

# 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

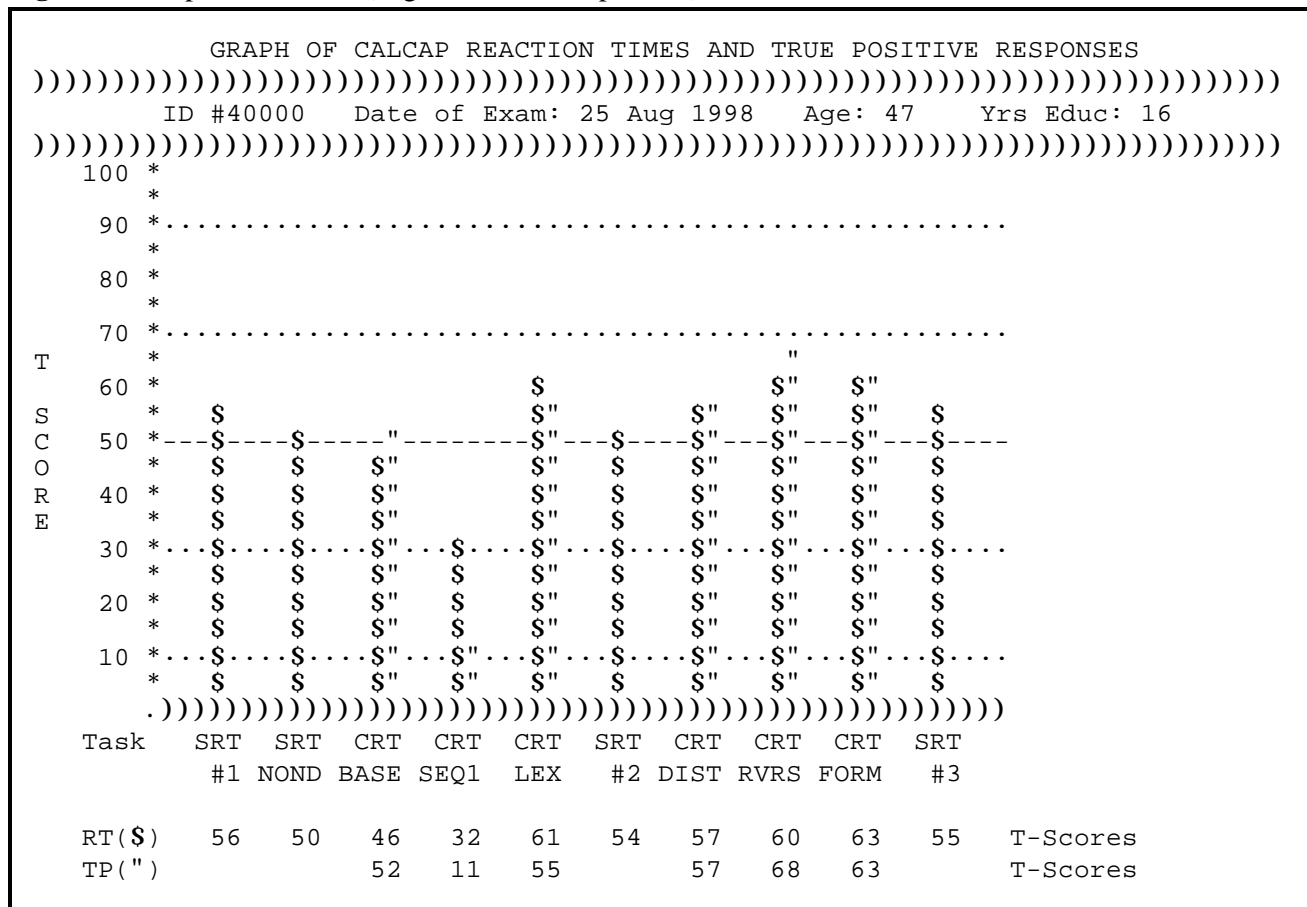
Reaction time correlates most highly with age, and, to a lesser extent, with years of education. A study of the effects of age, education and ethnicity is reprinted in Appendix F. Two small studies of gender effects on CalCAP reaction time have shown no differences between men and women on any of the 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 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 4.** Difference Scores (Page 4 of standard printout).

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

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                                CALCAP REACTION TIMES
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ID #40000    Date of Exam: 25 Aug 1998    Age: 47    Yrs Educ: 16
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                                Mean Reaction Time (RT)
##  Description                                Range            Median           RT            z-score        %ile
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  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

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**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 visuo-perceptual skills.