328	335	0.48	69%

*Score is more than 1.5 SDs outside of normal range
**Score is more than 2.0 SDs outside of normal range
***Score is more than 3.0 SDs outside of normal range

Page 3 - Reaction Times
(see Figure 3)

This page summarizes the critical reaction time indices used in the CalCAP task. One, two or three asterisks are used to indicate scores that are 1.5, 2.0 or 3.0 SDs below the mean of the normative sample. Norms are available only for the Range of reaction times and the Mean reaction time. No norms are available for Median reaction times, so these values should never be flagged with asterisks, even when they are clearly abnormal.

Range: The range of reaction times shown represents the best and worst performances during this testing session. Range is considered abnormal if the difference between the fastest and slowest reaction times deviates significantly from the range of reaction times observed in the normal control sample.

An abnormal result indicates that the subject is responding extremely quickly to some items, but extremely slowly to others. Unusually large ranges suggest inconsistent responding across the trial. This may be due to transient distractions during the testing, difficulties keeping up with the pace of the testing, or losing track of the task instructions. Abnormal ranges across multiple tests suggest poor motivation, malingering, or significant fluctuations in attention due to psychoactive drugs or neurologic injury.

Median: Median reaction time is the median of all trials on a particular task. Note that no norms are available for Median reaction times, so these values will never be flagged with an asterisk, even when they are clearly abnormal.

Mean: The mean reaction times shown on Page 3 represent the arithmetic mean of all target trials, excluding the two best and two worst performances.. An abnormal value indicates that the subject is, on average, responding unusually slowly to the items on this task.

Mean reaction times indicate the average speed with which the individual was able to respond to target stimuli. Abnormal reaction times on multiple tasks suggest generalized slowing in cognitive processing or artifacts such as inattention, visual problems, or random responding. Selective slowing on certain tasks may indicate a passing distraction during the test procedure or may indicate a focal deficit in the cognitive ability measured by that subtest. Note that abnormal performance on the Language Discrimination task only may suggest that the individual is not a native speaker.

Figure 4. Difference Scores (Page 4 of standard printout).

```
                          CALCAP DIFFERENCE SCORES
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
        ID #40000   Date of Exam: 25 Aug 1998   Age: 47    Yrs Educ: 16
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
                                Diff. from Baseline   Diff. from Baseline
## Description                  Simple RT ( 332 ms)   Choice RT ( 426 ms)
-- ---------------------------- -------------------   -------------------
 1 Simple RT 1 - Dominant Hand       ---Baseline---
 2 Simple RT - Nondominant Hand        19 ms slower
 3 Choice Reaction Time - Digits                          ---Baseline---

 4 Sequential Reaction Time 1                              287 ms slower
 5 Language Discrimination                                  62 ms slower
 6 Simple RT 2 - Dominant Hand         53 ms slower

 7 Degraded Words with Distract                             77 ms slower
 8 Response Reversal - Words                               175 ms slower
 9 Form Discrimination                                     187 ms slower

10 Simple RT 3 - Dominant Hand          3 ms slower
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))

                                    Notes
  Normative data are not available for Difference Scores.
```

Page 4 - Difference Scores
(see Figure 4)

This page provides information on the difference in mean reaction time between the baseline Simple and Choice Reaction Time tasks and subsequent, more complex tasks. Currently there are no normative data for these difference scores, so the interpretations discussed below are based on the theoretical rationale that underlies the development of these tasks as well as clinical judgment.

The baseline Simple Reaction Time task is Task #1 (Simple RT 1 - Dominant Hand). Subsequent iterations should be similar (within about 1 SD of the baseline value) or slightly faster due to practice effects. Scores that are significantly slower than the baseline value suggest fatigue, inattention, or lack of motivation.

The baseline Choice Reaction Time task is Task #3 (Choice Reaction Time - Digits). This is the most basic of all of the Choice Reaction Time tasks. Subsequent tasks require greater analytical reasoning decision-making, so they should, in general, be slower than the baseline task. If one or more of the more complex choice reaction time measures are faster than the baseline task, this suggests that the baseline measure was spoiled due to attentional problems, lack of motivation, or environmental distractors.

Since each of the Choice Reaction Time tasks places different levels of cognitive demands on the subjects, it is not possible to define a simple rule-of-thumb for what constitutes an abnormal deviation from baseline. The choice reaction time tasks in the Standard CalCAP test battery are ordered by increasing level of difficulty, so, in general, performance should be slower with each subsequent task.

If one of the Choice Reaction Time difference scores differs dramatically from the other difference scores, this can be reasonably interpreted as a selective area of weakness. For example, if the Form Discrimination difference score is twice as slow as any of the other difference scores, this would be suggestive of a specific problem with visual-perceptual skills that should be explored using other neuropsychological measures. Some of the possible interpretations of selective deficits associated with specific measures from the Standard CalCAP battery are outlined below:

- Sequential Reaction Time 1: Problems with divided attention or short-term memory
- Language Discrimination: Problems with English language skills
- Degraded Words with Distraction: Heightened susceptibility to external distractors
- Response Reversal: Problems with rapid visual scanning
- Form Discrimination: Possible visual-perceptual deficits

Figure 5. Accuracy Indices (Page 5 of standard printout).

```
                          CALCAP ACCURACY INDICES
                       (not computed for Simple RT tasks)
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
        ID #40000   Date of Exam: 25 Aug 1998   Age: 47    Yrs Educ: 16
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
                                        True Positives          False Positives
## Description                     Score   z-score %ile    Score   z-score %ile
-- ------------------------------ -------   ------- ----  -------   ------- ----
 3 Choice Reaction Time - Digits   15/15      0.20  58%     0/85      0.52  70%

 4 Sequential Reaction Time 1       9/20***  -3.89   1%     1/80      0.14  56%
 5 Language Discrimination         24/24      0.52  70%     0/96      1.17  88%

 7 Degraded Words with Distract    15/15      0.72  76%     1/85      0.50  69%
 8 Response Reversal - Words       15/15      1.76  96%     1/85      0.28  61%
 9 Form Discrimination             19/20      1.27  90%     7/80**   -2.37   1%


  *Score is more than 1.5 SDs outside of normal range
 **Score is more than 2.0 SDs outside of normal range
***Score is more than 3.0 SDs outside of normal range
```

Page 5 - Accuracy Indices
(see Figure 5)

This page summarizes the accuracy indices of True and False Positive responses (Choice Reaction Time measures only). One, two or three asterisks are used to indicate scores that are 1.5, 2.0 or 3.0 SDs below the mean of the normative sample. Percentile ranks and *z*-scores are included separately for True Positive and False Positive responses.

True Positives: True Positive responses are responses where the individual correctly identifies a target stimulus. Abnormal True Positive scores may indicate inattention, random responding, visual problems, or a true inability to identify and respond to the target stimulus in the amount of time available. Note that abnormal performance on the Language Discrimination task only may suggest that the individual is not a native speaker. True Positive responses are only computed for Choice Reaction Time measures.

False Positives: False Positive responses are responses where the individual incorrectly identifies a distractor as being a target stimulus. Abnormal False Positive scores may indicate inattention, random responding, visual problems, a response bias toward excessive button pressing, or a true difficulty with separating distractor stimuli from target stimuli, due either to slowed cognitive processing or an inability to remember the task instructions. False Positive responses are only computed for Choice Reaction Time measures.

Figure 6. Signal Detection Parameters (Page 6 of standard printout).

```
                              CALCAP REACTION TIMES
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
        ID #40000   Date of Exam: 25 Aug 1998   Age: 47    Yrs Educ: 16
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
                                                          Mean Reaction Time (RT)
## Description                      Range     Median    RT     z-score   %ile
-- ------------------------------  -------   ------  ------   -------   ----
 1 Simple RT 1 - Dominant Hand    283- 352      333     332      0.64    74%
 2 Simple RT - Nondominant Hand   295- 428      343     351      0.03    51%
 3 Choice Reaction Time - Digits  375- 502      427     426     -0.36    36%

 4 Sequential Reaction Time 1     437- 853      853     712*    -1.78     4%
 5 Language Discrimination        382- 552      482     488      1.15    87%
 6 Simple RT 2 - Dominant Hand    338- 868**    354     385      0.40    65%

 7 Degraded Words with Distract   431- 669      515     503      0.68    75%
 8 Response Reversal - Words      407- 757      613     601      1.05    85%
 9 Form Discrimination            435-1133      607     613      1.27    90%

10 Simple RT 3 - Dominant Hand    298- 458      328     335      0.48    69%

  *Score is more than 1.5 SDs outside of normal range
 **Score is more than 2.0 SDs outside of normal range
***Score is more than 3.0 SDs outside of normal range
```

Page 6 - Signal Detection Parameters
(see Figure 6)

Signal detection parameters provide an index of an individual's ability to accurately discriminate target stimuli from distractor stimuli. A' is a population estimate of the signal detection parameter d'. An abnormal value in A' indicates that the individual had greater than average difficulty with differentiating the target stimuli from the distractor stimuli. This type of error might be due to inattention, visual problems, random responding, visual processing deficits, or an inability to process the stimuli at the rate they are presented by the CalCAP program.

The signal detection parameter beta is also collected and can be used for research studies (consult Appendices D and E for instructions on how to use CalCAP data files). Beta is not included in the clinical printouts since it is not normally distributed, has a very restricted range, and does not seem to be particularly predictive of clinical abnormalities.

General Tips for Interpretation

In general, you should consider the first simple and choice reaction time tasks to be practice trials. Even though each individual task has a practice component, many subject's scores do not stabilize until after the first tasks.

The reaction time tasks measure cognitive functioning that is not ordinarily assessed using standard neuropsychological procedures. Although the tasks correlate modestly (.2 - .4) with other neuropsychological measures (especially Symbol Digit Substitution and Trails B), based on factor analyses the reaction time measures form two factors (Simple reaction time and Choice reaction time) that are different from standard NP tasks.

The cognitive functions assessed by the CALCAP program are best described as timed psychomotor skills requiring focused or sustained attention. Impaired reaction time across multiple measures is usually indicative of generalized motor slowing. Impaired reaction time on specific measures, particularly when coupled with scores outside of normal bounds on true positive responding, is suggestive of a more specific functional deficit, usually in the area of fluctuating attention.

In general, poor performance on a single measure is not indicative of a specific type of cognitive impairment. Certain tasks, however, do seem to be related to specific skills.

Serial Pattern Matching (Sequential Reaction Time) is largely a measure of divided attention skills (similar to Trails B, Consonant Trigrams, etc.)

Lexical Discrimination is frequently impaired in non-native English speakers.

A large discrepancy in reaction time between tasks 1 (simple reaction time–dominant hand) and 2 (simple reaction time–non-dominant hand) may be suggestive of a lateralizing finding.

An isolated finding of impaired performance on Form Discrimination may be suggestive of focal impairment in visuoperceptual skills.

SUPPLEMENTARY PROGRAMS

Re-Viewing Results from the CALCAP Program

The CALCAP program stores a copy of all data collected during the task in a file called '*subjn-xx*.DAT' where '*subjn*' is the subject number entered at the beginning of the program and '*xx*' is a coded form of the date of the exam. You can review exam results by typing 'Review' or 'Review *subjn*' at the system prompt. (Note: You must already be in the \CALCAP subdirectory before using this command.) In the Windows version of the CalCAP you can click on the 'Review' icon in the CalCAP folder (Start –> Programs –> CalCAP –> Review).

Preparing Data Sets for Additional Data Analyses [DOS Version Only]

It is possible to simplify the data structure of the raw CALCAP data files significantly by using the SHORTEN utility. This utility takes all CALCAP data and arranges it in a fixed format suitable for use by statistical packages or database programs. The SHORTEN program is invoked by typing:

```
SHORTEN
```

at the DOS command prompt. The SHORTEN program will merge all CALCAP raw data files of the form *subjn-xx.dat* into a single data file named MMDDYYA.DTA where MM is the month, DD is the day, YY is the year, and the letter A is appended to the date if this is the first such file in your directory, the letter B is appended if this is the second such file, and so on. This file can then be used as an input file for your database program or statistical package.

The SHORTEN program is designed for use with the Standard and Abbreviated versions of the CALCAP program, and should work with most Customized versions, as long as no single task (e.g., Choice Reaction Time Task 03) is repeated more than once. For more information on the structure of this data file and procedures for using the SHORTEN program, see Appendix E.

Archiving Data to Save Disk Space [DOS Version Only]

In the DOS version of the CalCAP program data can be archived by using the 'Transfer' command. 'Transfer' compresses the data on your hard disk and then transfers this compressed data to a floppy diskette. After the data have been compressed you will no longer be able to use 'Review' to look at old exam results.

To use the 'Transfer' command to compress and transfer data to a disk in Drive A you would type

```
TRANSFER A:
```

at the DOS prompt. You must already be in the \CALCAP subdirectory before using this command. This command will not work with the Windows version of the CalCAP since no external drives are recognized from the virtual machine DOS prompt.

Safety Tips: You should be sure that the floppy disk that you use has already been formatted and has no other files on the disk. Since TRANSFER deletes all of your old data files when it is finished you should always back up your data files [*.DAT] to a floppy diskette before using the TRANSFER command. In addition to the DOS Copy command (for example, COPY *.DAT A:), there are a number of commercial and shareware programs that can be used to back up your data.

Technical Notes: TRANSFER uses a shareware data compression program called LHARC (Copyright © Haruyasu Yoshizaki 1988-89).

Identifying Multiple Program Drivers for the CALCAP Program

If you want to know which versions of the CALCAP program are installed on your hard disk, type the command 'CALCAP' at the DOS prompt. You must already be in the \CALCAP subdirectory for this command to work.

SPECIAL CONFIGURATIONS FOR THE CALCAP PROGRAM

Customizing the CALCAP Program

The CALCAP program can be customized in a variety of ways to accomodate different research protocols. The following features are available:

- In the DOS version of the CalCAP, summary output can be sent to the screen or to a printer. Printed output includes additional information explaining special codes and describing the normative comparison group.

- At the end of each task the computer can give feedback on the subject's performance relative to age- and education-matched controls. Many subjects find this feedback helpful and motivating.

- A brief tune is played at the end of all choice reaction time measures in the Standard version of the CalCAP. Some subjects enjoy this feature, others are annoyed by it. Music can be turned on or off at any time during the tasks.

- The background can be either black or blue. All normative data is based on a blue background.

- A demo version of the program can be invoked for instructional purposes or presentations.

Most of these features can be controlled from the command line when the CALCAP program is started. The different command line switches are described below and in the Figure on the next page.

Command Line Switches

Feedback. [/feed] The CALCAP program can provide feedback on performance at the end of each task. This feedback takes the form of statements designed to encourage or motivate the examinee ('That was very good,' 'You had a little trouble with that task–the next task will be quite different.') Each task has three levels of feedback: (1) performance above expected levels; (2) performance in the average range; (3) performance below expected levels. Feedback is tailored to the age and education of the examinee. Default value is Feedback OFF. The /feed command line switch turns Feedback ON.

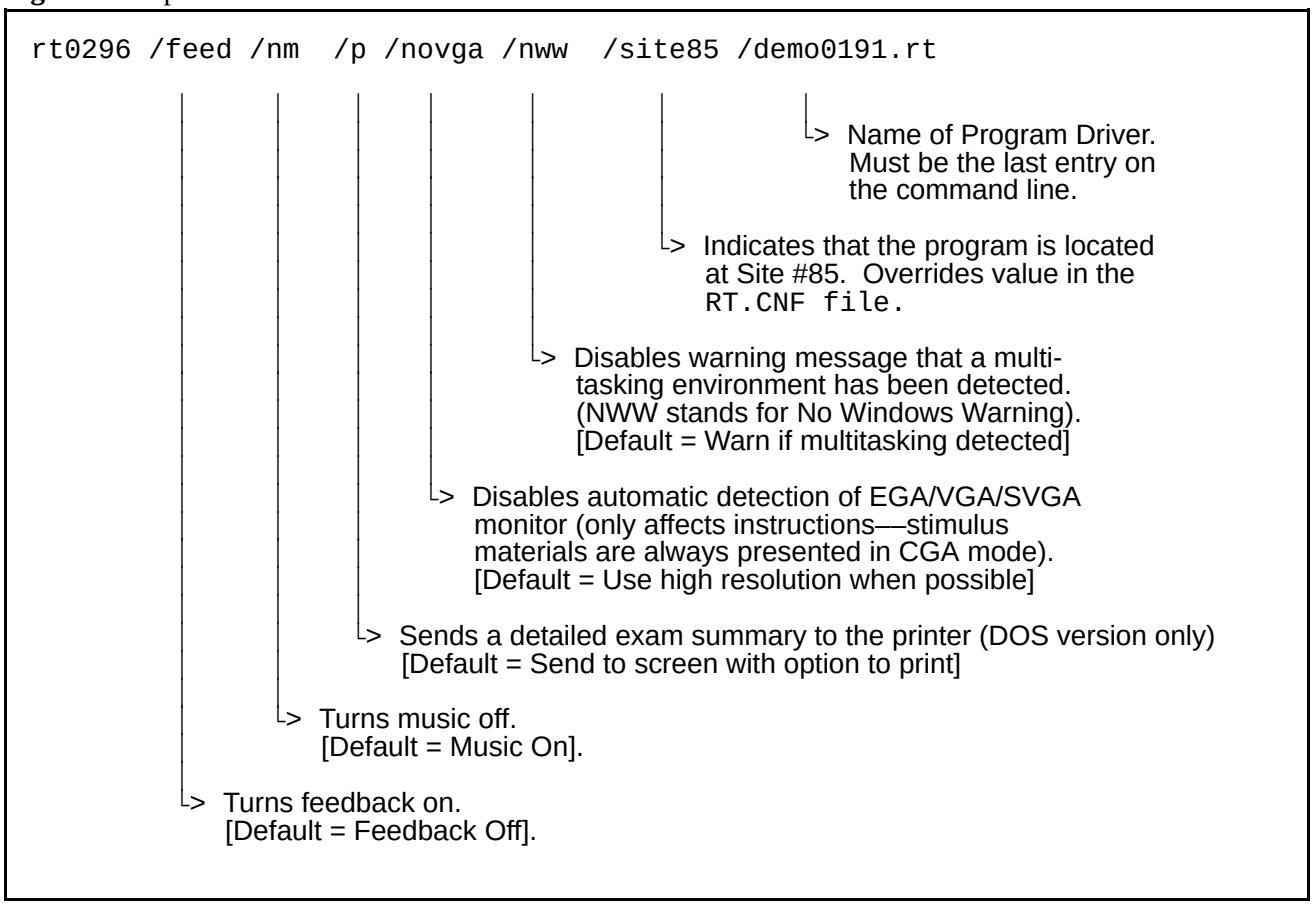
Music. [/nm] The CALCAP program plays a random 5-15 second musical selection at the end of each choice reaction time measure. Default value is Music ON. The /nm command line switch turns Music OFF.

Printer. [/p] At the end of the CALCAP test battery you are shown the test results on the video display. In the DOS version of the CalCAP you can optionally specify that you always want the results sent to the printer by using the /p option. Default value is Printer OFF. The /p command line switch turns Printer ON. This function does not work with the Windows version of the CalCAP.

Text Resolution. [/novga] The original CALCAP program was designed for CGA monitors and all formal stimulus materials are displayed at CGA resolution. On EGA, VGA and XGA monitors, however, the CALCAP program will display text instructions using a high-resolution display font. You can force the CalCAP program to use CGA resolution for both instructions and stimulus materials by adding the /novga switch to the command line. Default is VGA Resolution ON. The /novga command line switch turns VGA Resolution OFF.

Multitasking Warning. [/nww] The CALCAP program needs exclusive use of the microprocessor in your computer. If it detects active multi-tasking software such as older versions of Microsoft Windows, it issues a warning. The /nww switch (No Windows Warning) eliminates this warning.

Figure 1. Explanation of Command Line 'Switches':



Site ID. [`/site00`] The Site identification code is defined in a configuration file called 'RT.CNF'. If you decide to override the Site ID in the configuration file you should be sure you *DO NOT* use site ID's lower than 30 or higher than 99.

The Site ID not only identifies the computer used for the task, but also is used to select appropriate normative data. Site ID's lower than 30 may use inappropriate normative data for evaluating the test results. The default value is the Site ID contained in the `RT.CNF` file.

Program Drivers. There is no default program driver. The last entry on the command line must specify the exact name of the program driver (e.g., /demo0191.rt).

Changing CALCAP Program Options

If you want to experiment with different configurations of the CALCAP program, you must re-initialize the program each time. To re-initialize the program, type '`DEL *.000`' before starting the CALCAP program.

For example, to try out a configuration where you want Feedback–Off, Music–Off, VGA–On, and Printer–On, enter the following commands:

```
DEL *.000
RT0296 /NM /P /ECTL0291.RT
```

TECHNICAL SPECIFICATIONS

Hardware Specifications

Stimulus materials are presented using DOS or Windows computers. The program requires at least an 80286 microprocessor running at 6MHz. Computers based on the Intel 8086 and 8088 microprocessors will run too slowly to be able to accurately time the stimulus materials.

The program requires a standard IBM CGA, EGA, VGA, or SVGA or 100% compatible color display. Non-standard liquid crystal displays and plasma displays such as those used in laptop computers will not function correctly, nor will Passive Matrix displays used in color laptops. Active Matrix color displays will work correctly.

The stimulus materials developed for this program will appear correctly using CGA, EGA, VGA or Active Matrix LCD color displays. Normative data were collected using 14" EGA and VGA monitors. There were no significant differences in reaction time or signal detection parameters as a function of the type of monitor used.

The program requires at least the speed of an 80286 microprocessor, but automatically adjusts for changes in clock speed to provide uniform timing.

The timing circuits have a minimum resolution of 0.70 msecs for timing of the materials displayed on the screen, and a minimum resolution of 1.34 msecs for detecting keypress responses from the subject. Interrupt timing introduces a maximum 27 msec timing error. All timing errors can be positive or negative and average out to 0 over repeated trials.

The hardware that controls the color monitor rewrites the screen image sixty times per second which means that there is a potential timing error of up to 34 msecs during which the stimulus image is written on the screen (17 msecs) and subsequently erased from the screen (another 17 msecs). The CALCAP checks the position of the electron scanning gun prior to writing to the screen, thus reducing actual error variance to 1-2 msecs.

Compatibility Issues

The CalCAP is a DOS program that runs correctly on a single-speed computer running DOS or Windows. Since the CalCAP requires exclusive use of your microprocessor and your screen, it runs within a virtual machine if you are using Windows Vista, Windows 7 or a later operating system.

The CalCAP is incompatible with laptop computers that automatically adjust their clock speed, though you may be able to permanently set your clock speed through the laptop BIOS or SpeedSwitchXP Software (http://www.diefer.de/speedswitchxp/index.html).

Software Timing

The timing accuracy of the CALCAP software is limited primarily by the hardware considerations detailed above. In addition to these hardware limitations, the following rules are used for computation of reaction times:

For simple reaction time measures, mean reaction time is computed by dropping the best and worst trials (or the two best and two worst trials if there are over 10 trials), and then averaging the remaining trials. The maximum reaction time is computed as the upper limit defined by the Program Drivers (1.5 seconds in the Standard, Abbreviated and CPT program drivers).

For choice reaction time measures, mean reaction time is computed by dropping the two best and two worst trials and then averaging the remaining trials. The maximum reaction time is equal to the sum of the minimum inter-stimulus interval and the stimulus duration, minus half of the speed at which the computer writes information on the screen [ISI.MIN + stimulus duration - (screen.write.speed / 2)]. As described under hardware considerations above, screen.write.speed is usually 34 msecs. Thus, if the minimum inter-stimulus interval (ISI.MIN) is equal to 800 msecs, stimulus duration is equal to 200 msecs, and screen writing speed = 34 msecs, then

maximum possible reaction time = 800 + 200 - (34/2) = 983.

Program Driver History

Standard Version. ECTL0291.RT is a modification of standard version (CTRL0191.RT) that increases the number of Simple RT trials from 6 to 12. Available beginning in February 1991. Designed to be used at all installations for commercial sales. A special version called ECRM0291.RT includes Task 11 (Recognition Memory). Recognition Memory was dropped from the MACS study in 9/89 to reduce the overall length of the test battery and because it did not appear particularly sensitive to HIV-specific cognitive deficits.

CPT Version. CPT0191.RT is the Continuous Performance Test version of the CALCAP program first developed in Spring 1989. Adapted and extended in Fall 1990 to allow 3 iterations of the standard CPT protocol.

Abbreviated Version. MACS0191.RT is a modification of standard version requiring less time (approx. 7-10 minutes) and VGA monitors. Available beginning in February 1991. Designed to be used at all MACS centers beginning in April 1991. Renamed ART0292.RT in February 1992.

Original Version. CTRL0191.RT is the original version used to develop norms in the MACS (based on AT-compatible computers). Takes approx. 20-25 minutes & requires CGA or EGA monitors. Simple RT tasks consist of 6 actual trials. Used primarily in the MACS study in Los Angeles from April 1987 through March 1991. (Last distributed on 1/31/91). A special version called CTRM0191.RT includes Task 11 (Recognition Memory). Recognition Memory was dropped from the MACS study in 9/89 to reduce the overall length of the test battery and because it did not appear particularly sensitive to HIV-specific cognitive deficits.

REFERENCES

Benton AL, Hamsher KS. Multilingual Aphasia Examination Manual. Iowa City:University of Iowa., 1978.

Benton AL, Hamsher KS, Varney NR, Spreen O. Contributions to neuropsychological assessment. New York:Oxford University Press, 1983.

Chapman LJ, Chapman JP. Artifactual and genuine relationships of lateral difference scores to overall accuracy in studies of laterality. Psychol Bull 1988;104:127-136.

Cronbach LJ, Furby L. How we should measure "change" - or should we? Psychol Bull 1970;74:68-80.

Gallway RA, Millington JT, Mirsky AF, Van Gorp WG, Miller EN, Wolcott CL. Neuropsychological consequences of hyperbaric nitrogen narcosis [abstract]. National Academy of Neuropsychology, Reno, Nevada, 1990.

Gallway RA, Millington JT, Van Gorp WG, Miller EN, Mirsky AF. Neuropsychological consequences of hyperbaric nitrogen narcosis II [abstract]. Journal of Clinical and Experimental Neuropsychology, 1991:13;440.

Halman M, Hamburg NM, Savage CR, Worth JL. Use of computer-based measures of complex reaction time in depressed HIV-1 infected patients [abstract]. Academy of Psychosomatic Medicine, Phoenix, 1994.

Kløve H. Clinical neuropsychology. In: Forster FM, ed. The medical clinics of North America. New York: Saunders, 1963.

Martin A, Kampen D, Salazar AM, et al . Slowed cognitive processing in HIV+ patients in comparison to psychiatric controls. Int Conf AIDS 1989;5:(Abstract)

Martin E, Edelstein H, Robertson L. Decision-making speed in early human immunodeficiency virus (HIV) infection. Int Conf AIDS 1989;5:462.(Abstract)

Martin EM, Sorensen DJ, Edelstein HE, Robertson LC. Decision-making speed in HIV-1 infection: a preliminary report. AIDS, 1992;6:109-113.

Matthews CG, Kløve H. Instruction manual for the Adult Neuropsychology Test Battery. Madison:University of Wisconsin Medical School, 1964.

Miller EN. Cognitive testing using reaction time and traditional neuropsychological procedures. Annual Meeting of the International Neuropsychological Society. Cincinnati, Ohio. February 1994, pp. 108-109.

Miller EN. Use of computerized reaction time in the assessment of dementia [abstract]. Neurology, 1992;42(suppl 3):220.

Miller EN, Bing EG, Selnes OA, Wesch J, Becker JT. The effects of sociodemographic factors on reaction time and speed of information processing. Journal of Clinical and Experimental Neuropsychology, 1993;15:66.

Miller EN, Satz P, Van Gorp W, Visscher B, Dudley J. Computerized screening for HIV-related cognitive decline in gay men: Cross-sectional analyses and one-year follow-up. (Abstract). Proceedings of the V International Conference on AIDS (Montreal, Canada), 1989; 465.

Miller EN, Satz P, Van Gorp W, Visscher B, Dudley J. Computerized screening for HIV-related cognitive decline in gay men. (Abstract). Proceedings of the IV International Conference on AIDS (Stockholm, Sweden), 1988;1:378.

Miller EN, Satz P, Visscher B. Neuropsychological tests in HIV [letter]. Neurology, 1992;42:2056.

Miller EN, Satz P, Visscher B. Computerized and conventional neuropsychological assessment of HIV-1 infected homosexual men. Neurology, 1991;41:1608-1616.

Miller EN, Satz P, Visscher B. Computerized neuropsychological assessment for HIV-related encephalopathy. Symposium on Novel and Traditional Approaches for Early Detection of HIV-1 Related Dementia (Vancouver, Canada). Journal of Clinical and Experimental Neuropsychology, 1989;11:34-35.

Miller EN, Wilkie FL. (in press). Problems and issues in the use of a computerized battery for the assessment of cognition in HIV-1 positive individuals. In I. Grant and A. Martin, Neuropsychology of HIV Infection: Current Research and New Directions. Oxford University Press: New York.

Perdices M, Cooper DA. Simple and choice reaction time in patients with human immunodeficiency virus infection. Ann Neurol 1989;25:460-467.

Posner MI, Cohen Y, Rafal RD. Neural systems control of spatial orienting. Phil Trans R Soc Lond 1982;298:187-198.

Radloff LS. The CES-D scale: A self-report depression scale for research in the general population. Appl Psychol Measurement 1977;1:385-401.

Reitan R. Validity of the Trail Making Test as an indicator of organic brain damage. Percept Mot Skills 1958;8:271-276.

Reitan R. Manual for administration of neuropsychological test batteries for adults and children. Tucson:Neuropsychology Laboratory, 1979.

Rey A. L'examen clinique en psychologie. Paris:Presses Universitaires de France, 1964.

Smith A. Symbol Digit Modalities Test: Manual. Los Angeles:Western Psychological Services, 1973.

Sternberg S. High speed scanning in human memory. Science 1966;153:652-654.

Sternberg S. Memory scanning: new findings and current controversies. Q J Exp Psychol 1975;27:1-32.

Waterloo K, Ingebrigtsen T, Romner B. Neuropsychological function in patients with increased serum levels of protein S-100 after minor head injury. Acta Neurochirurgica, 1997:139;26-32.

Wechsler D. Wechsler Adult Intelligence Scale - Revised. New York:Psychological Corporation, 1981.

Wilkie FL, Eisdorfer C, Morgan R, Loewenstein DA, Szapocznik J. Cognition in early human immunodeficiency virus infection. Arch Neurol 1990;47:433-440.

Worth JL, Savage CR, and Navia BA. Computer-based measures of neuropsychological deficits in patients with HIV-1 cognitive/motor complex. Int Conf AIDS, 1992;8.

Worth JL, Savage CR, and Navia BA. Computer-based screening test for AIDS dementia complex. Presented at the Annual Meeting of the American Psychiatric Association, Washington, DC, 1992.

Worth JL, Savage CR, Baer L, Esty EK, and Navia BA. Computer-based neuropsychological screening for AIDS dementia complex. AIDS, 1993;7:677-681.

APPENDIX A

TASK DEVELOPMENT AND NORMATIVE DATA

The normative sample included 641 HIV-1 seronegative gay men drawn from the Multicenter AIDS Cohort Study (MACS). Subjects received a test battery consisting of 6 conventional neuropsychological tests and 9 computerized reaction time measures at the time of their regular 6-month visit conducted as a part of the MACS protocol. The conventional screening battery consisted of the following measures (task selection is described in Miller, Satz & Visscher, 1991):

1. Trail-Making Test, Parts A and B. The Trail-Making task measures divided attention and psychomotor functioning.

2. Digit Span subtest (Forward and Backward) of the WAIS-R. This test measures brief attentional skills.

3. Controlled Oral Word Association Test (Verbal Fluency). The Verbal Fluency test requires the subject to produce as many words beginning with a given letter of the alphabet as he can generate over a one-minute period.

4. Grooved Pegboard Test. This task is sensitive to motor slowing and clumsiness and provides indices for both the dominant and nondominant hands.

5. Symbol Digit Modalities Test. The Symbol Digit task is a sensitive measure of psychomotor speed, memory, attention and concentration.

6. Rey Auditory Verbal Learning Test (RAVLT). The RAVLT is a measure of serial list learning for verbal materials.

These 6 tasks were selected to be sensitive to most major areas of cognitive functioning, including language (Verbal Fluency; Rey Auditory Verbal Learning Test), memory (Rey Auditory Verbal Learning Test; Digit Span; Symbol Digit Modalities), attention (Digit Span, Trail-Making Test Part A), motor speed and manual dexterity (Grooved Pegboard), and psychomotor functioning (Trail-Making Test Part B; Symbol Digit Modalities). In addition to these neuropsychological measures, the Center for Epidemiologic Studies Depression Scale (CES-D) was used as a measure of self-reported mood.

The normative sample had a mean age of 36.0 years (SD = 6.97) and a mean educational level of 16.4 years (SD = 2.26). Mean CES Depression score was 9.2 (SD = 9.01)—well below the cut-off of 16 used for assessing clinical depression. By self-report, 86% of the sample were right-handed, 1% ambidextrous, and 13% left-handed. 93% of the sample was Caucasian, 2% African-American, 4% Hispanic, and 1% Asian or other ethnicity.

The Tables that follow describe the current forms of the CALCAP test batteries (Standard, Abbreviated, CPT), show normative data broken down by age and education, and include information on internal consistency reliability, test-retest reliability, and intercorrelations of the CALCAP and conventional test measures. Also included is a factor analysis illustrating that the reaction time measures form two factors (simple and choice reaction time) that are distinct from the factors assessed using conventional neuropsychological measures.

CALCAP Test Batteries

Standard RT		Abbreviated RT	CPT RT
SIMPLE01	SIMPLE06	SIMPLE15	SIMPLE15
SIMPLE02	CHOICE07	CHOICE03	CHOICE16
CHOICE03	CHOICE08	CHOICE04	CHOICE17
CHOICE04	CHOICE09	CHOICE14	
CHOICE05	SIMPLE10		

CALCAP Task Descriptions

SIMPLE01 – **Simple Reaction Time - Dominant Hand**. Subjects are asked to press a key as soon as they see anything at all on the screen. This procedure provides a basal measure of reaction time. [Normal visual quality for stimuli; random inter-stimulus interval (ISI) from 1000 to 5000 msecs; 12 trials; 4 practice trials] [NOTE: Current normative data are based on a 6-trial version of this task]

SIMPLE02 – **Simple Reaction Time - Nondominant Hand**. Subjects are asked to press a key as soon as they see anything at all on the screen, but using the non-dominant hand instead of the dominant hand. [Normal visual quality for stimuli; random inter-stimulus interval (ISI) from 1000 to 5000 msecs; 12 trials; no practice trials] [NOTE: Current normative data are based on a 6-trial version of this task].

SIMPLE06 – **Simple Reaction Time - Dominant Hand - 2nd Iteration**. Subjects are asked for a 2nd time to press a key as soon as they see anything at all on the screen. This procedure provides a measure of fatigue. Norms are based on a 10 minute interval between Simple RT #1 and this task. [Normal visual quality for stimuli; random inter-stimulus interval (ISI) from 1000 to 5000 msecs; 12 trials; 2 practice trials] [NOTE: Current normative data are based on a 6-trial version of this task].

SIMPLE10 – **Simple Reaction Time - Dominant Hand - 3rd Iteration**. Subjects are asked for a 3rd time to press a key as soon as they see anything at all on the screen. This procedure provides a measure of fatigue. Norms are based on a 20 minute interval between Simple RT #1 and this task. [Normal visual quality for stimuli; random inter-stimulus interval (ISI) from 1000 to 5000 msecs; 12 trials; 2 practice trials] [NOTE: Current normative data are based on a 6-trial version of this task].

SIMPLE15 – **Extended Version of Simple Reaction Time - Dominant Hand**. Subjects are asked to press a key as soon as they see anything at all on the screen. This procedure provides a basal measure of reaction time. [Normal visual quality for stimuli; random inter-stimulus-interval (ISI) from 1000 to 5000 msecs; 15 trials; 4 practice trials]

CHOICE03 – **Choice Reaction Time for Single Digits**. Subjects are asked to press a key as soon as they see a specific number such as '7', otherwise they are to do nothing. This procedure adds a simple element of memory to the task. [Degraded visual quality for stimuli; 70 msec stimulus duration; 800 msec ISI; 100 trials with 15 target stimulus presentations; 10 practice trials with 3 target stimuli presented with 175 msec stimulus duration and 1000 msec ISI]

CHOICE04 – **Serial Pattern Matching #1 - Sequential Reaction Time #1**. Subjects are asked to press a key only when they see two of the same number in sequence, for example, if they see the number '3' followed by a second occurrence of the number '3'. This procedure adds a more complex element of memory since the subject must keep in mind the last number that was seen. [Normal visual quality for stimuli; 70 msec stimulus duration; 800 msec ISI; 100 trials with 20 target stimulus presentations; 10 practice trials with 2 target stimuli presented with 175 msec stimulus duration and 1000 msec ISI]

CHOICE05 – **Lexical Discrimination**. Subjects are asked to press a key when they see a word which fits into a specific category such as animal names (such as, 'COW' or 'HORSE'), but not when they see a word which fits into a category of non-animals (such as 'DESK' or 'FOOD'). This procedure introduces an additional level of language skills by requiring meaningful differentiation between semantic categories. The task requires rapid language processing and should be sensitive to any disruption in language skills. [Normal visual quality for stimuli; 80 msec stimulus duration; 800 msec ISI; 120 trials with 24 target stimulus presentations; 10 practice trials with 3 target stimuli presented with 200 msec stimulus duration and 1000 msec ISI]

CHOICE07 – **Visual Selective Attention**. Subjects are asked to press a key as soon as they see a specific word such as 'SEVEN' in the center of the screen. An additional set of the words are displayed around the periphery of the target stimulus located in the center of the screen. These distractors require that the subject focus his or her attention much more narrowly. [Degraded visual quality for stimuli, normal visual quality for distractor stimuli presented in the screen periphery; 90 msec stimulus duration; 800 msec ISI for stimuli in center of screen; distractors start 25 msec before target and persist 25 msec after target is gone; 100 trials with 15 target stimulus presentations; 10 practice trials with 3 target stimuli presented with 300 msec stimulus duration and 1000 msec ISI]

CHOICE08 – **Response Reversal and Rapid Visual Scanning**. This task is identical to task 5 described above, but the subject must ignore the stimuli presented in the middle of the screen while responding to target stimuli displayed around the periphery of the computer screen. This task taps into the subject's ability to change cognitive set from the previous task, and requires more rapid visual scanning across the entire display screen. [Normal visual quality for stimuli and for distractor stimuli; 200 msec stimulus and distractor duration; 800 msec ISI for all stimuli; 100 trials with 15 target stimulus presentations; 10 practice trials with 3 target stimuli presented with 425 msec stimulus duration and 1000 msec ISI]

CHOICE09 – **Form Discrimination**. Subjects are shown three geometric figures simultaneously and asked to press a key only when two of the figures are identical. This task requires rapid comparison of non-nameable forms, and, because of the brief exposure time, may measure the subject's ability to retain an iconic memory of the figures. [Normal visual quality for stimuli; 150 msec stimulus duration; 1000 msec ISI; 100 trials with 20 target stimulus presentations; 10 practice trials with 3 target stimuli presented with 425 msec stimulus duration and 1200 msec ISI]

CHOICE14 – **Serial Pattern Matching #2 - Sequential Reaction Time #2**. Subjects are asked to press a key only when they see two numbers in sequence (increasing order). For example, if they see the number '3' followed by the number '4', the number '6' followed by '7' and so on. [Normal visual quality for stimuli; 100 msec stimulus duration; 800 msec ISI; 100 trials with 20 target stimulus presentations; 19 practice trials with 4 target stimuli presented with 400 msec stimulus duration and 1000 msec ISI]

CHOICE16 – **CPT Version Choice Reaction Time for Single Digits**. Subjects are asked to press a key as soon as they see a specific number such as '7', otherwise they are to do nothing. This procedure adds a simple element of memory to the task. [Degraded visual quality for stimuli; 200 msec stimulus duration; 800 msec ISI; 200 trials with 30 target stimulus presentations; 10 practice trials with 3 target stimuli presented with 200 msec stimulus duration and 800 msec ISI]. [NOTE: Normative data are estimated based on the short form of Choice Reaction Time for Single Digits]

CHOICE17 – **CPT Serial Pattern Matching #1 - Sequential Reaction Time #1**. Subjects are asked to press a key only when they see two of the same number in sequence, for example, if they see the number '3' followed by a second occurrence of the number '3'. This procedure adds a more complex element of memory since the subject must keep in mind the last number that was seen. [Normal visual quality for stimuli; 200 msec stimulus duration; 800 msec ISI; 200 trials with 30 target stimulus presentations; 10 practice trials with 2 target stimuli presented with 200 msec stimulus duration and 800 msec ISI]. [NOTE: Normative data are estimated based on the short form of Sequential Reaction Time #1]

MEMORY11 – **Recognition Memory**. Recognition memory for items presented during the Lexical Discrimination and Visual Selective Attention tasks. [Normal visual quality for stimuli; stimuli appear on screen for 1500 msec with 500 msec ISI; 90 stimuli including 36 target stimulus presentations; no practice trial]

Summary of Normative Data Used by CALCAP

Task Code	Description	Trials	Normative Sample
SIMPLE01	Simple RT 00 minutes	6	641 men*
SIMPLE02	Simple RT (Nondominant Hand)	6	641 men*
CHOICE03	Basic Choice RT	100	641 men*
CHOICE04	Sequential RT #1	100	641 men*
CHOICE05	Lexical Discrimination	120	641 men*
SIMPLE06	Simple RT 10 minutes	6	641 men*
CHOICE07	Visual Selective Attention	100	641 men*
CHOICE08	Response Reversal/Rapid Vis Scanning	100	641 men*
CHOICE09	Form Discrimination	100	641 men*
SIMPLE10	Simple RT 20 minutes	6	641 men*
MEM11	Recognition Memory	90	641 men*
CHOICE12	Visual Selective Attention/8088	not used	not used
CHOICE13	Response Reversal/8088	not used	not used
CHOICE14	Sequential RT #2	100	656 men†
SIMPLE15	Simple RT 00 minutes	15	656 men†
CHOICE16	Basic Choice RT	200	estimated from CHOICE03
CHOICE17	Sequential RT #1	200	estimated from CHOICE04
SIMPLE18	Simple RT 00 minutes	12	656 men†
SIMPLE19	Simple RT (Nondominant Hand)	12	estimated from SIMPLE02
SIMPLE20	Simple RT 10 minutes	12	estimated from SIMPLE06
SIMPLE21	Simple RT 20 minutes	12	estimated from SIMPLE10

*Sample 1: 641 men drawn from the Multicenter AIDS Cohort Study centers of Los Angeles, Baltimore, Chicago and Pittsburgh. All men were medically asymptomatic and HIV-1 seronegative.

†Sample 2: 656 men drawn from the Multicenter AIDS Cohort Study centers of Los Angeles, Baltimore, Chicago and Pittsburgh. All men were medically asymptomatic at the time of testing.

NORMATIVE DATA

All Subjects	Mean (StdDev)	Minimum	Maximum	N
Age in Years	36.39 (7.21)	21	59	634
Education (Years)	16.33 (2.28)	11	21	634
Simple RT 1 - Dominant Hand	367.07 (104.49)	177	954	628
Simple RT - Nondominant Hand	323.53 (68.03)	187	771	633
Simple RT 2 - Dominant Hand	387.40 (93.09)	217	857	633
Simple RT 3 - Dominant Hand	366.90 (81.06)	180	930	632
Choice Reaction Time - Digits	408.08 (41.65)	315	628	632
Sequential Reaction Time 1	542.14 (93.73)	314	833	630
Sequential Reaction Time 2	605.20 (112.64)	321	886	641*
Lexical Discrimination	531.88 (58.51)	397	821	632
Degraded Words with Distract	540.00 (82.11)	385	913	633
Response Reversal - Words	654.50 (88.93)	462	966	633
Form Discrimination	774.23 (133.54)	483	1133	627

Shown below are detailed explanations of the variable names used above and elsewhere in the normative tables. For a complete description of the individual tasks, refer to the section of the manual entitled 'Standard Stimulus Materials.'

Key to Simple Reaction Time Tasks:

Simple RT 1 - Dominant	=	First iteration of the Simple Reaction Time task (first task in RT battery)
Simple RT 2 - Dominant	=	Second iteration of the Simple Reaction Time task (given after approx. 10 minutes)
Simple RT 3 - Dominant	=	Third iteration of the Simple Reaction Time task (last task in RT battery; given after approx. 20 minutes)
Simple RT - Nondominant	=	Simple Reaction Time task for the non-dominant hand (for all other tasks the subject is asked to use his or her dominant hand).

Key to Choice Reaction Time Tasks:

Choice RT - Digits	=	Choice Reaction Time for Single Digits
Sequential RT 1	=	Sequential Reaction Time (Identical Numbers)
Sequential RT 2	=	Sequential Reaction Time (Numbers in Sequence)
Lexical Discrimination	=	Lexication Discrimination
Degraded Words w/Distract	=	Visual Selective Attention
Response Reversal	=	Response Reversal and Rapid Visual Scanning
Form Discrimination	=	Form Discrimination

*Norms for Sequential RT 2 are based on an independent normative sample of 656 men drawn from the same population as the original normative sample.

NORMATIVE DATA BY AGE STRATA

Ages 21-34	Mean	(StdDev)	Minimum**	Maximum	N
Age in Years	29.69	(3.09)	21	34	263
Education (Years)	15.92	(2.15)	12	21	263
Simple RT 1 - Dominant Hand	360.02	(106.25)	177	954	260
Simple RT - Nondominant Hand	316.82	(65.37)	187	771	262
Simple RT 2 - Dominant Hand	375.98	(95.25)	217	857	262
Simple RT 3 - Dominant Hand	356.63	(88.68)	180	930	262
Choice Reaction Time - Digits	404.26	(37.93)	315	628	263
Sequential Reaction Time 1	542.99	(92.43)	314	833	260
Sequential Reaction Time 2	602.70	(110.64)	321	886	165*
Lexical Discrimination	528.11	(56.11)	397	821	261
Degraded Words with Distract	529.53	(80.80)	385	913	262
Response Reversal - Words	640.48	(81.45)	462	966	262
Form Discrimination	752.25	(130.37)	483	1133	262
Ages 35-44					
Age in Years	38.41	(2.80)	35	44	266
Education (Years)	16.63	(2.28)	11	21	266
Simple RT 1 - Dominant Hand	364.54	(97.21)	177	954	266
Simple RT - Nondominant Hand	323.39	(64.72)	187	771	266
Simple RT 2 - Dominant Hand	387.09	(88.28)	217	857	266
Simple RT 3 - Dominant Hand	367.29	(70.61)	180	930	266
Choice Reaction Time - Digits	406.58	(43.66)	315	628	265
Sequential Reaction Time 1	535.92	(95.13)	314	833	266
Sequential Reaction Time 2	604.67	(114.01)	321	886	320*
Lexical Discrimination	529.35	(57.73)	397	821	266
Degraded Words with Distract	537.03	(74.42)	385	913	266
Response Reversal - Words	652.73	(90.62)	462	966	266
Form Discrimination	778.05	(132.76)	483	1133	262
Ages 45-59					
Age in Years	48.00	(3.38)	45	59	105
Education (Years)	16.62	(2.46)	12	21	105
Simple RT 1 - Dominant Hand	391.65	(115.27)	177	954	102
Simple RT - Nondominant Hand	340.63	(79.49)	187	771	105
Simple RT 2 - Dominant Hand	416.69	(94.00)	217	857	105
Simple RT 3 - Dominant Hand	391.76	(81.29)	180	930	104
Choice Reaction Time - Digits	421.60	(43.06)	315	628	104
Sequential Reaction Time 1	555.92	(92.70)	314	833	104
Sequential Reaction Time 2	608.94	(112.51)	321	886	156*
Lexical Discrimination	547.65	(64.10)	397	821	105
Degraded Words with Distract	573.61	(95.05)	385	913	105
Response Reversal - Words	693.94	(91.71)	462	966	105
Form Discrimination	820.41	(131.99)	483	1133	103

*Norms for Sequential RT 2 are based on an independent normative sample of 656 men drawn from the same population as the original normative sample.

**Note: Minimum and maximum RTs are based on the full normative sample.

NORMATIVE DATA BY EDUCATION STRATA

Educ < 16 Years	Mean	(StdDev)	Minimum**	Maximum	N
Age in Years	35.74	(7.73)	22	59	202
Education (Years)	13.78	(1.08)	11	15	202
Simple RT 1 - Dominant Hand	382.92	(118.78)	177	954	199
Simple RT - Nondominant Hand	332.03	(67.35)	187	771	201
Simple RT 2 - Dominant Hand	403.01	(104.75)	217	857	202
Simple RT 3 - Dominant Hand	382.44	(88.16)	180	930	202
Choice Reaction Time - Digits	411.60	(41.48)	315	628	201
Sequential Reaction Time 1	551.71	(97.11)	314	833	199
Sequential Reaction Time 2	626.29	(113.80)	321	886	225*
Lexical Discrimination	540.68	(62.46)	397	821	201
Degraded Words with Distract	547.01	(86.42)	385	913	201
Response Reversal - Words	672.03	(96.25)	462	966	201
Form Discrimination	787.43	(133.84)	483	1133	201

Educ = 16 Years					
Age in Years	35.33	(7.06)	23	56	182
Education (Years)	16.00	(.00)	16	16	182
Simple RT 1 - Dominant Hand	369.50	(111.64)	177	954	180
Simple RT - Nondominant Hand	324.84	(73.04)	187	771	182
Simple RT 2 - Dominant Hand	384.48	(93.11)	217	857	182
Simple RT 3 - Dominant Hand	355.50	(81.38)	180	930	181
Choice Reaction Time - Digits	400.44	(36.13)	315	628	181
Sequential Reaction Time 1	536.70	(92.10)	314	833	182
Sequential Reaction Time 2	599.49	(107.15)	321	886	163*
Lexical Discrimination	526.71	(55.06)	397	821	181
Degraded Words with Distract	531.53	(86.22)	385	913	182
Response Reversal - Words	643.49	(82.06)	462	966	182
Form Discrimination	753.24	(129.39)	483	1133	179

Educ > 16 Years					
Age in Years	37.68	(6.70)	23	53	250
Education (Years)	18.64	(1.24)	17	21	250
Simple RT 1 - Dominant Hand	352.65	(83.24)	177	954	249
Simple RT - Nondominant Hand	315.74	(64.06)	187	771	250
Simple RT 2 - Dominant Hand	376.87	(80.90)	217	857	249
Simple RT 3 - Dominant Hand	362.58	(72.81)	180	930	249
Choice Reaction Time - Digits	410.79	(44.84)	315	628	250
Sequential Reaction Time 1	538.47	(91.94)	314	833	249
Sequential Reaction Time 2	590.12	(112.62)	321	886	253*
Lexical Discrimination	528.54	(57.09)	397	821	250
Degraded Words with Distract	540.53	(74.94)	385	913	250
Response Reversal - Words	648.41	(85.81)	462	966	250
Form Discrimination	778.69	(134.97)	483	1133	247

*Norms for Sequential RT 2 are based on an independent normative sample of 656 men drawn from the same population as the original normative sample.

**Note: Minimum and maximum RTs are based on the full normative sample.

NORMATIVE DATA FOR AGES 21-34 BY EDUCATION STRATA

Age 21-34, Ed < 16 Yr	Mean	(StdDev)	Minimum**	Maximum	N
Age in Years	29.34	(3.44)	21	34	96
Education (Years)	13.76	(1.12)	12	15	96
Simple RT 1 - Dominant Hand	369.55	(114.81)	177	954	95
Simple RT - Nondominant Hand	319.45	(64.16)	187	771	95
Simple RT 2 - Dominant Hand	395.10	(113.61)	217	857	96
Simple RT 3 - Dominant Hand	370.56	(90.25)	180	930	96
Choice Reaction Time - Digits	411.23	(39.82)	315	628	96
Sequential Reaction Time 1	554.96	(93.78)	314	833	94
Sequential Reaction Time 2	612.69	(111.57)	321	886	80*
Lexical Discrimination	536.29	(58.08)	397	821	95
Degraded Words with Distract	529.77	(67.72)	385	913	95
Response Reversal - Words	645.40	(83.59)	462	966	95
Form Discrimination	763.96	(129.11)	483	1133	96

Age 21-34, Ed = 16 Yr					
Age in Years	29.59	(3.10)	21	34	90
Education (Years)	16.00	(.00)	16	16	90
Simple RT 1 - Dominant Hand	360.92	(117.15)	177	954	88
Simple RT - Nondominant Hand	317.48	(75.86)	187	771	90
Simple RT 2 - Dominant Hand	372.58	(91.07)	217	857	90
Simple RT 3 - Dominant Hand	346.49	(89.13)	180	930	89
Choice Reaction Time - Digits	393.81	(33.08)	315	628	90
Sequential Reaction Time 1	525.70	(90.35)	314	833	90
Sequential Reaction Time 2	601.38	(102.05)	321	886	50*
Lexical Discrimination	522.74	(55.96)	397	821	89
Degraded Words with Distract	524.41	(97.14)	385	913	90
Response Reversal - Words	630.88	(82.83)	462	966	90
Form Discrimination	734.96	(123.37)	483	1133	90

Age 21-34, Ed > 16 Yr					
Age in Years	30.23	(2.52)	21	34	77
Education (Years)	18.52	(1.26)	17	21	77
Simple RT 1 - Dominant Hand	347.25	(78.59)	177	954	77
Simple RT - Nondominant Hand	312.81	(53.08)	187	771	77
Simple RT 2 - Dominant Hand	355.86	(67.00)	217	857	76
Simple RT 3 - Dominant Hand	350.99	(85.01)	180	930	77
Choice Reaction Time - Digits	407.78	(38.66)	315	628	77
Sequential Reaction Time 1	548.67	(91.30)	314	833	76
Sequential Reaction Time 2	581.74	(120.10)	321	886	35*
Lexical Discrimination	524.23	(53.28)	397	821	77
Degraded Words with Distract	535.23	(75.04)	385	913	77
Response Reversal - Words	645.64	(77.07)	462	966	77
Form Discrimination	757.95	(139.29)	483	1133	76

*Norms for Sequential RT 2 are based on an independent normative sample of 656 men drawn from the same population as the original normative sample.

**Note: Minimum and maximum RTs are based on the full normative sample.

NORMATIVE DATA FOR AGES 35-44 BY EDUCATION STRATA

Age 35-44, Ed < 16 Yr	Mean	(StdDev)	Minimum**	Maximum	N
Age in Years	38.46	(3.04)	35	44	74
Education (Years)	13.82	(1.05)	11	15	74
Simple RT 1 - Dominant Hand	393.39	(115.37)	177	954	74
Simple RT - Nondominant Hand	343.20	(69.13)	187	771	74
Simple RT 2 - Dominant Hand	405.43	(90.38)	217	857	74
Simple RT 3 - Dominant Hand	384.53	(80.57)	180	930	74
Choice Reaction Time - Digits	410.03	(45.58)	315	628	74
Sequential Reaction Time 1	544.85	(102.86)	314	833	74
Sequential Reaction Time 2	630.15	(116.60)	321	886	99*
Lexical Discrimination	537.20	(58.57)	397	821	74
Degraded Words with Distract	549.54	(84.06)	385	913	74
Response Reversal - Words	684.62	(99.22)	462	966	74
Form Discrimination	796.63	(138.79)	483	1133	73

Age 35-44, Ed = 16 Yr					
Age in Years	38.40	(2.46)	35	44	67
Education (Years)	16.00	(.00)	16	16	67
Simple RT 1 - Dominant Hand	369.63	(106.01)	177	954	67
Simple RT - Nondominant Hand	324.09	(61.41)	187	771	67
Simple RT 2 - Dominant Hand	384.58	(87.17)	217	857	67
Simple RT 3 - Dominant Hand	359.49	(66.36)	180	930	67
Choice Reaction Time - Digits	404.65	(38.92)	315	628	66
Sequential Reaction Time 1	541.67	(96.14)	314	833	67
Sequential Reaction Time 2	600.19	(112.26)	321	886	89*
Lexical Discrimination	531.12	(59.77)	397	821	67
Degraded Words with Distract	530.70	(69.53)	385	913	67
Response Reversal - Words	644.37	(76.54)	462	966	67
Form Discrimination	765.92	(132.33)	483	1133	66

Age 35-44, Ed > 16 Yr					
Age in Years	38.40	(2.84)	35	44	125
Education (Years)	18.63	(1.23)	17	21	125
Simple RT 1 - Dominant Hand	344.73	(73.97)	177	954	125
Simple RT - Nondominant Hand	311.28	(61.22)	187	771	125
Simple RT 2 - Dominant Hand	377.58	(86.65)	217	857	125
Simple RT 3 - Dominant Hand	361.26	(65.14)	180	930	125
Choice Reaction Time - Digits	405.55	(45.06)	315	628	125
Sequential Reaction Time 1	527.55	(89.74)	314	833	125
Sequential Reaction Time 2	588.57	(110.69)	321	886	132*
Lexical Discrimination	523.74	(55.96)	397	821	125
Degraded Words with Distract	533.02	(70.51)	385	913	125
Response Reversal - Words	638.33	(88.22)	462	966	125
Form Discrimination	773.52	(129.23)	483	1133	123

*Norms for Sequential RT 2 are based on an independent normative sample of 656 men drawn from the same population as the original normative sample.

**Note: Minimum and maximum RTs are based on the full normative sample.

NORMATIVE DATA FOR AGES 45+ BY EDUCATION STRATA

Age 45+, Ed < 16 Yr	Mean	(StdDev)	Minimum**	Maximum	N
Age in Years	48.62	(3.75)	45	59	32
Education (Years)	13.72	(1.02)	12	15	32
Simple RT 1 - Dominant Hand	399.47	(137.67)	177	954	30
Simple RT - Nondominant Hand	343.56	(67.91)	187	771	32
Simple RT 2 - Dominant Hand	421.16	(108.70)	217	857	32
Simple RT 3 - Dominant Hand	413.25	(93.39)	180	930	32
Choice Reaction Time - Digits	416.48	(36.89)	315	628	31
Sequential Reaction Time 1	558.26	(95.02)	314	833	31
Sequential Reaction Time 2	641.63	(111.35)	321	886	46*
Lexical Discrimination	561.75	(79.45)	397	821	32
Degraded Words with Distract	592.31	(120.80)	385	913	32
Response Reversal - Words	721.97	(101.34)	462	966	32
Form Discrimination	836.84	(123.81)	483	1133	32

Age 45+, Ed = 16 Yr					
Age in Years	47.80	(3.46)	45	56	25
Education (Years)	16.00	(.00)	16	16	25
Simple RT 1 - Dominant Hand	399.36	(105.42)	177	954	25
Simple RT - Nondominant Hand	353.32	(86.46)	187	771	25
Simple RT 2 - Dominant Hand	427.08	(106.37)	217	857	25
Simple RT 3 - Dominant Hand	376.84	(87.27)	180	930	25
Choice Reaction Time - Digits	413.20	(35.28)	315	628	25
Sequential Reaction Time 1	562.96	(83.86)	314	833	25
Sequential Reaction Time 2	592.96	(102.04)	321	886	24*
Lexical Discrimination	529.04	(36.19)	397	821	25
Degraded Words with Distract	559.36	(82.29)	385	913	25
Response Reversal - Words	686.56	(81.85)	462	966	25
Form Discrimination	788.39	(137.85)	483	1133	23

Age 45+, Ed > 16 Yr					
Age in Years	47.78	(3.08)	45	53	48
Education (Years)	18.88	(1.23)	17	21	48
Simple RT 1 - Dominant Hand	382.55	(106.16)	177	954	47
Simple RT - Nondominant Hand	332.06	(83.40)	187	771	48
Simple RT 2 - Dominant Hand	408.29	(76.42)	217	857	48
Simple RT 3 - Dominant Hand	385.06	(66.76)	180	930	47
Choice Reaction Time - Digits	429.27	(49.43)	315	628	48
Sequential Reaction Time 1	550.75	(97.05)	314	833	48
Sequential Reaction Time 2	595.91	(113.50)	321	886	86*
Language Discrimination	547.94	(62.76)	397	821	48
Degraded Words with Distract	568.56	(80.83)	385	913	48
Response Reversal - Words	679.10	(87.35)	462	966	48
Form Discrimination	824.79	(134.53)	483	1133	48

*Norms for Sequential RT 2 are based on an independent normative sample of 656 men drawn from the same population as the original normative sample.

**Note: Minimum and maximum RTs are based on the full normative sample.

NORMATIVE DATA FOR THIRD GRADE CHILDREN

Third Graders	Mean (StdDev)	Minimum	Maximum	N
Males				
Age in Years	8.23 (.43)	8	9	22
Simple RT 1 - Dominant Hand	388.71 (68.93)	284	511	21
Simple RT - Nondominant Hand	427.23 (246.72)	248	1398	22
Simple RT 2 - Dominant Hand	400.05 (253.33)	267	1484	21
Simple RT 3 - Dominant Hand	347.43 (50.80)	255	434	21
Choice Reaction Time - Digits	603.71 (115.09)	438	856	21
Sequential Reaction Time 1	684.86 (115.07)	488	856	21
Lexical Discrimination	692.18 (121.45)	456	865	22
Degraded Words with Distract	643.00 (127.96)	366	936	22
Response Reversal - Words	841.00 (152.30)	347	973	21
Form Discrimination	888.41 (110.92)	664	1133	22
Females				
Age in Years	8.05 (.49)	7	9	22
Simple RT 1 - Dominant Hand	467.64 (139.77)	320	812	22
Simple RT - Nondominant Hand	396.59 (47.66)	312	518	22
Simple RT 2 - Dominant Hand	444.59 (128.95)	308	893	22
Simple RT 3 - Dominant Hand	462.95 (129.24)	306	781	22
Choice Reaction Time - Digits	550.14 (89.25)	351	731	22
Sequential Reaction Time 1	675.18 (80.91)	500	850	22
Lexical Discrimination	699.18 (88.06)	536	855	22
Degraded Words with Distract	660.18 (133.86)	457	913	22
Response Reversal - Words	858.42 (78.58)	701	971	19
Form Discrimination	882.32 (138.56)	592	1109	22

Normative data for 3rd, 5th and 6th grade children were collected by Leah M. Budzinski and Dr. Frank Spellacy at the Department of Psychology, University of Victoria, Canada. The sample of children was drawn from three suburban Canadian schools. Consent was obtained from parents of the children. (Budzinski LM, Honours Thesis 92-06984, University of Victoria, Victoria, B.C., 1994).

NORMATIVE DATA FOR FIFTH GRADE CHILDREN

Fifth Graders	Mean (StdDev)	Minimum	Maximum	N
Males				
Age in Years	10.14 (.36)	10	11	21
Simple RT 1 - Dominant Hand	382.14 (134.94)	228	710	21
Simple RT - Nondominant Hand	340.05 (60.67)	271	521	21
Simple RT 2 - Dominant Hand	366.95 (93.64)	262	629	21
Simple RT 3 - Dominant Hand	332.19 (48.19)	270	428	21
Choice Reaction Time - Digits	508.24 (75.60)	351	632	21
Sequential Reaction Time 1	649.40 (75.44)	497	790	20
Lexical Discrimination	661.57 (118.22)	412	828	21
Degraded Words with Distract	594.33 (87.57)	485	776	21
Response Reversal - Words	796.95 (112.79)	480	944	23
Form Discrimination	829.33 (171.65)	312	1132	21
Females				
Age in Years	10.09 (.29)	10	11	22
Simple RT 1 - Dominant Hand	390.77 (88.89)	273	590	22
Simple RT - Nondominant Hand	367.05 (76.92)	259	553	22
Simple RT 2 - Dominant Hand	365.77 (82.70)	238	536	22
Simple RT 3 - Dominant Hand	378.36 (80.82)	252	569	22
Choice Reaction Time - Digits	500.64 (54.65)	374	588	22
Sequential Reaction Time 1	642.19 (96.17)	457	834	21
Lexical Discrimination	638.00 (81.75)	493	862	22
Degraded Words with Distract	588.68 (89.28)	437	788	22
Response Reversal - Words	804.64 (109.30)	604	954	22
Form Discrimination	860.32 (155.06)	477	1111	22

NORMATIVE DATA FOR SIXTH GRADE CHILDREN

Sixth Graders	Mean (StdDev)	Minimum	Maximum	N
Males				
Age in Years	11.09 (.29)	11	12	22
Simple RT 1 - Dominant Hand	327.41 (95.30)	251	641	22
Simple RT - Nondominant Hand	332.91 (183.99)	203	1122	22
Simple RT 2 - Dominant Hand	325.09 (108.68)	232	709	22
Simple RT 3 - Dominant Hand	301.45 (43.41)	234	426	22
Choice Reaction Time - Digits	481.27 (60.70)	346	620	22
Sequential Reaction Time 1	583.14 (90.73)	444	763	21
Lexical Discrimination	636.18 (84.72)	457	776	22
Degraded Words with Distract	548.27 (90.43)	420	746	22
Response Reversal - Words	762.18 (97.81)	530	898	22
Form Discrimination	789.18 (130.46)	547	1050	22
Females				
Age in Years	11.26 (.45)	11	12	23
Simple RT 1 - Dominant Hand	405.78 (126.39)	241	690	23
Simple RT - Nondominant Hand	348.26 (75.61)	255	633	23
Simple RT 2 - Dominant Hand	349.57 (54.26)	237	451	23
Simple RT 3 - Dominant Hand	353.09 (61.21)	257	467	23
Choice Reaction Time - Digits	482.04 (67.25)	378	649	23
Sequential Reaction Time 1	627.55 (70.82)	425	722	22
Lexical Discrimination	605.77 (78.34)	496	821	23
Degraded Words with Distract	564.57 (85.37)	435	810	23
Response Reversal - Words	779.57 (115.16)	593	954	23
Form Discrimination	842.39 (121.15)	552	1125	23

NORMATIVE DATA
COMPARISON OF MEN AND WOMEN

Males	Mean (StdDev)	Minimum	Maximum	N
Age in Years	40.22 (19.06)	21	90	36
Education (Years)	14.86 (3.07)	7	20	36
Simple RT 1 - Dominant Hand	392.94 (166.69)	235	995	36
Simple RT - Nondominant Hand	330.39 (74.84)	236	539	36
Simple RT 2 - Dominant Hand	355.28 (75.25)	260	530	36
Simple RT 3 - Dominant Hand	349.28 (69.08)	249	559	36
Choice Reaction Time - Digits	438.19 (54.25)	348	584	36
Sequential Reaction Time 1	523.22 (94.25)	400	732	36
Lexical Discrimination	547.61 (76.32)	436	782	36
Degraded Words with Distract	533.31 (71.11)	417	727	36
Response Reversal - Words	642.39 (98.66)	464	949	36
Form Discrimination	742.64 (127.11)	517	1054	36
Females				
Age in Years	48.59 (22.35)	17	88	39
Education (in Years)	14.46 (3.11)	8	20	39
Simple RT 1 - Dominant Hand	467.03 (252.93)	257	1353	39
Simple RT - Nondominant Hand	366.79 (170.10)	237	1268	39
Simple RT 2 - Dominant Hand	396.54 (101.98)	272	737	39
Simple RT 3 - Dominant Hand	373.59 (81.69)	276	600	37
Choice Reaction Time - Digits	465.44 (93.71)	366	766	39
Sequential Reaction Time 1	547.49 (97.83)	365	723	35
Lexical Discrimination	565.03 (89.71)	449	789	39
Degraded Words with Distract	586.11 (97.26)	449	844	38
Response Reversal - Words	683.06 (120.44)	515	928	36
Form Discrimination	770.43 (152.37)	556	1080	37

Normative data for this study were collected by Debra Berg and Dr. Frank Spellacy at the Department of Psychology, University of Victoria, Canada. The sample was recruited from the University of Victoria, the Victoria Public Library, and retirement residences and community centers in British Columbia. (Berg D, Honours Thesis, University of Victoria, Victoria, B.C., 1994). There were no statistically significant differences between men and women after controlling for differences in age and education.

NORMATIVE DATA – REPEATED TESTINGS

Visit 1	Mean (StdDev)	Minimum	Maximum	N
Age at Visit 1 (Years)	36.12 (6.56)	23	52	175
Education (Years)	16.63 (2.22)	12	21	175
Simple RT 1 - Dominant Hand	350.19 (88.49)	213	794	175
Simple RT - Nondominant Hand	315.65 (69.63)	209	771	175
Simple RT 2 - Dominant Hand	368.63 (83.60)	217	776	175
Simple RT 3 - Dominant Hand	349.42 (59.60)	231	576	175
Choice Reaction Time - Digits	404.16 (37.67)	315	550	175
Sequential Reaction Time 1	539.90 (94.45)	345	853	175
Lexical Discrimination	519.05 (48.40)	397	715	174
Degraded Words with Distract	536.62 (80.52)	385	886	175
Response Reversal - Words	635.90 (78.75)	472	901	175
Form Discrimination	762.15 (131.03)	499	1120	172
Visit 2				
Simple RT 1 - Dominant Hand	363.13 (80.73)	227	692	174
Simple RT - Nondominant Hand	323.18 (58.19)	226	507	175
Simple RT 2 - Dominant Hand	388.41 (73.68)	229	621	174
Simple RT 3 - Dominant Hand	371.58 (72.99)	234	719	175
Choice Reaction Time - Digits	404.51 (42.13)	306	548	175
Sequential Reaction Time 1	524.64 (83.95)	338	748	175
Lexical Discrimination	512.75 (53.68)	408	720	175
Degraded Words with Distract	522.45 (70.18)	363	739	175
Response Reversal - Words	624.42 (81.53)	437	918	175
Form Discrimination	749.90 (126.83)	446	1107	175
Visit 3				
Simple RT 1 - Dominant Hand	330.91 (65.42)	181	531	173
Simple RT - Nondominant Hand	308.09 (57.63)	167	514	174
Simple RT 2 - Dominant Hand	357.84 (74.32)	200	589	175
Simple RT 3 - Dominant Hand	351.06 (65.85)	210	549	175
Choice Reaction Time - Digits	407.56 (40.46)	295	535	175
Sequential Reaction Time 1	525.80 (86.95)	308	773	175
Lexical Discrimination	512.46 (52.95)	395	733	175
Degraded Words with Distract	522.53 (75.60)	382	814	175
Response Reversal - Words	622.94 (83.21)	447	863	175
Form Discrimination	741.67 (135.60)	488	1133	175

Visit 4	Mean (StdDev)	Minimum	Maximum	N
Simple RT 1 - Dominant Hand	327.38 (62.67)	211	595	175
Simple RT - Nondominant Hand	310.99 (61.48)	179	532	174
Simple RT 2 - Dominant Hand	352.35 (70.73)	189	625	175
Simple RT 3 - Dominant Hand	349.52 (75.67)	177	636	175
Choice Reaction Time - Digits	414.99 (37.77)	329	555	175
Sequential Reaction Time 1	536.52 (97.52)	332	853	175
Lexical Discrimination	520.39 (45.33)	413	674	175
Degraded Words with Distract	530.93 (79.13)	392	807	175
Response Reversal - Words	623.64 (88.06)	467	945	175
Form Discrimination	745.57 (128.48)	519	1134	175
Visit 5				
Simple RT 1 - Dominant Hand	330.61 (58.54)	212	543	175
Simple RT - Nondominant Hand	310.55 (49.64)	223	478	175
Simple RT 2 - Dominant Hand	346.87 (61.76)	222	600	175
Simple RT 3 - Dominant Hand	350.86 (68.88)	214	630	175
Choice Reaction Time - Digits	418.94 (39.94)	333	543	175
Sequential Reaction Time 1	532.89 (93.12)	310	854	175
Lexical Discrimination	520.31 (48.33)	403	682	175
Degraded Words with Distract	527.49 (68.34)	383	788	175
Response Reversal - Words	618.92 (84.24)	455	911	175
Form Discrimination	743.49 (136.32)	498	1103	175
Visit 6				
Simple RT 1 - Dominant Hand	329.27 (58.79)	218	610	175
Simple RT - Nondominant Hand	309.90 (48.88)	211	540	175
Simple RT 2 - Dominant Hand	344.51 (68.11)	220	574	175
Simple RT 3 - Dominant Hand	348.65 (71.86)	212	583	175
Choice Reaction Time - Digits	420.44 (44.28)	314	588	175
Sequential Reaction Time 1	530.58 (86.51)	346	767	175
Lexical Discrimination	524.47 (52.37)	393	748	175
Degraded Words with Distract	528.14 (78.78)	390	913	175
Response Reversal - Words	620.52 (90.69)	435	967	175
Form Discrimination	734.01 (129.27)	480	1133	175

Normative data were collected as part of the longitudinal Multicenter AIDS Cohort Study. This sample is described in detail in Appendix A of the CalCAP manual. On average, six months elapsed between each visit. Data were restricted to those participants who completed at least six evaluations.

Psychometric Properties of Reaction Time Measures

Reaction Time Task (n=509)	6-month Test-Retest	Coefficient Alpha Internal Consistency
Simple Reaction Time 00 minutes	.26	.91
Simple Reaction Time (Nondominant)	.29	.95
Basic Choice Reaction Time	.52	.81
Sequential Reaction Time 1	.68	.86
Lexical Discrimination	.61	.89
Simple Reaction Time 10 minutes	.20	.79
Visual Selective Attention	.43	.96
Response Reversal	.58	.89
Form Discrimination	.68	.85
Simple Reaction Time 20 minutes	.29	.77

Conventional Neuropsychological Procedures (n=524)	
Digit Span Forward	.68
Digit Span Backward	.73
Symbol Digit Substitution	.76
Rey Auditory Verbal Learning Test	
Trial 5	.49
Sum of Trials 1 through 5	.57
Verbal Fluency (Sum of F, A, S)	.77
Trail-Making Part A	.64
Trail-Making Part B	.70
Grooved Pegboard Dominant Hand	.47
Grooved Pegboard Nondominant Hand	.49

The CALCAP Reaction Time measures have very high internal consistency reliability, indicating that the constructs measured are assessed in a uniform manner across the multiple trials of each reaction time task.

In general, the simple reaction time measures have very low test-retest reliability (.20 - .29), but very high internal consistency reliability (.77 - .95), suggesting that the psychomotor skills measured by the simple reaction time tasks vary considerably depending on state variables such as mood, attention, fatigue, time of day, etc. This hypothesis is also supported by the modest intercorrelations observed between the first, second and third iterations of the simple reaction time task (.41 - .68) during the standard CALCAP test battery.

The choice reaction time measures show 6-month test-retest reliability (.43 - .68) that is comparable to that seen in conventional neuropsychological procedures (.47 - .77), though it is likely that, as with the simple reaction time measures, choice reaction time is somewhat more state dependent than conventional neuropsychological procedures. Internal consistency reliability for the choice reaction time measures is quite high (.81 - .96).

NOTE: Simple Reaction Time in the CALCAP test package was originally derived based on a very short set of 6 reaction time trials. For greater stability, CALCAP currently uses either 12 (Standard Version) or 15 (Abbreviated Version) simple reaction time trials. The numbers below show the differences among the different lengths of these tasks:

Reaction Time Task	Mean (SD)	Coeff Alpha	N
Simple RT - 6 trials	354 (103)	.85	647
Simple RT - 12 trials	341 (95)	.91	647
Simple RT - 15 trials	337 (93)	.90	647

Intercorrelations of Reaction Time and Conventional Neuropsychological Measures (n = 1023)

Task	SRT1	SRT2	CRT3	CRT4	CRT5	SRT6	CRT7	CRT8	CRT9	SRT10
SRT1 - Simple RT 0 minutes										
SRT2 - Simple RT Nondominant	.68									
CRT3 - Basic Choice RT	.18	.29								
CRT4 - Sequential RT 1	.12	.17	.48							
CRT5 - Lexical Discrimination	.24	.28	.60	.49						
SRT6 - Simple RT 10 minutes	.41	.46	.23	.15	.24					
CRT7 - Visual Select Attention	.19	.19	.44	.36	.51	.17				
CRT8 - Response Reversal	.21	.26	.50	.39	.55	.20	.56			
CRT9 - Form Discrimination	.17	.15	.36	.31	.38	.17	.33	.47		
SRT10 - Simple RT 20 minutes	.43	.46	.19	.11	.20	.58	.15	.22	.18	
Digit Span Forward	-.19	-.16	-.02	-.08	-.15	-.08	-.11	-.17	-.15	-.13
Digit Span Backward	-.20	-.20	-.07	-.10	-.14	-.12	-.09	-.17	-.15	-.15
Symbol Digit Substitution	-.20	-.21	-.27	-.25	-.31	-.22	-.21	-.37	-.36	-.19
Rey Auditory Verbal Learning Test										
Trial 5	-.12	-.18	-.09	-.07	-.12	-.18	-.06	-.15	-.15	-.16
Sum of Trials 1 through 5	-.17	-.19	-.09	-.06	-.14	-.17	-.08	-.18	-.16	-.17
Verbal Fluency (Sum of F, A, S)	-.19	-.20	-.17	-.21	-.24	-.16	-.15	-.24	-.25	-.13
Trail-Making Part A	.16	.19	.15	.16	.18	.16	.16	.26	.28	.15
Trail-Making Part B	.26	.23	.17	.19	.26	.17	.21	.32	.27	.24
Grooved Pegboard Dominant	.07	.10	.11	.09	.08	.11	.09	.11	.15	.06
Grooved Pegboard Nondominant	.09	.11	.12	.12	.10	.07	.08	.11	.18	.03

Summary:

Multiple iterations of the same simple reaction time task, administered at four separate times during the standard CALCAP procedures, correlate from .41 to .68 with each other.

Choice reaction time measures correlate from .31 to .60. Form Discrimination shows the lowest intercorrelations with the other choice reaction time measures.

Intercorrelations between simple and choice reaction time are very small (from .11 to .29).

Intercorrelations of reaction time measures with conventional neuropsychological procedures are small (.02 to .37). The conventional procedures that correlate most highly with reaction time are Symbol Digit Substitution (.19 to .37), Verbal Fluency (.13 to .25), and Trail-Making, Part B (.17 to .32). Surprisingly, the Grooved Pegboard, a relatively pure motor measure, had negligible correlations with the reaction time tasks (.07 to .18).

FACTOR ANALYSIS OF COMPUTERIZED AND CONVENTIONAL NEUROPSYCHOLOGICAL MEASURES (N = 433)

	FACTORS				
Measure	1	2	3	4	5
Choice Reaction Time					
Lexical Discrimination	.82*				
Simple Choice	.81				
Rapid Visual Scanning	.74				
Sequential Processing	.68				
Selective Attention	.67				
Form Discrimination	.56				
Digit Span/Trail-Making					
Digit Span Forward		.80			
Digit Span Backward		.78			
Trails A		.52			
Trails B		.58			
Verbal Fluency		.50			
Simple Reaction Time					
Trial 1			.69		
Trial 2			.83		
Trial 3			.83		
Grooved Pegboard					
Dominant Hand				.87	
Nondominant Hand				.83	
Rey Auditory Verbal Learning					
Trial 5					.91
Total Trials 1-5					.88

*Only factor loadings exceeding .50 are shown.

APPENDIX B

SAMPLE REPORT

The following pages show a sample 6-page printout from a standard CalCAP test battery. See “Interpretation of Reaction Time Results” in the manual for additional information about test interpretation.

Sample Printed Report
Page 1 - Summary of Abnormal Exam Results

CALIFORNIA COMPUTERIZED ASSESSMENT PACKAGE (CalCAP)

ID#: 40000
Exam #:
Date of Exam: 25 Aug 1998
Gender: Male
Age: 47
Yrs Education: 16
Handedness: Right
Vision: Corrected
Race: White (not Hispanic)
Occupation: CLERICAL
Site ID: 64
Test Version:

Medical Record Number:
Diagnosis:
Notes:

SUMMARY OF ABNORMAL CALCAP EXAM RESULTS
(only results 1.5 SDs below norms are marked)

##	Description	Reaction Time	Accuracy	Signal Detection	Normative Data
1	Simple RT 1 - Dominant Hand				Std (a)
2	Simple RT - Nondominant Hand				Std (a)
3	Choice Reaction Time - Digits				Std (a)
4	Sequential Reaction Time 1	*	***	***	Std (a)
5	Language Discrimination				Std (a)
6	Simple RT 2 - Dominant Hand				Std (a)
7	Degraded Words with Distract				Std (a)
8	Response Reversal - Words				Std (a)
9	Form Discrimination		**		Std (a)
10	Simple RT 3 - Dominant Hand				Std (a)

*One or more indices are more than 1.5 SDs outside of normal range
**One or more indices are more than 2.0 SDs outside of normal range
***One or more indices are more than 3.0 SDs outside of normal range

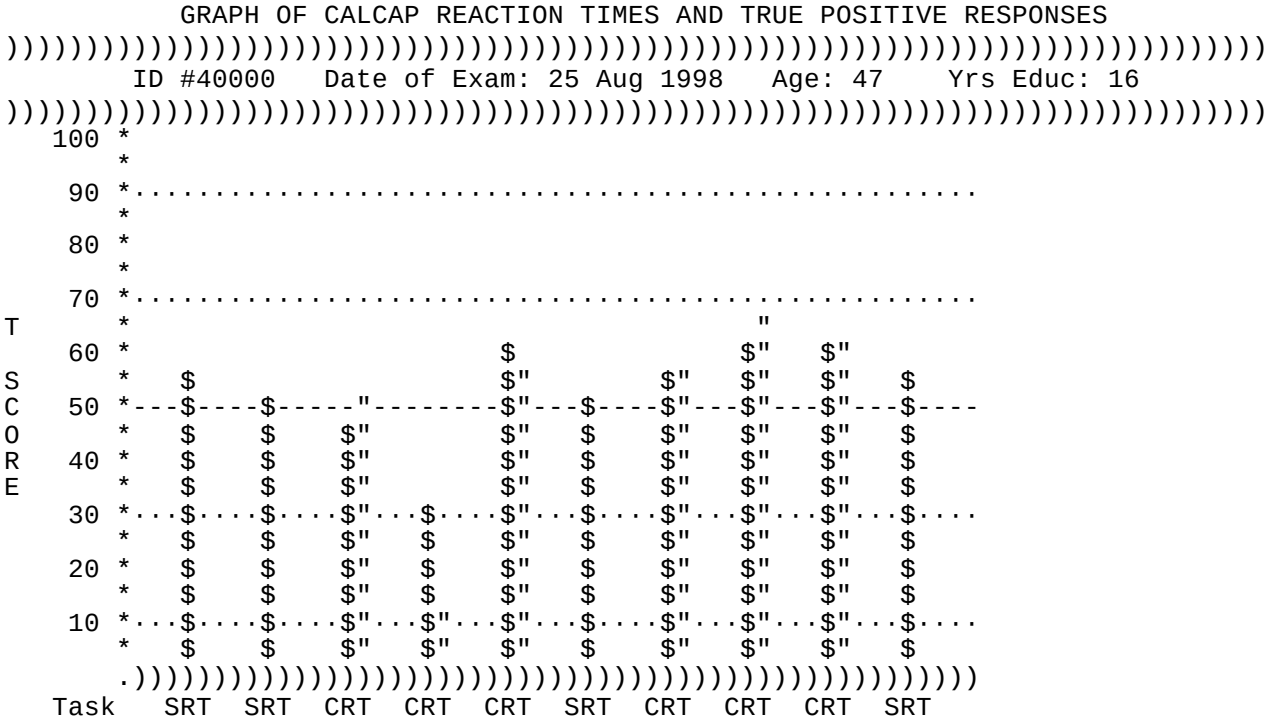
Normative Sample(s)

(a) Norms are based on 25 U.S. males ages 45 - 54 with education level
= 16 years. Normative Sample = NORM0292/509.

Report Prepared on 22 Jan 1999

Sample Printed Report

Page 2 - Graph of Reaction Times and True Positive Responses



Explanation of Codes:

RT = Age & education adjusted T-score for Mean Computed Reaction Time
TP = Age & education adjusted T-score for # of True Positive responses

SRT #1 = Simple RT, Dominant Hand (1st iteration)
SRT NOND = Simple RT, Nondominant Hand
SRT #2 = Simple RT, Dominant Hand (2nd iteration)
SRT #3 = Simple RT, Dominant Hand (3rd iteration)

CRT BASE = Choice RT, Basic Go-No Go Paradigm
CRT SEQ1 = Choice RT, Sequential Reaction Time 1 (Repetition of Numbers)
CRT LEX = Choice RT, Word Discrimination
CRT DIST = Choice RT, Go-No Go Paradigm with Distraction
CRT RVRS = Choice RT, Rapid Visual Scanning/Response Reversal
CRT FORM = Choice RT, Form Discrimination

Report Prepared on 22 Jan 1999

Sample Printed Report
Page 3 - Reaction Times

CALCAP REACTION TIMES

ID #40000 Date of Exam: 25 Aug 1998 Age: 47 Yrs Educ: 16

##	Description	Range	Median	Mean Reaction Time (RT) RT	z-score	%ile
1	Simple RT 1 - Dominant Hand	283- 352	333	332	0.64	74%
2	Simple RT - Nondominant Hand	295- 428	343	351	0.03	51%
3	Choice Reaction Time - Digits	375- 502	427	426	-0.36	36%
4	Sequential Reaction Time 1	437- 853	853	712*	-1.78	4%
5	Language Discrimination	382- 552	482	488	1.15	87%
6	Simple RT 2 - Dominant Hand	338- 868**	354	385	0.40	65%
7	Degraded Words with Distract	431- 669	515	503	0.68	75%
8	Response Reversal - Words	407- 757	613	601	1.05	85%
9	Form Discrimination	435-1133	607	613	1.27	90%
10	Simple RT 3 - Dominant Hand	298- 458	328	335	0.48	69%

*Score is more than 1.5 SDs outside of normal range
**Score is more than 2.0 SDs outside of normal range
***Score is more than 3.0 SDs outside of normal range

Notes

Reaction times indicate the average speed with which the individual was able to respond to target stimuli. Norms displayed above are based on mean reaction times. Norms are not currently available for median reaction times. Abnormal reaction times on multiple tasks suggest generalized slowing in cognitive processing or artifacts such as inattention, visual problems, or random responding. Selective slowing on certain tasks may indicate a passing distraction during the test procedure or may indicate a focal deficit in the cognitive ability measured by that subtest. Note that abnormal performance on the Language Discrimination task only may suggest that the individual is not a native speaker. Consult the CalCAP manual for additional discussion of the skills measured by the individual subtests.

The range of reaction times shown represents the best and worst performances during this testing session. Unusually large ranges suggest inconsistent responding across the trial. This may be due to transient distractions during the testing, difficulties keeping up with the pace of the testing, or losing track of the task instructions. Abnormal ranges across multiple tests suggest poor motivation, malingering, or significant fluctuations in attention due to psychoactive drugs or neurologic injury.

Report Prepared on 22 Jan 1999

Sample Printed Report
Page 4 - Difference Scores

CALCAP DIFFERENCE SCORES

ID #40000 Date of Exam: 25 Aug 1998 Age: 47 Yrs Educ: 16

##	Description	Diff. from Baseline Simple RT (332 ms)	Diff. from Baseline Choice RT (426 ms)
1	Simple RT 1 - Dominant Hand	---Baseline---	
2	Simple RT - Nondominant Hand	19 ms slower	
3	Choice Reaction Time - Digits		---Baseline---
4	Sequential Reaction Time 1		287 ms slower
5	Language Discrimination		62 ms slower
6	Simple RT 2 - Dominant Hand	53 ms slower	
7	Degraded Words with Distract		77 ms slower
8	Response Reversal - Words		175 ms slower
9	Form Discrimination		187 ms slower
10	Simple RT 3 - Dominant Hand	3 ms slower	

Notes

Normative data are not available for Difference Scores.

Report Prepared on 22 Jan 1999

Sample Printed Report
Page 5 -True Positive and False Positive Responses

CALCAP ACCURACY INDICES
(not computed for Simple RT tasks)

ID #40000 Date of Exam: 25 Aug 1998 Age: 47 Yrs Educ: 16

		True Positives			False Positives		
##	Description	Score	z-score	%ile	Score	z-score	%ile
3	Choice Reaction Time - Digits	15/15	0.20	58%	0/85	0.52	70%
4	Sequential Reaction Time 1	9/20***	-3.89	1%	1/80	0.14	56%
5	Language Discrimination	24/24	0.52	70%	0/96	1.17	88%
7	Degraded Words with Distract	15/15	0.72	76%	1/85	0.50	69%
8	Response Reversal - Words	15/15	1.76	96%	1/85	0.28	61%
9	Form Discrimination	19/20	1.27	90%	7/80**	-2.37	1%

*Score is more than 1.5 SDs outside of normal range
**Score is more than 2.0 SDs outside of normal range
***Score is more than 3.0 SDs outside of normal range

Notes

True Positive responses are responses where the individual correctly identifies a target stimulus. Abnormal True Positive scores may indicate inattention, random responding, visual problems, or a true inability to identify and respond to the target stimulus in the amount of time available. Note that abnormal performance on the Language Discrimination task only may suggest that the individual is not a native speaker. See the CalCAP manual for additional discussion of the relevance of each individual subtest.

False Positive responses are responses where the individual incorrectly identifies a distractor as being a target stimulus. Abnormal False Positive scores may indicate inattention, random responding, visual problems, a response bias toward excessive button pressing, or a true difficulty with separating distractor stimuli from target stimuli, due either to slowed cognitive processing or an inability to remember the task instructions.

Report Prepared on 22 Jan 1999

Sample Printed Report
Page 6 - Signal Detection Parameters

```
                       CALCAP SIGNAL DETECTION PARAMETERS
                       (not computed for Simple RT tasks)
)))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
        ID #40000   Date of Exam: 25 Aug 1998   Age: 47    Yrs Educ: 16
)))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
                                          A' estimate of d'
## Description                          Score   z-score %ile
-- -----------------------------      -------   ------- ----
 3 Choice Reaction Time - Digits         1.00      0.42  66%

 4 Sequential Reaction Time 1            0.85***  -3.50   1%
 5 Language Discrimination               1.00      0.93  82%

 7 Degraded Words with Distract          1.00      0.80  79%
 8 Response Reversal - Words             1.00      1.76  96%
 9 Form Discrimination                   0.96      1.10  86%


  *Score is more than 1.5 SDs outside of normal range
 **Score is more than 2.0 SDs outside of normal range
***Score is more than 3.0 SDs outside of normal range
)))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
                                     Notes

  Signal detection parameters provide an index of an individual's
  ability to accurately discriminate target stimuli from distractor
  stimuli.  A' is a population estimate of the signal detection parameter
  d'.  An abnormal value in A' indicates that the individual had greater
  than average difficulty with differentiating the target stimuli from the
  distractor stimuli. This type of error might be due to inattention,
  visual problems, random responding, visual processing deficits, or an
  inability to process the stimuli at the rate they are presented by the
  CalCAP program.
)))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
```

Report Prepared on 22 Jan 1999

APPENDIX C

SAMPLE REPORTS - CLASSIC STYLE USED 1986-1998

INCLUDES INTERPRETATION GUIDE AND SAMPLE REPORTS

INTERPRETATION OF REACTION TIME RESULTS

The CALCAP program provides three types of printed output, one displaying the individual's range of scores and median values [Standard Printout], one displaying normative ranges [Alternate Printout], and one showing these data in a graph [Graphical Printout]. You can toggle between these screens by pressing the letter 'T'. This feature is always available when viewing results.

Sample output from the CALCAP program is shown below [Standard Printout] and on the following pages [Alternate Printout], [Graphical Printout].

The headings at the top of the printouts are described in greater detail on the following page.

Outcome Codes, *z*-Scores and Percentile Ranks

In the right-hand margin the program will display either *z*-scores (the default), percentile ranks, or outcome codes. You can toggle between these three options by pressing `'Z'` while viewing the results. The *z*-scores and percentile ranks refer only to the mean reaction time scores. The outcome codes (shown below in Figures 2 and 3) indicate abnormal performance (below 2 SDs) on reaction time, number of correct responses, and signal detection parameters. A complete description of the outcome codes is detailed in 'Interpretation of Outcome Codes.'

Figure 1. Standard Printout (Press 'T' to toggle between the Standard, Alternate and Graphical printouts; press 'Z' to toggle between *z*-scores [the default], Percentile Ranks, and Outcome Codes [shown below]).

```
Subject #40000     Age 47   Educ 16  Vision C  CLERICAL

Date of testing: 25 AUG 1990      Site ID: 64

                                   True   False         RT Scores
## Description                      Pos     Pos    Range  Median Mean
-- ------------------------------  ------ -------  -------- ------ ----
 1 Simple RT - Dominant Hand                      283- 352    333  332
 2 Simple RT - Nondominant Hand                   295- 428    343  351
 3 Choice Reaction Time - Digits  15/15    0/85   375- 502    427  426

 4 Sequential Reaction Time 1      9/20    1/80   437- 853    853  712  CT A
 5 Language Discrimination        24/24    0/96   382- 552    482  488
 6 Simple RT - Dominant Hand                      338- 868    354  385 R

 7 Degraded Words with Distract   15/15    1/85   431- 669    515  503
 8 Response Reversal - Words      15/15    1/85   407- 757    613  601
 9 Form Discrimination            19/20    7/80   435-1133    607  613    F

10 Simple RT - Dominant Hand                      298- 458    328  335

-----> RECOMMEND FOLLOW-UP                                          8 8
                                                                  Outcome
                                                                   Codes
```

Figure 2. Alternate Printout (Press 'T' to toggle between the Standard, Alternate and Graphical printouts; press 'Z' to toggle between *z*-scores, Percentile Ranks, and Outcome Codes [shown below]).

```
Subject #40000     Age 47   Educ 16  Vision C  CLERICAL

Date of testing: 25 AUG 1990      Site ID: 64

                                    TP  True False  Lower Upper Computed
## Description                    Bound   Pos   Pos  Bound Bound       RT
-- ------------------------------ ----- ----- -----  ----- ----- --------
 1 Simple RT - Dominant Hand                          211   666   332.00
 2 Simple RT - Nondominant Hand                       201   485   350.75
 3 Choice Reaction Time - Digits  15-15   15     0     360   484   425.91

 4 Sequential Reaction Time 1     14-20 <  9>    1     414   687   712.44  CT A
 5 Language Discrimination        22-24   24     0     482   590   487.50
 6 Simple RT - Dominant Hand                          217   626   385.00 R

 7 Degraded Words with Distract   10-15   15     1     415   682   503.18
 8 Response Reversal - Words       7-15   15     1     509   831   601.00
 9 Form Discrimination             5-20   19  <  7>    589  1049   613.00    F

10 Simple RT - Dominant Hand                          234   514   334.75

----> RECOMMEND FOLLOW-UP                                                 8 8
                                                                        Outcome
                                                                          Codes
```

Understanding the Column Headings

The headings from the Alternate and Standard Printouts are described in greater detail below:

##	Code number for the task
Description	A brief description of the task
True Pos	The actual number of true positive responses made by the subject. On the Alternate Printout the maximum number of possible true positive responses also is shown. (Choice reaction time measures only.)
False Pos	The actual number of false positive responses made by the subject. On the Alternate Printout the maximum number of possible false positive responses also is shown. (Choice reaction time measures only.)
Range	The range of reaction times recorded for this subject [Standard Printout only].
Median	Median reaction time (including all trials) [Standard Printout only].
Mean	The mean reaction time obtained by the subject (excluding the two best and two worst performances) [Standard Printout only; identical to Computed RT on the Alternate Printout].
TP Bound	Normative range for true positive responses (lower and upper bounds defined as 2 SDs below/above the age- and education-matched mean for the normative sample†). (Choice reaction time measures only.)
Lower Bound	Normative lower bound for mean reaction time (2 SDs below the age- and education-matched mean for the

normative sample†) [Alternate Printout only].

Upper Bound — Normative upper bound for mean reaction time (2 SDs above the age- and education-matched mean for the normative sample†) [Alternate Printout only].

Computed RT — The mean reaction time obtained by the subject (excluding the two best and two worst performances) [Alternate Printout only; identical to Mean on the Standard Printout].

†Subjects who are not within the age groupings of the normative sample are evaluated based on means and standard deviations for all subjects within their educational stratum. If years of education are missing, subjects are evaluated using means and standard deviations for all subjects within their age stratum. If age and education data are missing or out of range, subjects are evaluated using means and standard deviations for all subjects within the normative sample.

Interpretation of Outcome Codes

The CALCAP program compares each subject's responses with normative data matched (when possible) by age and education. The normative sample consisted of over 600 men between the ages of 21 to 59, with a mean educational level of a college degree. Normative data are stratified by both age (20-34, 35-44, 45+) and education (< 16 years, 16 years, > 16 years). Reaction time correlates most highly with age, and, to a lesser extent, with years of education.

Results that are outside of normal limits (> 2 SDs below the mean for the control sample) are tagged as described below. The code '-SKIP' appears when the subject did not complete the full subtest.

R – Range between fastest and slowest reaction times is abnormal. In other words, the subject is responding extremely quickly to some items, but extremely slowly to others. The response inconsistency may be due to fluctuating attention or environmental distractors.

C – Computed reaction time is abnormal. Mean reaction time (after dropping the two best and two worst performances) is excessively slow.

T – Number of true positive responses is low. The subject is performing poorly on the task of identifying target stimuli.

F – Number of false positive responses is high. The subject is showing a bias where s/he is incorrectly responding to distractor stimuli.

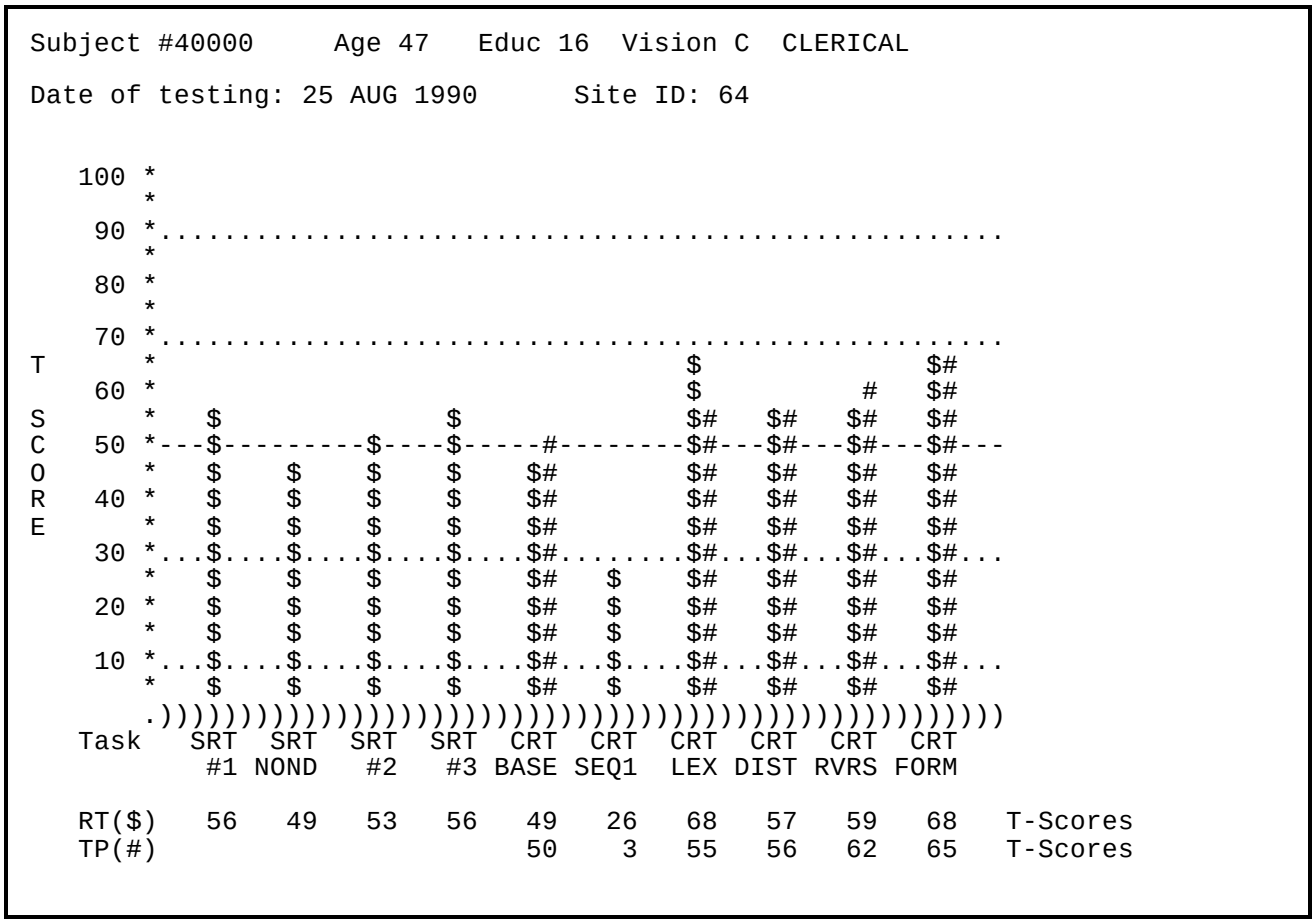
A – Signal detection parameters are outside of normal limits. The subject is having difficulty correctly discriminating the target stimuli from the distractor stimuli.

Summary Evaluations

At the end of the Standard Version of the CALCAP program you will be informed whether the individual fell 'Within Normal Limits.' If not, the message 'Recommend Follow-Up' will be displayed.

The outcome of 'Recommend Follow-Up' occurs approximately 10-15% of the time in unselected populations. 'Recommend Follow-Up' is displayed if the subject scores 2 or more SDs below the mean for age- and education-matched controls on 2 or more tasks. This message is also displayed if the subject scores 3 or more SDs below the mean on any one task. Only tasks 4 through 10 (standard version of the CALCAP program) are considered in making this judgment. Although performance on individual tasks is measured in many ways, the judgment of 'Recommend Follow-Up' is based solely on reaction time.

Figure 3. Graphical Printout (Press 'T' to toggle between the Standard, Alternate and Graphical printouts)



Understanding the Graphical Printout

The graphical representation of exam results is presented using T-score (standard score) values where a score of 50 is average. The standard deviation for a T-score is 10. Higher T-scores correspond to better performance, lower T-scores correspond to poorer performance.

The CALCAP program displays the age- and education-adjusted reaction time T-scores for all of the simple and choice measures. In addition, the program displays the age- and education-adjusted T-scores for the number of true positive responses on each choice reaction time measure.

The following codes are used:

- RT = Age & education adjusted T-score for Mean Computed Reaction Time
- TP = Age & education adjusted T-score for # of True Positive responses

Task Codes:

- SRT #1 = Simple RT, Dominant Hand (1st iteration)
- SRT NOND= Simple RT, Nondominant Hand
- SRT #2 = Simple RT, Dominant Hand (2nd iteration)
- SRT #3 = Simple RT, Dominant Hand (3rd iteration)
- CRT BASE = Choice RT, Basic Go-No Go Paradigm
- CRT SEQ1 = Choice RT, Serial Pattern Matching (Repetition of Numbers)
- CRT LEX = Choice RT, Word Discrimination
- CRT DIST = Choice RT, Go-No Go Paradigm with Distraction
- CRT RVRS = Choice RT, Rapid Visual Scanning/Response Reversal
- CRT FORM= Choice RT, Form Discrimination
- CRT SEQ2 = Choice RT, Serial Pattern Matching (Numbers in Sequence)
- MEMORY = Recognition Memory

General Tips for Interpretation

In general, you should consider the first simple and choice reaction time tasks to be practice trials. Even though each individual task has a practice component, many subject's scores do not stabilize until after the first tasks.

The reaction time tasks measure cognitive functioning that is not ordinarily assessed using standard neuropsychological procedures. Although the tasks correlate modestly (.2 - .4) with other neuropsychological measures (especially Symbol Digit Substitution and Trails B), based on factor analyses the reaction time measures form two factors (Simple reaction time and Choice reaction time) that are different from standard NP tasks.

The cognitive functions assessed by the CALCAP program are best described as timed psychomotor skills requiring focused or sustained attention. Impaired reaction time across multiple measures is usually indicative of generalized motor slowing. Impaired reaction time on specific measures, particularly when coupled with scores outside of normal bounds on true positive responding, is suggestive of a more specific functional deficit, usually in the area of fluctuating attention.

In general, poor performance on a single measure is not indicative of a specific type of cognitive impairment. Certain tasks, however, do seem to be related to specific skills.

Serial Pattern Matching (Sequential Reaction Time) is largely a measure of divided attention skills (similar to Trails B, Consonant Trigrams, etc.)

Lexical Discrimination is frequently impaired in non-native English speakers.

A large discrepancy in reaction time between tasks 1 (simple reaction time–dominant hand) and 2 (simple reaction time–non-dominant hand) may be suggestive of a lateralizing finding.

An isolated finding of impaired performance on Form Discrimination may be suggestive of focal impairment in visuoperceptual skills.

Sample Output - Standard Stimulus Materials

Standard Printout

CALIFORNIA COMPUTERIZED ASSESSMENT PACKAGE (Report prepared on 08-12-1993)

Subject #40000 14 Age 40 Educ 16 Vision N WRITER

Date of testing: 10-14-1990 Site ID: 63

##	Description	True Pos	False Pos	RT Scores Range	Median	Mean	z-score
1	Simple RT - Dominant Hand			328- 452	343	346	0.23
2	Simple RT - Nondominant Hand			244- 281	263	265	0.96
3	Choice Reaction Time - Digits	15/15	0/85	313- 450	396	403	0.05
4	Sequential Reaction Time 1	20/20	0/80	386- 760	559	552	-0.10
5	Language Discrimination	23/24	1/96	396- 863	521	517	0.23
6	Simple RT - Dominant Hand			268- 394	309	306	0.90
7	Degraded Words with Distract	15/15	0/85	475- 593	524	516	0.21
8	Response Reversal - Words	12/15	2/85	436- 967	616	650	-0.07
9	Form Discrimination	20/20	2/80	471-1021	604	605	1.22
10	Simple RT - Dominant Hand			282- 398	320	322	0.57

----> WITHIN NORMAL LIMITS
----> NOTE: BEST AND WORST PERFORMANCES ON A' DIFFER BY MORE THAN 2 SDs

Explanation of Codes: (Normal range = +/- 2 SDs from normative sample mean)

R = Range between best and worst RTs is outside of normal limits
C = Mean Reaction Time (RT) is below normal limits
T = Number of True Positive (TP) responses is below normal limits
F = Number of False Positive (FP) responses is above normal limits
A = Signal detection estimate of d' [sensitivity] is below normal limits

Selection criteria # 5 developed on 04/27/87

Means are based on 47 males aged 35- 44 with education level = 16 years
(Normative Group = SERONEG/509)

Sample Output - Standard Stimulus Materials
Alternate Printout

CALIFORNIA COMPUTERIZED ASSESSMENT PACKAGE (Report prepared on 08-12-1993)

Subject #40000 14 Age 40 Educ 16 Vision N WRITER

Date of testing: 10-14-1990 Site ID: 63

##	Description	TP Bound	True Pos	False Pos	Lower Bound	Upper Bound	Computed RT	z
1	Simple RT - Dominant Hand				211	577	345.50	0.23
2	Simple RT - Nondominant Hand				207	456	265.25	0.96
3	Choice Reaction Time - Digits	15-15	15	0	325	489	402.82	0.05
4	Sequential Reaction Time 1	12-20	20	0	358	739	551.69	-0.10
5	Language Discrimination	21-24	23	1	427	665	517.25	0.23
6	Simple RT - Dominant Hand				217	580	306.00	0.90
7	Degraded Words with Distract	11-15	15	0	393	693	515.82	0.21
8	Response Reversal - Words	8-15	12	2	494	837	649.64	-0.07
9	Form Discrimination	6-20	20	2	519	1045	604.63	1.22
10	Simple RT - Dominant Hand				234	481	321.50	0.57

----> WITHIN NORMAL LIMITS
----> NOTE: BEST AND WORST PERFORMANCES ON A' DIFFER BY MORE THAN 2 SDs

Explanation of Codes: (Normal range = +/- 2 SDs from normative sample mean)

R = Range between best and worst RTs is outside of normal limits
C = Mean Reaction Time (RT) is below normal limits
T = Number of True Positive (TP) responses is below normal limits
F = Number of False Positive (FP) responses is above normal limits
A = Signal detection estimate of d' [sensitivity] is below normal limits

Selection criteria # 5 developed on 04/27/87

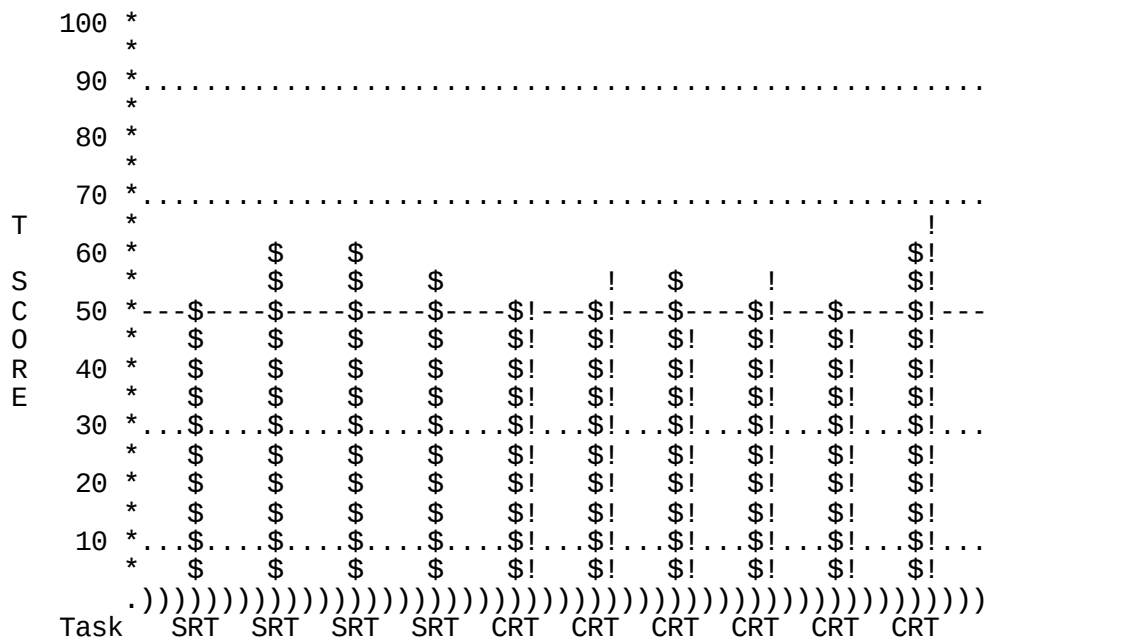
Means are based on 47 males aged 35- 44 with education level = 16 years
(Normative Group = SERONEG/509)

Sample Output - Standard Stimulus Materials
Graphical Printout

CALIFORNIA COMPUTERIZED ASSESSMENT PACKAGE (Report prepared on 08-12-1993)

Subject #40000 Age 40 Educ 16 Vision N WRITER

Date of testing: 10-14-1990 Site ID: 63



Task	SRT #1	SRT NOND	SRT #2	SRT #3	CRT BASE	CRT SEQ1	CRT LEX	CRT DIST	CRT RVRS	CRT FORM	
RT($)	54	61	60	56	51	50	55	54	52	63	T-Scores
TP(!)					51	59	48	57	48	65	T-Scores

Explanation of Codes:

RT = Age & education adjusted T-score for Mean Computed Reaction Time
TP = Age & education adjusted T-score for # of True Positive responses

SRT #1 = Simple RT, Dominant Hand (1st iteration)
SRT NOND = Simple RT, Nondominant Hand
SRT #2 = Simple RT, Dominant Hand (2nd iteration)
SRT #3 = Simple RT, Dominant Hand (3rd iteration)

CRT BASE = Choice RT, Basic Go-No Go Paradigm
CRT SEQ1 = Choice RT, Serial Pattern Matching (Repetition of Numbers)
CRT LEX = Choice RT, Word Discrimination
CRT DIST = Choice RT, Go-No Go Paradigm with Distraction
CRT RVRS = Choice RT, Rapid Visual Scanning/Response Reversal
CRT FORM = Choice RT, Form Discrimination

Norms are based on 47 males aged 35- 44 with education level = 16 years
(Normative Group = SERONEG/509)

Sample Output - Abbreviated Stimulus Materials
Standard Printout

CALIFORNIA COMPUTERIZED ASSESSMENT PACKAGE (Report prepared on 08-12-1993)

Subject #40000 150 Age 35 Educ 20 Vision C NEUROPSYCHOLOGIST

Date of testing: 03-05-1991 Site ID: 80

##	Description	True Pos	False Pos	RT Scores Range	Median	Mean	z-score
1	Simple RT - Dominant Hand			186- 347	256	247	0.82
2	Choice Reaction Time - Digits	15/15	0/85	319- 416	388	371	0.77
3	Sequential Reaction Time 1	20/20	0/80	305- 524	354	369	1.77
4	Sequential Reaction Time 2	19/20	2/80	309- 884	399	454	1.22

Explanation of Codes: (Normal range = +/- 2 SDs from normative sample mean)

R = Range between best and worst RTs is outside of normal limits
C = Mean Reaction Time (RT) is below normal limits
T = Number of True Positive (TP) responses is below normal limits
F = Number of False Positive (FP) responses is above normal limits
A = Signal detection estimate of d' [sensitivity] is below normal limits

Selection criteria # 5 developed on 04/27/87

Means are based on 82 males aged 35- 44 with education level > 16 years
(Normative Group = SERONEG/509)

Sample Output - Abbreviated Stimulus Materials
Alternate Printout

CALIFORNIA COMPUTERIZED ASSESSMENT PACKAGE (Report prepared on 08-12-1993)

Subject #40000 150 Age 35 Educ 20 Vision C NEUROPSYCHOLOGIST

Date of testing: 03-05-1991 Site ID: 80

##	Description	TP Bound	True Pos	False Pos	Lower Bound	Upper Bound	Computed RT	z
1	Simple RT - Dominant Hand				211	485	246.55	0.82
2	Choice Reaction Time - Digits	14-15	15	0	315	496	371.00	0.77
3	Sequential Reaction Time 1	14-20	20	0	341	717	368.50	1.77
4	Sequential Reaction Time 2	14-20	19	2	341	717	454.25	1.21

Explanation of Codes: (Normal range = +/- 2 SDs from normative sample mean)

R = Range between best and worst RTs is outside of normal limits
C = Mean Reaction Time (RT) is below normal limits
T = Number of True Positive (TP) responses is below normal limits
F = Number of False Positive (FP) responses is above normal limits
A = Signal detection estimate of d' [sensitivity] is below normal limits

Selection criteria # 5 developed on 04/27/87

Means are based on 82 males aged 35- 44 with education level > 16 years
(Normative Group = SERONEG/509)

APPENDIX D

STRUCTURE OF RAW DATA FILES

The CALCAP program generates detailed records of all responses to the reaction time stimuli. Data are stored in a file named *subj#-xx.dat.* Where *subj#* is the subject number (maximum of 5 digits) and *xx* is an encrypted code representing the date when the subject was tested.

These files can be condensed by using the SHORTEN utility program. See Appendix E for a description of the data file structure for files that have been SHORTENed.

Raw Data Files

Each CALCAP data file consists of 4 sections: (1) a header record with relevant demographic information; (2) individual records for each simple reaction time task; (3) individual records for each choice reaction time task; and (4) a closing record indicating the total amount of time elapsed.

The number of lines varies as a function of the number of reaction time tasks that are administered. These sections are described in greater detail below. All lines show the subject number and visit number in the following format:

Description	Columns
Subject Number	01-05
Visit Number	07-09

The remaining elements of the CALCAP data files are detailed below:

I. Header Record

A. Clinical Information Section (5 lines). *Note that this section is optional and is not included in all versions of the CALCAP program.*

Line #	Description	Columns	Legal Values/Codes
1	Not used		
2	Site Identification Text	20-59	The site identification description that is entered by using the RTCONFIG utility (default value is GENERIC).
3	Medical Record # Text	20-77	Information about patient name or medical record number entered by the examiner on the screen for collecting demographic information.
4	Diagnosis Text	20-82	Information about patient diagnosis entered by the examiner on the screen for collecting demographic information.
5	Misc Text Notes	20-81	Miscellaneous notes entered by the examiner on the screen for collecting demographic information.

B. CALCAP Host Computer Information/Subject Demographics Section (3 lines)

Line #	Description		Columns	Legal Values/Codes
1	Site Identification Number		20-21	01-99
1	Delay.Resolution		23-28	Resolution of choice reaction time timing circuit, in msecs. This value is a function of the speed of the microprocessor.
1	Delay.Error		30-35	Average error in timing choice reaction time tasks, per msec. This value is a function of the design of the PC's internal timer (clock rate of 18.2 ticks per second) and the speed of the microprocessor. Note that timing for the CALCAP program is considerably more accurate than the PC's internal timer.*
1	Keyboard.Resolution		37-42	This value represents the average error in msecs for timing keyboard responses for the simple reaction time tasks. This value is a function of the speed of the microprocessor and any idiosyncracies of the keyboard processor.
1	Display.Duration #1		44-49	Indicates the time required (in msecs) to display and remove a single-digit stimulus target. This value is a function of the hardware characteristics of the video card and display and the speed of the microprocessor.
1	Display.Duration #5		51-56	Indicates the time required (in msecs) to display and remove a five-digit stimulus target. This value is a function of the hardware characteristics of the video card and display and the speed of the microprocessor.
1	Exam Date:	Month	58-59	01-12
		Day	61-62	01-31
		Year	64-67	1980-2050
1	Exam Time:	Hour	69-70	00-23
		Minute	72-73	00-59
		Second	75-76	00-59
1	Name of Program Driver		78-89	
1	Version of CalCAP Program		91-96	blank before 09/2007; RT0907
2	Age		20-21	08-99
2	Gender		24	M = Male, F = Female

*Use the following formula to compute the actual error range (± xx msecs) for choice RT tasks:

Error range = (Task duration in msecs) * Delay.Error + Delay.Resolution

For example, if a task is supposed to last 1000 msecs and Delay.Error = 0.0089 and Delay.Resolution = 1.12, then the accuracy of timing is equal to: 1000 * 0.0089 + 1.12 = 10.02. Thus, Accuracy = 1000 msecs ± 10 msecs.

B. CALCAP Host Computer Information/Subject Demographics Section (continued)

Line #	Description	Columns	Legal Values/Codes
2	Handedness	26	R = Right L = Left
2	Ethnicity	28	1 = Asian 2 = Black 3 = Hispanic 4 = American Indian 5 = White (not Hispanic) 6 = Other
2	Years of Education	30-31	06-20
2	Normal/Corrected Vision	33	N = Normal C = Corrected
2	Allergies	35	Y = Yes N = No
2	Occupation	37-66	
3	Reserved for future use		

II. Simple Reaction Time tasks (3 lines)

Line #	Description	Columns	Legal Values/Codes
1	Task Number	15-17	01 = Simple RT #1, 6 Trials 02 = Simple RT Nondominant, 6 Trials 06 = Simple RT #2, 6 Trials 10 = Simple RT #3, 6 Trials 15 = Simple RT #1, 15 Trials 18 = Simple RT #1, 12 Trials 19 = Simple RT Nondominant, 12 Trials 20 = Simple RT #2, 12 Trials 21 = Simple RT #3, 12 Trials
1	Task Type	20-21	01 = Simple Reaction Time
1	# of Failed Practice Trials	23-26	If task was aborted, this value is $ 10.
1	Total Number of Trials	28-31	Total # of Simple RT Trials
1	Slow Error Trials	33-36	Not used
1	Total Number of Trials	38-41	Total # of Simple RT Trials
1	Minimum ISI	43-47	Minimum Inter-Stimulus-Interval
1	Maximum ISI	49-53	Maximum Inter-Stimulus-Interval

II. Simple Reaction Time tasks (continued)

Line #	Description	Columns	Legal Values/Codes
1	Random ISI indicator	55-57	00 = Use minimum ISI for all trials -1 = ISI varies randomly between minimum and maximum values.
2	Total Number of Trials	20-23	Total # of Simple RT Trials
2	Reaction Times for each each trial	26-29 31-34 36-39 41-44 46-49 . . etc.	Reaction Time, Trial 1 Reaction Time, Trial 2 Reaction Time, Trial 3 Reaction Time, Trial 4 Reaction Time, Trial 5 . . etc. *Note:* If a subject makes no response to an item, then the maximum presentation time is recorded. This value is equal to the sum of the Minimum and Maximum ISIs.
3	Total of all Rts	20-26	Sum of all RT trials
3	Mean RT	28-34	Mean of all RT trials
3	Fastest RT	36-39	Fastest Reaction Time
3	Slowest RT	41-44	Slowest Reaction Time
3	Range of RTs	46-49	Slowest minus fastest RT
3	Computed Reaction Time	51-57	Mean of all RT trials, excluding the best and worst trials (or, if there are more than 10 trials, excluding the 2 best and the 2 worst trials).

III. Choice Reaction Time tasks (6 lines)

Line #	Description	Columns	Legal Values/Codes
1	Task Number	15-17	03 = Basic Choice RT 04 = Sequential RT #1 05 = Lexical Discrimination 07 = Visual Selective Attention with Distraction 08 = Response Reversal and Rapid Visual Scanning 09 = Form Discrimination 11 = Recognition Memory 12 = 8088 version of Visual Selection Attention 13 = 8088 version of Response Reversal 14 = Sequential RT #2 16 = Basic Choice RT for CPT RT (200 trials) 17 = Sequential RT #1 for CPT RT (200 trials)

III. Choice Reaction Time tasks (continued)

Line #	Description	Columns	Legal Values/Codes
1	Task Type	20-21	02 = Choice Reaction Time 03 = Choice RT with Stimuli in both the center & periphery
1	# of Failed Practice Trials	23-26	If task was aborted, this value is $ 10.
1	Total Number of Trials	28-31	Total # of Choice RT Trials
1	Minimum ISI	43-47	Minimum Inter-Stimulus-Interval
1	Maximum ISI	49-53	Maximum Inter-Stimulus-Interval
1	Random ISI indicator	55-57	00 = Use minimum ISI for all trials -1 = ISI varies randomly between minimum and maximum values.
1	Delay.Duration	59-62	*Not Currently Available.* When materials are presented both in the center of the screen and in the periphery, this number represents the amount of time (in msecs) between the initial presentation of the materials in the periphery and the onset of display of the materials in the center of the screen.
1	Delay.Duration.2	64-67	*Not Currently Available.* When materials are presented both in the center of the screen and in the periphery, this number represents the amount of time (in msecs) between when the materials in the center of the screen are removed and the removal of the materials in the periphery of the screen.
1	Stimulus Duration	69-76	Amount of time (in msecs) that the target stimulus is displayed.
2	Reaction Times for each each trial	21-24 26-29 31-34 36-39 41-44 46-49 . . etc.	Reaction Time, Trial 1 Reaction Time, Trial 2 Reaction Time, Trial 3 Reaction Time, Trial 4 Reaction Time, Trial 5 Reaction Time, Trial 6 . . etc. *Note:* If a subject makes no response to an item, then the maximum presentation time is recorded. This value is equal to the sum of the ISI and the Stimulus Duration, minus one half of the Display.Duration for the given target.
3	Total of all Rts	20-26	Sum of all RT trials
3	Mean RT	28-34	Mean of all RT trials

III. Choice Reaction Time tasks (continued)

Line #	Description	Columns	Legal Values/Codes
3	Fastest RT	36-39	Fastest Reaction Time
3	Slowest RT	41-44	Slowest Reaction Time
3	Range of RTs	46-49	Slowest minus fastest RT
3	Computed Reaction Time	51-57	Mean of all RT trials, excluding the 2 best and the 2 worst trials.
3	True Positive Responses	59-61	Total number of target stimuli where the subject correctly responded before the next stimulus was displayed.
3	False Negative Responses	63-65	Total number of target stimuli where the subject incorrectly made no response.
3	False Positive Responses	67-69	Total number of distractor stimuli where the subject incorrectly responded as though the target was displayed.
3	True Negative Responses	71-73	Total number of distractor stimuli where the subject correctly made no response.
4	d' (d prime)	20-28	Signal detection parameter of d'
4	A' (A prime)	30-38	Signal detection estimate of A'
4	Beta	40-48	Signal detection parameter ß
5	Number of target stimuli	20-23	Total number of target stimuli
5	Accuracy on Target 1	25	0=Incorrect, 1=Correct
	Accuracy on Target 2	26	0=Incorrect, 1=Correct
	Accuracy on Target 3	27	0=Incorrect, 1=Correct
	Accuracy on Target 4	28	0=Incorrect, 1=Correct
	Accuracy on Target 5	29	0=Incorrect, 1=Correct
	.	.	.
	.	.	.
	etc.	etc.	etc.
6	# of distractor stimuli	20-23	Total number of distractor stimuli
6	Accuracy on Distractor 1	25	0=Incorrect, 1=Correct
	Accuracy on Distractor 2	26	0=Incorrect, 1=Correct
	Accuracy on Distractor 3	27	0=Incorrect, 1=Correct
	Accuracy on Distractor 4	28	0=Incorrect, 1=Correct
	Accuracy on Distractor 5	29	0=Incorrect, 1=Correct
	.	.	.
	.	.	.
	etc.	etc.	etc.

III. Choice Reaction Time tasks (continued)

Note: Recognition Memory (Task 11) is a special case of Choice Reaction Time where reaction times are irrelevant. Recognition Memory requires that the subject has seen the tasks for Lexical Discrimination and Visual Selective Attention.

IV. Closing Record (1 line)

Line #	Description	Columns	Legal Values/Codes
1	Elapsed Time	20-24	Elapsed time from beginning to end of RT tasks
1	Multi.Tasking	26-28	State of multi-tasking during program execution: -1 = Windows 386 Enhanced mode 0 = Neither Windows nor DOS shell active 1 = DOS Shell 2 = Windows Standard mode

APPENDIX E

SHORTENED DATA FILES

How to SHORTEN CALCAP Data Files

It is possible to simplify the data structure of the raw CALCAP data files significantly by using the SHORTEN utility. This utility takes all CALCAP data and arranges it in a fixed format suitable for use by statistical packages or database programs. The SHORTEN program is invoked by typing:

```
SHORTEN
```

at the DOS command prompt. The SHORTEN program will merge all CALCAP raw data files of the form *subjn-xx.dat* into two data files named MMDDYYA.DTA and MMDDYYA.DBF where MM is the month, DD is the day, YY is the year, and the letter A is appended to the date if this is the first such file in your directory, the letter B is appended if this is the second such file, and so on. The .DTA file is a plain ASCII file that uses the structure described below. The .DBF file is in dBase® III format and can be used directly by most database programs and statistical packages.

In order to stay within the 128 variable limit of dBase, several variables are not included in the .DBF file, including the computer accuracy/resolution parameters (Delay.Resolution, Delay.Error, Keyboard.Resolution, Display.Duration #1, Display.Duration #5, Multi-tasking), the second of the day that the exam was started (Exam Time: Second), the Uncorrected Reaction Time variables for all tasks, and the Maximum Reaction Time variables for all tasks. The values for Maximum Reaction Time can be derived by summing the Range and Minimum Reaction Time variables (i.e., Maximum Reaction Time = Minimum Reaction Time + Range).

The SHORTEN program is designed for use with the Standard and Abbreviated versions of the CALCAP program, and should work with most Customized versions, as long as no single task (e.g., Choice Reaction Time Task 03) is repeated more than once.

Edit Checks for SHORTENed Data Files

There are several checks that you should perform to ensure data integrity. These checks are necessary to exclude subjects who score unusually poorly because they did not complete the task or did not understand the instructions.

1. If the number of True Positives plus the number of False Positives is less than 5, then all data from that task should be coded as missing.

2. If the Range of reaction time scores for any task is equal to 0, then all data from that task should be coded as missing.

3. If the Range of reaction time scores for any of the simple reaction time measures exceeds 1500 msecs, all of the data from that task should be coded as missing.

4. If the Range of reaction time scores for any of the choice reaction time measures (any measure aside from simple reaction time) exceeds 1000 msecs, then all data from that task should be coded as missing.

5. If the Corrected Reaction Time for any of the simple reaction time procedures is less than 200 msecs or exceeds 1600 msecs, all data from that task should be coded as missing.

6. If the Corrected Reaction Time for any of the choice reaction time measures (any measure aside from simple reaction time) is less than 200 msecs or exceeds 1000 msecs, then all data from that task should be coded as missing.

7. If the number of True Positive responses is less than 2, then all data from that task should be coded as missing.

Structure of SHORTENed Data Files

If the variable is included in the dBase format file, then the dBase variable name is listed under VarName below:

Line #	VarName	Description	Columns	Legal Values/Codes
1	ID	Subject ID Number	01-05	Any combination of 5 alphanumeric characters. First character must be a letter from A-Z.
1	VISIT	Visit Number	07-09	Any numeric value up to 999.
1	SITEID	Site Identification Number	20-21	01-99
1		Delay.Resolution	23-28	Resolution of choice reaction time timing circuit, per msec. This value is a function of the speed of the microprocessor.
1		Delay.Error	30-35	Average error in timing choice reaction time tasks, in msecs. This value is a function of the design of the PC's internal timer (clock rate of 18.2 ticks per second) and the speed of the microprocessor. Note that timing for the CALCAP program is considerably more accurate than the PC's internal timer.**
1		Keyboard.Resolution	37-42	This value represents the average error in msecs for timing keyboard responses for the simple reaction time tasks. This value is a function of the speed of the microprocessor and any idiosyncracies of the keyboard processor.
1		Display.Duration #1	44-49	Indicates the time required (in msecs) to display and remove a single-digit stimulus target. This value is a function of the hardware characteristics of the video card and display and the speed of the microprocessor.
1		Display.Duration #5	51-56	Indicates the time required (in msecs) to display and remove a five-digit stimulus target. This value is a function of the hardware characteristics of the video card and display and the speed of the microprocessor.

**Use the following formula to compute the actual error range (± xx msecs) for choice RT tasks:

Error range = (Task duration in msecs) * Delay.Error + Delay.Resolution

For example, if a task is supposed to last 1000 msecs and Delay.Error = 0.0089 and Delay.Resolution = 1.12, then the accuracy of timing is equal to: 1000 * 0.0089 + 1.12 = 10.02. Thus, Accuracy = 1000 msecs ± 10 msecs.

Line #	VarName	Description		Columns	Legal Values/Codes
1	EXMON	Exam Date:	Month	58-59	01-12
	EXDAY		Day	61-62	01-31
	EXYR		Year	64-67	1980-2050
1	PROGDRIV	Name of Program Driver		69-76	There are a variety of CALCAP program drivers. If the first letter of the driver is "S", then the program driver is written in Spanish. If the first letter of the driver is "N", then the program driver is written in Norwegian.
2	PROGVER	Version of CalCAP Program		01-06	blank before 09/2007; RT0907
2	AGE	Age		20-21	08-99
2	GENDER	Gender		24	M = Male, F = Female
2	HAND	Handedness		26	R = Right L = Left
2	ETHNIC	Ethnicity		28	1 = Asian 2 = Black 3 = Hispanic 4 = American Indian 5 = White (not Hispanic) 6 = Other
2	EDUCY	Years of Education		30-31	06-20
2	VISION	Normal/Corrected Vision		33	N = Normal C = Corrected
2	ALLERGY	Allergies		35	Y = Yes N = No
2	JOB	Occupation		37-66	Text description of the subject's occupation entered by the examiner on the screen for collecting demographic information.
2	EXHR	Exam Time:	Hour	69-70	00-23
	EXMIN		Minute	72-73	00-59
			Second	75-76	00-59
3	**Simple RT #1 - Dominant Hand**				
		Uncorrected Reaction Time***		05-08	0100-1500
	SRT1	Corrected Reaction Time***		10-13	0100-1500
	MEDIAN1	Median Reaction Time		15-18	0100-1500
	MINRT1	Minimum Reaction Time		20-23	0100-1500
		Maximum Reaction Time		25-28	0100-1500
	RANGE1	Range of Reaction Times		71-74	0100-1500

*** Uncorrected reaction time is the mean reaction time using all available trials. Corrected reaction time is the reaction time excluding the 2 best and 2 worst reaction time scores.

Line #	VarName	Description	Columns	Legal Values/Codes
4	**Simple RT - Nondominant Hand**			
		Uncorrected Reaction Time	05-08	0100-1500
	SRT2	Corrected Reaction Time	10-13	0100-1500
	MEDIAN2	Median Reaction Time	15-18	0100-1500
	MINRT2	Minimum Reaction Time	20-23	0100-1500
		Maximum Reaction Time	25-28	0100-1500
	RANGE2	Range of Reaction Times	71-74	0100-1500
5	**Choice RT - Basic Go-No Go Paradigm**			
		Uncorrected Reaction Time	05-08	0100-1500
	CRT3	Corrected Reaction Time	10-13	0100-1500
	MEDIAN3	Median Reaction Time	15-18	0100-1500
	MINRT3	Minimum Reaction Time	20-23	0100-1500
		Maximum Reaction Time	25-28	0100-1500
	TP3	True Positive Responses	30-32	00-15
	FN3	False Negative Responses	34-36	00-15
	FP3	False Positive Responses	38-40	00-85
	TN3	True Negative Responses	42-44	00-85
	DPRIME3	d prime (Signal Detection)	46-53	0.000-99.00
	APRIME3	A prime (Signal Detection)	54-61	0.000-1.000
	BETA3	beta (Signal Detection)	62-69	00.00-19.00
	RANGE3	Range of Reaction Times	71-74	0100-1500
6	**Sequential RT 1**			
		Uncorrected Reaction Time	05-08	0100-1500
	CRT4	Corrected Reaction Time	10-13	0100-1500
	MEDIAN4	Median Reaction Time	15-18	0100-1500
	MINRT4	Minimum Reaction Time	20-23	0100-1500
		Maximum Reaction Time	25-28	0100-1500
	TP4	True Positive Responses	30-32	00-20
	FN4	False Negative Responses	34-36	00-20
	FP4	False Positive Responses	38-40	00-80
	TN4	True Negative Responses	42-44	00-80
	DPRIME4	d prime (Signal Detection)	46-53	0.000-99.00
	APRIME4	A prime (Signal Detection)	54-61	0.000-1.000
	BETA4	beta (Signal Detection)	62-69	00.00-19.00
	RANGE4	Range of Reaction Times	71-74	0100-1500
7	**Lexical Discrimination**			
		Uncorrected Reaction Time	05-08	0100-1500
	CRT5	Corrected Reaction Time	10-13	0100-1500
	MEDIAN5	Median Reaction Time	15-18	0100-1500
	MINRT5	Minimum Reaction Time	20-23	0100-1500
		Maximum Reaction Time	25-28	0100-1500
	TP5	True Positive Responses	30-32	00-24
	FN5	False Negative Responses	34-36	00-24
	FP5	False Positive Responses	38-40	00-96
	TN5	True Negative Responses	42-44	00-96
	DPRIME5	d prime (Signal Detection)	46-53	0.000-99.00
	APRIME5	A prime (Signal Detection)	54-61	0.000-1.000
	BETA5	beta (Signal Detection)	62-69	00.00-19.00
	RANGE5	Range of Reaction Times	71-74	0100-1500

Line #	VarName	Description	Columns	Legal Values/Codes
8	**Simple RT - Dominant Hand #2**			
		Uncorrected Reaction Time	05-08	0100-1500
	SRT6	Corrected Reaction Time	10-13	0100-1500
	MEDIAN6	Median Reaction Time	15-18	0100-1500
	MINRT6	Minimum Reaction Time	20-23	0100-1500
		Maximum Reaction Time	25-28	0100-1500
	RANGE6	Range of Reaction Times	71-74	0100-1500
9	**Choice w/Distraction**			
		Uncorrected Reaction Time	05-08	0100-1500
	CRT7	Corrected Reaction Time	10-13	0100-1500
	MEDIAN7	Median Reaction Time	15-18	0100-1500
	MINRT7	Minimum Reaction Time	20-23	0100-1500
		Maximum Reaction Time	25-28	0100-1500
	TP7	True Positive Responses	30-32	00-15
	FN7	False Negative Responses	34-36	00-15
	FP7	False Positive Responses	38-40	00-85
	TN7	True Negative Responses	42-44	00-85
	DPRIME7	d prime (Signal Detection)	46-53	0.000-99.00
	APRIME7	A prime (Signal Detection)	54-61	0.000-1.000
	BETA7	beta (Signal Detection)	62-69	00.00-19.00
	RANGE7	Range of Reaction Times	71-74	0100-1500
10	**Rapid Visual Scanning**			
		Uncorrected Reaction Time	05-08	0100-1500
	CRT8	Corrected Reaction Time	10-13	0100-1500
	MEDIAN8	Median Reaction Time	15-18	0100-1500
	MINRT8	Minimum Reaction Time	20-23	0100-1500
		Maximum Reaction Time	25-28	0100-1500
	TP8	True Positive Responses	30-32	00-15
	FN8	False Negative Responses	34-36	00-15
	FP8	False Positive Responses	38-40	00-85
	TN8	True Negative Responses	42-44	00-85
	DPRIME8	d prime (Signal Detection)	46-53	0.000-99.00
	APRIME8	A prime (Signal Detection)	54-61	0.000-1.000
	BETA8	beta (Signal Detection)	62-69	00.00-19.00
	RANGE8	Range of Reaction Times	71-74	0100-1500
11	**Form Discrimination**			
		Uncorrected Reaction Time	05-08	0100-1500
	CRT9	Corrected Reaction Time	10-13	0100-1500
	MEDIAN9	Median Reaction Time	15-18	0100-1500
	MINRT9	Minimum Reaction Time	20-23	0100-1500
		Maximum Reaction Time	25-28	0100-1500
	TP9	True Positive Responses	30-32	00-20
	FN9	False Negative Responses	34-36	00-20
	FP9	False Positive Responses	38-40	00-80
	TN9	True Negative Responses	42-44	00-80
	DPRIME9	d prime (Signal Detection)	46-53	0.000-99.00
	APRIME9	A prime (Signal Detection)	54-61	0.000-1.000
	BETA9	beta (Signal Detection)	62-69	00.00-19.00
	RANGE9	Range of Reaction Times	71-74	0100-1500

Line #	VarName	Description	Columns	Legal Values/Codes
12	**Simple RT - Dominant Hand #3**			
		Uncorrected Reaction Time	05-08	0100-1500
	SRT10	Corrected Reaction Time	10-13	0100-1500
	MEDIAN10	Median Reaction Time	15-18	0100-1500
	MINRT10	Minimum Reaction Time	20-23	0100-1500
		Maximum Reaction Time	25-28	0100-1500
	RANGE10	Range of Reaction Times	71-74	0100-1500
13	**Recognition Memory**			
	TP11	True Positive Responses	30-32	00-36
	FN11	False Negative Responses	34-36	00-36
	FP11	False Positive Responses	38-40	00-54
	TN11	True Negative Responses	42-44	00-54
	DPRIME11	d prime (Signal Detection)	46-53	0.000-99.00
	APRIME11	A prime (Signal Detection)	54-61	0.000-1.000
	BETA11	beta (Signal Detection)	62-69	00.00-19.00
14	Reserved for data collected using 8088 microprocessors			
15	Reserved for data collected using 8088 microprocessors			
16		**Sequential RT 2**		
		Uncorrected Reaction Time	05-08	0100-1500
	CRT14	Corrected Reaction Time	10-13	0100-1500
	MEDIAN14	Median Reaction Time	15-18	0100-1500
	MINRT14	Minimum Reaction Time	20-23	0100-1500
		Maximum Reaction Time	25-28	0100-1500
	TP14	True Positive Responses	30-32	00-20
	FN14	False Negative Responses	34-36	00-20
	FP14	False Positive Responses	38-40	00-80
	TN14	True Negative Responses	42-44	00-80
	DPRIME14	d prime (Signal Detection)	46-53	0.000-99.00
	APRIME14	A prime (Signal Detection)	54-61	0.000-1.000
	BETA14	beta (Signal Detection)	62-69	00.00-19.00
	RANGE14	Range of Reaction Times	71-74	0100-1500
17	MEDREC	Medical Record # Text	11-68	Information about patient name or medical record number entered by the examiner on the screen for collecting demographic information.
18	DX	Diagnosis Text	11-73	Information about patient diagnosis entered by the examiner on the screen for collecting demographic information.
19	MISCNOTE	Misc Text Notes	11-72	Miscellaneous notes entered by the examiner on the screen for collecting demographic information.
20	RTTIME	Elapsed Time	20-24	Elapsed time from beginning to end of RT tasks
20		Multi.Tasking	26-28	Multi-tasking during program execution: -1 = Windows 386 Enhanced mode 0 = Neither Windows nor DOS shell 1 = DOS Shell 2 = Windows Standard mode

APPENDIX F

CALCAP Reaction Time

Bibliography and Selected Abstracts from Articles and Conference Presentations

Attached are abstracts from articles and conference presentations that contain valuable information about clinical and research applications of the CalCAP test battery, as well as psychometric properties of the instrument.

Suggested Readings about Reaction Time and CALCAP

(Research that uses the CALCAP procedures is highlighted with italics)

Berg D. Adults' reaction time as affected by age and education level. B.A. Honours Thesis supervised by Dr. Frank Spellacy, University of Victoria, 1994

Bruhn P, Parsons OA. Continuous reaction time in brain damage. Cortex, 1971:7;278-291.

Budzinski LM, An exploration of simple and choice reaction times in children. B.A. Honours Thesis supervised by Dr. Frank Spellacy, University of Victoria, Victoria, B.C., 1994.

Caretti DM. Cognitive performance during long-term respirator wear while at rest. American Industrial Hygiene Association Journal, 1997:58:105-109.

Caretti DM, Bay-Hansen LA, Kuhlmann WD. Cognitive performance during respirator wear in the absence of other stressors. American Industrial Hygiene Association Journal, 1995:56:776-781.

Clarkson PM, Kroll W. Practice effects on fractionated response time related to age and activity level. Journal of Motor Behavior, 1978:10;275-286.

Crabtree DA, Antrim LR. Guidelines for measuring reaction time. Perceptual and Motor Skills, 1988:66;363-370.

The Dana Consortium on Therapy for HIV Dementia and Related Cognitive Disorders. Clinical confirmation of the American Academy of Neurology algorithm for HIV-1-associated cognitive/motor disorder. Neurology, 1996;47:1247-1253.

Donders FC. On the speed of mental processes. Acta Psychologica (Amsterdam), 1969:30;412-431.

Dunlop O, Myrvang B. Neuropsychological tests in HIV [letter]. Neurology, 1992:42:2055-2056.

Durvasula RS, Myers HM, Satz P, Miller EN, Forney D, Evans G, Richardson M, Morgenstern H. HIV-1, cocaine, and neuropsychological performance in African American men. Submitted for publication.

Durvasula RS, Miller EN, Myers HM, Satz P, Wyatt G. Neuropsychological performance and HIV-1 in ethnic minority samples of women and men: serostatus effects, comparative data and methodological considerations. Presented at the Annual Meeting of the International Neuropsychological Society, Honolulu, February, 1998.

Durvasula RS, Miller EN, Wyatt GE. Longitudinal assessment of neuropsychological performance in HIV+ women (baseline and 6 months). Presented at the 12th Worlds AIDS Conference, Geneva, Switzerland, 1998.

Gallway RA, Millington JT, Van Gorp WG, Miller EN, Mirsky AF. Neuropsychological consequences of hyperbaric nitrogen narcosis II [abstract]. Journal of Clinical and Experimental Neuropsychology, 1991:13;440.

Halman M, Hamburg NM, Savage CR, Worth JL. Use of computer-based measures of complex reaction time in depressed HIV-1 infected patients [abstract]. Psychosomatics, 1995:36;175.

Kerr B. Processing demands during mental operations. Memory and Cognition, 1973:1;401-412.

Llorente AM, Miller EN, D'Elia LF, Selnes OA, Wesch J, Becker JT, Satz P for the Multicenter AIDS Cohort Study (MACS). Slowed information processing in HIV-1 disease. Journal of Clinical and Experimental Neuropsychology. 1998; 20: 60-72.

Martin A, Heyes MP, Salazar AM, Kampen DL, Williams J, Law WA, Coats ME, Markey SP. Progressive slowing of reaction time and increasing cerebrospinal fluid concentrations of quinolinic acid in HIV-infected

individuals. Journal of Neuropsychiatry and Clinical Neurosciences, 1992:4;270-279.

Martin EM, Sorensen DJ, Edelstein HE, Robertson LC. Decision-making speed in HIV-1 infection: a preliminary report. AIDS, 1992;6:109-113.

Martin EM, Sorensen DJ, Robertson LC, Edelstein HE, Chirurgi VA. Spatial attention in HIV-1 infection: a preliminary report. Journal of Neuropsychiatry and Clinical Neurosciences, 1992;4:288-293.

Martin EM, Robertson LC, Sorensen DJ, Jagust WJ, Mallon KF, Chirurgi VA. Speed of memory scanning is not affected in early HIV-1 infection. Journal of Clinical and Experimental Neuropsychology, 1993;15:311-320.

Mateos JLA. Actas Luso-Espanolas de Neurologia Psiquiatria y Ciencias Afines, 1997;25:45.

Miller EN. California Computerized Assessment Battery (CalCAP) Manual. Los Angeles: Norland Software, 1990.

Miller EN. Cognitive testing using reaction time and traditional neuropsychological procedures. Journal of the International Neuropsychological Society. 1995;1:393.

Miller EN. Use of computerized reaction time in the assessment of dementia [abstract]. Neurology, 1992;42(suppl 3):220.

Miller EN, Bing EG, Selnes OA, Wesch J, Becker JT. The effects of sociodemographic factors on reaction time and speed of information processing. Journal of Clinical and Experimental Neuropsychology, 1993;15:66.

Miller EN, Satz P, Van Gorp W, Visscher B, Dudley J. Computerized screening for HIV-related cognitive decline in gay men: Cross-sectional analyses and one-year follow-up. (Abstract). Proceedings of the V International Conference on AIDS (Montreal, Canada), 1989; 465.

Miller EN, Satz P, Van Gorp W, Visscher B, Dudley J. Computerized screening for HIV-related cognitive decline in gay men. (Abstract). Proceedings of the IV International Conference on AIDS (Stockholm, Sweden), 1988;1:378.

Miller EN, Satz P, Visscher B. Neuropsychological tests in HIV: Reply from the authors [letter]. Neurology, 1992;42:2056.

Miller EN, Satz P, Visscher B. Computerized and conventional neuropsychological assessment of HIV-1 infected homosexual men. Neurology, 1991;41:1608-1616.

Miller EN, Satz P, Visscher B. Computerized neuropsychological assessment for HIV-related encephalopathy. Symposium on Novel and Traditional Approaches for Early Detection of HIV-1 Related Dementia (Vancouver, Canada). Journal of Clinical and Experimental Neuropsychology, 1989;11:34-35.

Miller EN, Wilkie FL. Computerized testing to assess cognition in HIV-positive individuals. In: Grant I, Martin A, eds. Neuropsychology of HIV Infection: Current Research and New Directions. New York: Oxford; 1994;161-175.

Mowbray GH, Rhoades MV. On the reduction of choice reaction times with practice. Quarterly Journal of Experimental Psychology, 1959:11;16-23.

Norrie ML. Practice effects on reaction latency for simple and complex movements. Research Quarterly: The American Association for Health and Physical Education, 1967:38;79-85.

Perdices M, Cooper DA. Simple and choice reaction time in patients with human immunodeficiency virus infection. Ann Neurol 1989;25:460-467.

Posner MI. Chronometric explorations of mind. Erlbaum: Hillsdale, NJ, 1978.

Posner MI, Mitchell RF. Chronometric analysis of classification. Psychological Review, 1967:74;392-409.

Posner MI, Cohen Y, Rafal RD. Neural systems control of spatial orienting. Phil Trans R Soc Lond 1982;298:187-198.

Richardson MA, Satz P, Myers HF, Miller EN, Bing EG, Fawzy FI, Maj M. Effects of depressed mood versus clinical depression on neuropsychological test performance among African American men impacted by HIV/AIDS. Submitted for publication.

Selnes OA, Miller EN. Development of a screening battery for HIV-related cognitive impairment: the MACS experience. In: Grant I, Martin A, eds. Neuropsychology of HIV Infection: Current Research and New Directions. New York: Oxford University Press; 1994:176-187.

Sternberg S. High speed scanning in human memory. Science 1966;153:652-654.

Sternberg S. Memory scanning: new findings and current controversies. Q J Exp Psychol 1975;27:1-32.

van Gorp WG, Miller EN, Marcotte TD, Dixon W, Paz D, Selnes O, Wesch J, Becker JT, Hinkin CH, Mitrushina M, Satz P, Weisman JD, Buckingham SL, Stenquist PK. The relationship between age and cognitive impairment in HIV-1 infection: findings from the Multicenter AIDS Cohort Study and a clinical cohort. Neurology. 1994;44:929-935.

Vernon PA. New developments in reaction time research. In P.A. Vernon, (Ed.) Speed of Information Processing and Intelligence. Ablex Publishing, Norwood, NJ, 1987, 1-20.

Waterloo K, Ingebrigtsen T, Romner B. Neuropsychological function in patients with increased serum levels of protein S-100 after minor head injury. Acta Neurochirurgica, 1997:139;26-32.

Welford AT. Reaction times. Academic Press: New York, 1980.

Welford AT. Note on the effects of practice on reaction times. Journal of Motor Behavior, 1986:18;343-345.

Wilkie FL, Eisdorfer C, Morgan R, Loewenstein DA, Szapocznik J. Cognition in early human immunodeficiency virus infection. Arch Neurol 1990;47:433-440.

Wilkinson RT, Allison S. Age and simple reaction time: decade differences for 5,325 subjects. Journal of Gerontology, 1989:44;29-36.

Worth JL, Savage CR, and Navia BA. Computer-based screening test for AIDS dementia complex. Presented at the Annual Meeting of the American Psychiatric Association, Washington, DC, 1992.

Worth JL, Savage CR, and Navia BA. Computer-based measures of neuropsychological deficits in patients with HIV-1 cognitive/motor complex. Int Conf AIDS, 1992;8.

Worth JL, Savage CR, Baer L, Esty EK, and Navia BA. Computer-based neuropsychological screening for AIDS dementia complex. AIDS, 1993;7:677-681.

Computerized and Conventional Neuropsychological Assessment of HIV-1-infected Homosexual Men

Eric N. Miller, PhD; Paul Satz, PhD; and Barbara Visscher, MD, DrPH

Department of Psychiatry and Biobehavioral Sciences and School of Public Health,
University of California, Los Angeles

Neurology, 1991, Vol. 41, pp. 1608-1616

Article Abstract

We administered a battery of computerized and conventional neuropsychological measures to a group of 507 HIV-1 seronegative, 439 asymptomatic HIV-1 seropositive (Centers for Disease Control [CDC] groups 2 and 3), and 47 symptomatic HIV-1 seropositive (CDC group 4) homosexual/bisexual men enrolled in the Los Angeles center of the Multicenter AIDS Cohort Study. Tasks included multiple measures of attention, reaction time, memory, and psychomotor speed.

Comparison of group means revealed significant differences in performance between HIV-1 seronegative and symptomatic HIV-1 seropositive men on computerized measures of choice reaction time and on conventional measures of memory and motor speed. These findings are consistent with previous research in this area and support the sensitivity of both computerized and conventional neuropsychological instruments for detecting cognitive changes found in symptomatic HIV-1-infected individuals. Asymptomatic seropositive men, on the other hand, did not differ significantly from seronegative subjects on any of the computerized or conventional neuropsychological measures.

Only 13% of the asymptomatic HIV-1 seropositive men showed abnormal performance on a composite measure of cognitive functioning from the computerized test battery. This proportion did not differ significantly from that of seronegative controls (14%), but was significantly lower than the percentage of abnormal findings observed among symptomatic HIV-1 seropositive subjects (28%).

Results from this study support the hypothesis that the frequency of neuropsychological abnormalities in asymptomatic HIV-1-infected homosexual men is low and not statistically different from that of seronegative controls.

For more information, consult the full article in *Neurology*, 1991;41:1608-1616.

Computer-based neuropsychological screening for AIDS dementia complex

Jonathan L. Worth, Cary R. Savage, Lee Baer, Elizabeth K. Esty and Bradford A. Navia

Departments of Psychiatry and Neurology, Massachusetts General Hospital and the Departments of Psychiatry and Neurology, Harvard Medical School

AIDS, 1993, Vol. 7, pp. 677-681

Article Abstract

Objective: To test the efficacy of reaction time (RT) measures as a screening test for AIDS dementia complex (ADC).

Design and methods: Forty-two patients with mild-to-moderate ADC and 33 healthy HIV-1-seronegative control subjects took a computer-administered battery of four RT measures: simple RT, choice RT, and two types of sequential RT (1 and 2).

Results: The performance of the ADC group was significantly worse than that of the control group on all four RT measures, but not all tasks were equally sensitive. The two tests of sequential RT were found to be the best discriminators, and receiver operating characteristic curve analyses indicated that the optimal cut-off z score was 1.0 for both tests.

Conclusions: These preliminary results suggest that computer-based RT, using these two measures of sequential RT, may provide a sensitive method of detecting HIV-1-associated cognitive deficits.

For more information, consult the full article in *AIDS*, 1993;7:677-681.

COMPUTERIZED SCREENING FOR HIV-RELATED COGNITIVE DECLINE IN GAY MEN: CROSS-SECTIONAL ANALYSES AND ONE-YEAR FOLLOW-UP

Eric N. Miller*, Paul Satz*, Wilfred Van Gorp*, Barbara Visscher**, Jan Dudley**
*UCLA Neuropsychiatric Institute, **UCLA School of Public Health, Los Angeles, California
International Conference on AIDS, 1989, Vol. 5, p. 465

Objectives. To standardize and validate a computerized neuropsychological (NP) screening battery for early identification of cognitive decline in HIV-infected individuals.

Methods. A cohort of 537 HIV-1 seronegative (SN), 433 asymptomatic seropositive (ASP), and 92 symptomatic seropositive (SSP; ARC or AIDS) native English-speaking gay men (the Los Angeles cohort of the Multicenter AIDS Cohort Study) with no history of learning disability were administered a computerized NP screening battery together with a traditional NP screening battery. Of this cohort, 698 were seen for one follow-up visit, and 327 were seen for a second follow-up visit. Both the computerized and traditional batteries were designed to tap cognitive domains representative of NP deficits found in HIV-related encephalopathy, including motor speed, verbal memory, rapid visual scanning of verbal and nonverbal materials, and divided attentional skills. Subjects were designated as 'outliers' on traditional and computerized measures if they scored two or more SDs below the mean for SN's on 2 or more measures.

NP Screening Battery	Computerized Screening Battery
1. Trail-Making, Parts A & B	1. Simple Reaction Time
2. Grooved Pegboard Test	2. Choice Reaction Time/Sequential Reaction Time
3. Rey Auditory Verbal Learning Test	3. Lexical Discrimination
4. WAIS-R Digit Span	4. Visual Selective Attention
5. Symbol Digit Test	5. Response Reversal and Rapid Visual Scanning
6. Verbal Fluency	6. Form Discrimination

Results. There was considerable agreement between the computerized and traditional screening measures, with the two sets of measure agreeing on outlier status from 84-87% of the time across the three visits. A factor analysis of the measures (shown below using the SN control group, n = 509) showed independent clustering of the computerized and traditional measures. This factor structure was replicate using the asymptomatic SP group (n = 436).

FACTOR ANALYSIS (PRINCIPAL COMPONENTS, VARIMAX ROTATION)

CRT Choice RT	.80*				
CRT Sequential RT	.67				
CRT Lexical Discrim	.78				
CRT Select Attention	.70				
CRT Visual Scanning	.73				
CRT Form Discrim	.54				
RAVLT Trial 5		.81			
RAVLT Trial 7		.90			
RAVLT Trial 8		.90			
RAVLT Recognition		.68			
Trails A			-.59		
Trails B			-.62		
Symbol Digit			.48		
DigSpan Forward			.75		
DigSpan Backward			.75		
Verbal Fluency			.52		
CRT Simple 2				.68	
CRT Simple 6				.79	
CRT Simple 10				.78	
Grooved Pegboard, Dominant					.89
Grooved Pegboard, Nondom					.86

Both the computerized and traditional screening measures identified approximately the same numbers of SN and SP men as being outlier at each visit. The percentages of outliers for each measure are shown on the next page. As can be seen from this table, discrimination o SN and SP groups is significantly improved when results from both the computerized and traditional screening measures are taken into consideration.

Cross-Sectional Analyses	Seronegative	Asymptomatic Seropositive	Symptomatic Seropositive	Chi-Square Significance
Baseline (Visit 1)	(n = 537)	(n = 433)	(n = 92)	
Neuropsychology (NP)	7% outliers	9%	15%	.0251
Computer (RT)	7%	11%	12%	ns
Neuropsych or Computer	13%	18%	23%	.0163
Six-Month Follow-up (Visit 2)	(n = 355)	(n = 289)	(n = 54)	
Neuropsychology (NP)	8%	13%	13%	ns
Computer (RT)	7%	10%	9%	ns
Neuropsych or Computer	13%	20%	19%	.0366
One-Year Follow-up (Visit 3)	(n = 171)	(n = 128)	(n = 28)	
Neuropsychology (NP)	8%	12%	18%	ns
Computer (RT)	5%	13%	14%	.0367
Neuropsych or Computer	12%	23%	32%	.0056

Attrition at six-month and one-year follow-ups was greater for subjects identified as outliers at Visit 1 than for subjects identified as normal at Visit 1 (subject loss at Visit 2 = 45% of outliers vs. 34% of normals; Visit 3 = 75% of outliers vs. 60% of normals). Selective attrition may have resulted in some underestimation of the sensitivity of these screening measures. Also, some improvement in the symptomatic group may have been related to the availability of AZT beginning at Visit 2.

In addition to these cross-sectional analyses, we computed the numbers of individuals who had shown significant decline from Visit 1 t Visit 2 and from Visit 1 to Visit 3 on the computerized and traditional screening measures. 'Decline' was operationally defined as a drop o 1 SD or greater on 3 or more measures.

Longitudinal Analyses	Seronegative	Asymptomatic Seropositive	Symptomatic Seropositive	Chi-Square Significance
Six-Month Follow-Up	(n = 355)	(n = 289)	(n = 54)	
Neuropsychology Screen	11% declined	15%	13%	ns
Computer Screen	10%	18%	24%	.0039
Neuropsych or Computer	20%	30%	32%	.0103
One-Year Follow-Up	(n = 171)	(n = 128)	(n = 28)	
Neuropsychology Screen	14% declined	14%	20%	ns
Computer Screen	16%	15%	24%	ns
Neuropsych or Computer	29%	26%	33%	ns

A significantly higher proportion of asymptomatic SP subjects showed decline on the computerized measures from Visit 1 to Visit 2 than did SN subjects (Chi-Square = 6.45, $p < .02$), although this finding was not replicated at one-year follow-up. Similarly, the symptomatic SP subjects showed greater decline on the computerized measures from Visit 1 to Visit 2 than did the SN subjects (Chi-Square = 6.92, $p <$ .01), although again this finding was not replicated at one-year follow-up. No such finding was obtained for the traditional neuropsycho logical screening battery either at six-month or one-year follow-up. The percentage of subjects showing a similar level of *improvement* ranged from 4-7% at six-month follow-up and from 5-15% at one-year follow-up for both the computerized and traditional measures across subject groups. There were no significant differences among the subject groups in level of improvement.

Conclusions. These findings suggest that computerized techniques may prove practical as a rapid, efficient and inexpensive screening for detecting early cognitive decline in HIV-infected individuals, although these measures work best in conjunction with traditional neuropsychological measures. When used longitudinally, this type of measure appears to have slightly greater sensitivity for identifyir individuals at risk for HIV-encephalopathy than do traditional neuropsychological screening procedures.

Use of Computerized Reaction Time in the Assessment of Dementia

Eric N. Miller
UCLA Neuropsychiatric Institute; Los Angeles, California
Neurology, 1992, Vol. 42, p. 220

Objectives: It is well-established that HIV-1-Associated Cognitive/Motor Complex is characterized by motor slowing similar to that seen in subcortical dementias. The current study was designed to evaluate the effectiveness of computerized reaction time (RT) and conventional neuropsychological procedures for assessment of cognitive changes secondary to HIV infection. Reaction time procedures should prove especially sensitive for detecting this kind of motor slowing.

Methods: *Subjects.* Subjects were drawn from the Los Angeles cohort of the Multicenter AIDS Cohort Study, a longitudinal epidemiological study of the natural history of AIDS. This cohort is a relatively homogenous sample of young, well-educated, gay and bisexual men who have been studied at semi-annual intervals since 1984. We selected only those subjects who met diagnostic criteria for HIV-1-Associated Cognitive/Motor Disorder as defined by the American Academy of Neurology AIDS Task Force (1991). Nine subjects received a diagnosis of HIV-1-Associated Dementia Complex, and 32 subjects received a diagnosis of HIV-1-Associated Minor Cognitive Motor Disorder using diagnostic criteria defined by the American Academy of Neurology AIDS Task Force (1991). All subjects had been tested repeatedly at semi-annual intervals using both reaction time measures and conventional neuropsychological tests.

Materials. Reaction time was assessed using the California Computerized Assessment Package (CALCAP; Miller, 1991) which includes 4 measures of simple reaction time and six measures of choice reaction time. Conventional neuropsychological procedures include the Trail-Making Test, Symbol Digit Modalities Test, and the Grooved Pegboard Test.

Data Analyses. Changes in performance across time were evaluated by computing difference scores between mean test performance before and after diagnosis of HIV-1-Associated Cognitive/Motor Complex.

Results: *HIV-1-Associated Minor Cognitive/Motor Disorder.* Decline in reaction time was observed on all 10 of the simple and choice reaction time measures following diagnosis of HIV-1-Associated Minor Cognitive/Motor Disorder. Mean levels of decline range from 0.1 SD for simple reaction time to 1 SD for choice reaction time. Nineteen out of 32 subjects (59%) declined 1 SD or greater on one or more reaction time tests. Sixteen subjects (50%) showed a comparable decline on a composite measure of the Trail-Making, Symbol Digit and Grooved Pegboard tests.

HIV-1-Associated Dementia Complex. Decline in reaction time was observed on seven out of 10 simple and choice reaction time measures. Mean level of decline ranged from ½ to 1 SD. Seven out of nine subjects (78%) declined 1 SD or greater on one or more reaction time tests. Only five subjects (56%) showed a comparable decline on a composite measure consisting of the Trail-Making, Symbol Digit and Grooved Pegboard tests.

Conclusions: The magnitude of change seen on reaction time testing was comparable to, or greater than, changes observed using conventional neuropsychological procedures. These data demonstrate the sensitivity of reaction time measures for detecting changes in motor functioning, and support the use of reaction time procedures for assessment and monitoring of symptoms of dementia and other cognitive slowing.

Presented at the Annual Meeting of the American Academy of Neurology, San Diego, California, May 5, 1992.

For more information about this study or the CALCAP Reaction Time procedures, contact: Eric N. Miller, Ph.D.; UCLA Neuropsychiatric Institute; 760 Westwood Plaza, Room C8-747; Los Angeles, CA 90024; (310) 825-2070

The Effects of Sociodemographic Factors on Reaction Time and Speed of Information Processing

Eric N. Miller, Eric G. Bing, Ola A. Selnes, Jerry Wesch, & James T. Becker
UCLA NPI, Johns Hopkins Hospitals, Howard Brown Memorial Clinic, University of Pittsburgh
Journal of Clinical and Experimental Neuropsychology, 1993, Vol. 15, p. 66

Performance on conventional neuropsychological testing is known to vary as a function of age and years of formal education, particularly among older and less well-educated individuals. We recently reported that, in addition to the effects of age and education, there may be an interaction between ethnicity and years of education on conventional neuropsychological testing procedures (Bing et al., 1991).

These kinds of studies highlight the need to develop age- and education-appropriate normative data, and to develop separate norms for different sociocultural groups, at least when utilizing traditional neuropsychological measures. The effects of these sociodemographic variables on more novel measures of reaction time and speed of information processing, however, are less well understood.

We report here the effects of age, education, and ethnicity on multiple measures of simple and choice reaction time. These effects are evaluated within a relatively homogeneous sample of young, well-educated men enrolled in the Multicenter AIDS Cohort Study (MACS).

METHODS

Subjects: The study cohort included 1526 native English-speaking men from the MACS evenly divided between medically asymptomatic HIV-1 seropositive subjects and HIV-1 seronegative control subjects. We have previously reported that there are no differences between seronegative and medically asymptomatic seropositive subjects in this cohort, both for conventional neuropsychological exams (Miller et al., 1990; Selnes et al., 1990) and for computerized reaction time measures (Miller, Satz & Visscher, 1991; Miller et al., 1990).

Of this cohort, 1400 were Caucasian, 58 Hispanic (with English as their first language), and 68 African American. Subjects ranged in age from 22 to 76 (mean age = 38, SD = 7.4). Mean educational level was 16 years (SD = 2.3; range = 9 to 21 years).

Procedures: Subjects in this cohort were administered a 10-minute computerized reaction time task. This task consisted of a simple reaction time procedure and two choice reaction time procedures using a basic Go-No Go paradigm designed to assess different two types of decision-making: basic pattern matching (match the number '7') and serial pattern matching (match 2 numbers in sequence).

RESULTS

Subjects were compared on the measures of simple and choice reaction time using multiple regression with all major sociodemographic factors entered simultaneously. Age and education were treated as continuous variables; ethnicity was treated as a categorical variable using dummy coding. Alpha was set at .05 for all analyses. The multiple regression analyses showed significant main effects for age on simple reaction time and basic pattern matching. There were significant main effects for years of education on simple reaction time only.

A breakdown of reaction time scores by age is shown in Table 1 (statistical tests were performed using age as a continuous variable—strata of age shown on the next page are for illustrative purposes only). This table illustrates a strong linear trend toward motor slowing with advancing age, even for individuals in their 30s and 40s.

Among the different ethnic groups, Hispanic Americans differed significantly from the other subjects on simple reaction time and basic pattern matching. The African American subjects differed significantly from the other subjects on simple reaction time only. There were no differences among the ethnic groups on serial pattern matching, nor were there significant effects of age or education for this measure. A breakdown of reaction time performance by ethnic group is shown in Table 2.

Table 1	Ages 20-29 Mean	(SD)	Ages 30-39 Mean	(SD)	Ages 40-49 Mean	(SD)	Ages 50+ Mean	(SD)
N	140		781		487		118	
Years of Education	15	(2.2)	16	(2.2)	16	(2.4)	17	(2.7)
Simple Reaction Time (in msecs)	348	(102)	352	(98)	363	(121)	375	(108)
Choice Reaction Time (in msecs)								
Basic Pattern Matching	395	(37)	401	(45)	403	(45)	407	(41)
Serial Pattern Matching	536	(87)	536	(98)	536	(97)	527	(100)

Table 2	Caucasian Mean	(SD)	Hispanic Mean	(SD)	Af. American Mean	(SD)
N	1400		58		68	
Age (in years)	38	(7.3)	36	(6.6)	40	(10.1)
Years of Education	16	(2.3)	15	(2.3)	15	(2.4)
Simple Reaction Time (in msecs)	354	(100)	389	(130)	395	(189)
Choice Reaction Time (in msecs)						
Simple Pattern Matching	401	(43)	413	(54)	396	(44)
Serial Pattern Matching	535	(96)	534	(101)	545	(119)

DISCUSSION

Our data suggest that investigators must consider the effects of age and years of education on reaction time measures, particularly for simple reaction time measures. These results also suggest that there are ethnic differences in how subjects respond to the task demands of reaction time procedures. For example, both African Americans and Hispanic Americans were, as a group, less likely to respond rapidly to a simple reaction time paradigm, even though they performed as well as other subjects on the more demanding choice reaction time paradigm of serial pattern matching. The choice reaction time measures present stimuli at a rapid pace determined by the type of task and controlled by the computer. The simple reaction time procedures, on the other hand, are self-paced and require only that the subject respond "as quickly as possible" after seeing a stimulus appear on the screen.

We have found in our longitudinal studies that, while choice reaction time remains quite stable across time, there is a slight slowing in simple reaction time as subjects become more familiar with the task. Thus, the simple reaction time procedures, unlike the choice reaction time tasks, are more susceptible to motivational factors and differing interpretations of "as quickly as possible."

For clinical and research purposes, these results indicate that normative data for reaction time measures, as with conventional neuropsychological procedures, need to be generated independently for different ethnic groups as well as for different levels of age and education.

For additional information, contact: Eric N. Miller, Ph.D., UCLA Neuropsychiatric Institute, 760 Westwood Plaza, Room C8-747; Los Angeles, CA 90024; (310) 825-2070.

Presented at the 1993 Annual Meeting of the International Neuropsychological Society in Galveston, Texas.

Cognitive Testing Using Reaction Time and Traditional Neuropsychological Procedures

Eric N. Miller
UCLA Neuropsychiatric Institute
Journal of the International Neuropsychological Society, 1995; Volume 1, p. 393

Overview: Reaction time (RT) measures often are viewed as more sensitive than traditional neuropsychological tests for studying the subtle kinds of cognitive changes that may occur in the early stages of many kinds of brain disease. We have studied the relative usefulness of two neuropsychological screening batteries — one consisting of traditional neuropsychological procedures and one consisting of multiple measures of simple and choice RT.

Methods: Subjects were 1034 native English-speaking men evenly divided between medically asymptomatic HIV-1 seropositive subjects and HIV-1 seronegative controls. All subjects were drawn from the Los Angeles cohort of the Multicenter AIDS Cohort Study, a longitudinal epidemiological study of the natural history of HIV infection. This cohort is a relatively homogenous sample of well-educated, gay and bisexual men who have been tested at semi-annual intervals using both RT tasks and traditional neuropsychological tests. RT was assessed using the California Computerized Assessment Package (CALCAP; Miller, 1991) which includes 4 measures of simple RT and six measures of choice RT (Go-No Go; Lexical Discrimination; Sequential Memory; Visual Distraction; Response Reversal; Form Discrimination). Traditional neuropsychological procedures included the Trail-Making Test, Rey Auditory Verbal Learning Test, Symbol Digit Modalities Test, Digit Span, Verbal Fluency, and the Grooved Pegboard Test. The RT procedures were evaluated for internal consistency reliability, test-retest reliability, and concurrent validity. The relationship between the traditional and computerized procedures was evaluated using factor analysis.

Results: The simple RT measures showed high internal consistency reliability (coefficient alpha = .77-.95), but low 6-month test-retest reliability (.20-.29), suggesting that the psychomotor skills measured by this task are assessed in a uniform manner across the multiple trials of each individual task, but that these skills vary considerably depending on state variables such as mood, attention, fatigue, etc. By contrast, the choice RT measures showed excellent internal consistency reliability (.81-.96) and 6-month test-retest reliability (.43-.68) that was comparable to that seen using the traditional neuropsychological measures (.47-.77).

A factor analysis of the RT and traditional NP tasks was performed and showed that the tasks measure 3 primary factors from the traditional neuropsychological testing (brief memory and attention; manual dexterity and motor speed; verbal learning and memory) and 2 factors from the RT testing (separate factors for simple and choice RT). These findings suggest that the RT tasks measure skills that are different from those assessed using traditional neuropsychological procedures. Despite this finding, the RT tasks and the traditional procedures showed considerable overlap in classification of outlier status. Subjects were designated as 'outliers' if they scored 2 SDs below the mean on two or more measures, or if they scored 3 SDs below the mean on any one measure. Using these criteria, the RT and the traditional measures agreed on outlier status 85% of the time. 51% of individuals identified as outliers on the RT tasks and 50% of individuals identified as outliers on the traditional neuropsychological tests were identified as having abnormal clinical neuropsychological or neurological exams on follow-up.

There were 41 individuals with multiple neuropsychological testing who developed HIV-associated Cognitive Motor Disorder. For these individuals, the magnitude of change seen on RT testing was comparable to, or greater than, changes observed using traditional neuropsychological procedures.

Conclusions: These findings show that simple and choice RT tasks measure at least two domains of cognitive functioning that are relatively independent of the psychomotor skills assessed by traditional neuropsychological tests. When properly developed and administered, RT tasks have psychometric properties that are comparable to those found in traditional neuropsychological procedures. RT measures are best seen as complementing, rather than replacing, traditional neuropsychological procedures.

The Use of Computer-Based Measures of Complex Reaction Time in Depressed HIV-1 Infected Patients

M Halman, NM Hamburg; CR Savage, JL Worth
Massachusetts General Hospital
Psychosomatics, 1995; Volume 36, page 175

Objective: Computer-based measures of reaction time provide a sensitive screening method for HIV-1-associated cognitive deficits. As major depression is frequent in the course of HIV disease and also thought to confound certain cognitive measures, we sought to evaluate the change in performance on a cognitive screening test in HIV-1 infected patients treated for major depression.

Method: All patients completed a Beck Depression Inventory (BDI), a computer-based measure of sequential reaction time (SQRT2) and a semi-structured psychiatric examination, and met DSM-III-R criteria for major depressive episode. Patients were treated and reevaluated at six month follow-up with a repeat BDI and SQRT2. At follow-up, patients were classified into two groups based on treatment response: 1) responders as defined by BDI < 14 or decreased by 50%; and 2) non-responders. The two groups were matched on age, education, CD4+ lymphocyte count and initial BDI score.

Results: Twenty-one depressed HIV-1 infected patients were examined. Ten were classified as responders and eleven as non-responders. On initial SQRT2, non-responders showed a trend toward slower performance (SD), 706.00 (70.96) vs. 638.80 (92.22) msec (t=1.882, df=19, p=.075), as compared to responders. Responders showed no significant change on their follow-up SQRT2 time (+7.300 msec); (p=.83), whereas non-responders showed a significant slowing in performance (-50.727 msec); (t=-2.514, df=10, p=.03). Pearson correlations between BDI and SQRT2 at both initial and follow-up times showed no significant correlations for both groups.

Conclusions: Although clinical lore suggests that major depression should be treated before performing cognitive testing on an HIV-1 infected patient, this study's findings suggest that successful treatment of major depression does not result in significant changes in cognitive performance on a complex reaction time measure known to be sensitive to HIV-1-associated cognitive deficits. Impairment on SQRT2 may also predict poor outcome in depressed patients, possibly by identifying the presence of significant cognitive deficits at the initial evaluation.

For more information, contact: Mark H. Halman, MD, FRCP(C); Massachusetts General Hospital - ACC 812; Boston, MA 02114.

Cognitive Performance during Long-Term Respirator Wear While at Rest

Caretti DM
American Industrial Hygiene Association Journal, 1997:58:105-109

Article Abstract

Cognitive performance was studied in six male and three female subjects exposed to two randomly administered 10-hour measurement periods, a control condition without a respirator, and a respirator wear trial requiring continuous wear, under nonexercise conditions. Reaction time and decision-making speed were assessed using a series of simple and choice reaction time tasks at the start of each test iteration and after hours 2, 4, 6, 8 and 10 of testing. Subject anxiety levels were assessed along with reaction time measures. Visual tracking ability was measured after each hour of testing. Reaction time and decision-making speed did not differ significantly between control and respirator conditions at any time throughout the 10 hours of testing. Female volunteers exhibited significantly faster reaction times and decision-making speeds than males independent of respirator wear conditions and time of measurement. Subject anxiety increased significantly from initial measurements after 8 hours of testing for each condition, but no differences were observed between conditions at any time. Respirator wear did not detrimentally influence visual tracking ability. These findings suggest that respirator wear over a relatively long time period under nonexercise conditions should not significantly inhibit cognitive function.

Neuropsychological Function in Patients with Increased Serum Levels of Protein S-100 After Minor Head Injury

K Waterloo, T Ingebrigtsen, B Romner
Acta Neurochirurgica, 1997; Volume 139: 26-32

Article Abstract

Protein S-100 is a calcium binding protein, synthesized in astroglial cells in all parts of the central nervous system (CNS). We have previously reported high serum levels of protein S-100 in patients after minor head injury (MHI). A battery of conventional and computerized neuropsychological measures was administered to two groups of MHI patients. Neuropsychological outcome at 12 months postinjury was examined in a group of 7 patients with increased serum levels of protein S-100 after MHI and 7 age- and sex-matched controls without detectable S-100 in serum after MHI. Our results demonstrate no overall cognitive dysfunction in either of the two groups. Our findings indicate specific dysfunction on measures of reaction time, attention and speed of information processing for the S-100 group. Posttraumatic depression does not explain the neuropsychological differences between the groups. These findings support that increased serum levels of protein S-100 may be of predictive and prognostic value for longlasting neurocognitive abnormalities after minor head injury. Presence of S-100 in serum may indicate the presence of diffuse brain damage. Our results suggest that information processing measures in computerized neuropsychological assessment are more sensitive for detecting small signs of neurocognitive abnormalities after MHI than conventional test batteries.

Neuropsychological Performance and HIV-1 in Ethnic Minority Samples of Women and Men: Serostatus Effects, Comparative Data and Methodological Considerations

Durvasula, R.S., Miller, E.N., Myers, H.M, Satz, P., & Wyatt, G.

Background and Rationale: As rates of HIV and AIDS continue to rise among women and ethnic minority group members, larger scale cross-sectional and longitudinal studies of neuropsychological (NP) performance among HIV-positive individuals from these understudied groups are needed. To date, much of the work assessing NP function in these groups has focused largely on cohorts of injection drug users (IDUs), a subgroup of individuals not representative of the majority of HIV infected men and women from ethnic minority groups.

Samples: The present data are derived from two separate studies on the psychosocial, medical, and NP sequelae of HIV infection: (a) the UCLA/Drew Women and Family Project, a longitudinal study of a multiethnic sample of 400 women and (b) the African American Health Project, a cross-sectional study of 502 African American men. Both studies were conducted in Los Angeles County, and the samples are comprised of HIV + and HIV - individuals at varying stages of infection, with a range of substance abuse histories.

Results: Preliminary analysis of baseline data from the women's samples (N=190) reveal a trend toward slower motor speed among HIV positive women as assessed by both the Grooved Pegboard ($F(2,163) = 2.7$; $p < .07$) and the Finger Tapping Test ($F(2,111) = 5.2$ $p < .007$), controlling for age, education, and recent drug exposure. In contrast, analysis of performance by a subsample of HIV + and HIV - African American men from the AAHP (N=237) on the Grooved Pegboard revealed no differences as a function of HIV serostatus. While women did not evidence any HIV serostatus differences on measures of reaction time (as assessed by the California Computerized Assessment Package (CalCAP), multivariate analysis revealed HIV serostatus effects for men on this test, with symptomatic seropositive men evidencing significantly poorer performance than asymptomatic seropositive men ($\underline{F}(2,214) = 2.26$, $\underline{p} < .04$), with significant univariate effects for Sequential Reaction Time I ($\underline{F}(2,214) = 4.63$, $\underline{p} < .01$) and Sequential Reaction Time II ($\underline{F}(2,214) = 5.48$, $\underline{p} < .005$). Both women and men were administered the WHO-Auditory Verbal Learning Test, a supraspan list learning test similar to the RAVLT and CVLT, and neither group evidenced differences as a function of HIV serostatus on this test. These findings are consistent with the primary deficit in psychomotor functioning captured by studies conducted with both IDUs and cohorts of White men, but, as has been seen in other studies, the specific measures that are most sensitive vary across different study samples, gender, and ethnic groups.

Conclusions: While both men and women evidence differences as a function of serostatus, the domains in which differences are observed vary across these two samples. While differences in education or other demographics may partially account for the dissociation between the men's and women's samples, other issues, including the differential contribution of substance use will be addressed. These discrepant findings highlight the importance of circumspection when generating conclusions from studies examining multiethnic samples or any other groups for whom appropriate culture fair tests or normative data are not available. Comprehensive characterization of samples, as well as careful assessment and quantification of psychosocial and demographic data are essential for accurate interpretation of findings obtained from any studies of the NP sequelae of HIV in understudied groups. Implementation of these issues into study design and execution will be discussed with a focus on methods of assessing sociodemographic factors, selection of culture-fair tests and recruitment and retention of ethnic minority samples, particularly women.

Presented at the Annual Meeting of the International Neuropsychological Society, Honolulu, Feb, 1998