Enhanced CALCAP Reports
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 can be sent to your printer and disk (press 'P') or to disk only (press 'D'). Additional information about test interpretation is included when you send the results to the printer. A sample printout is shown in Appendix B.

A disk image of the printed output is created whenever you send information to the printer (by pressing 'P') as well as when you explicitly request disk output by pressing 'D'. The disk images consist of two ASCII files, one named REVIEW.TXT (suitable for any generic word processor) and one named REVIEW.PRN (suitable for word processors that can read the PC-8 ASCII character set, such as WordPerfect). If you connect your computer to a printer at some later time, you can still print the most recent test results by typing 'PRINTIT' at the DOS command prompt in the CALCAP subdirectory.

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)

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

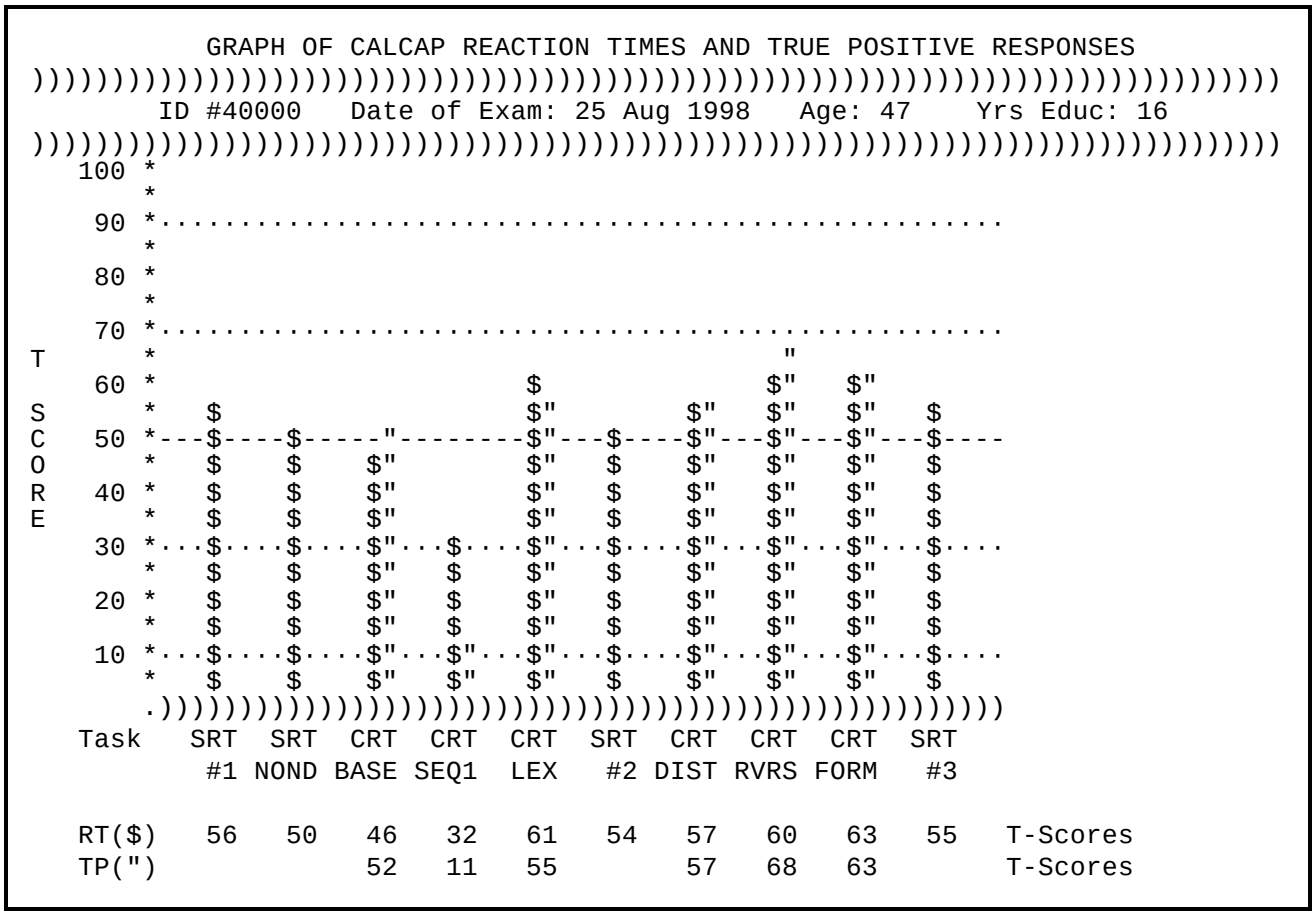
Accuracy: Indicates whether True Positive and/or False Positive indices of response accuracy all outside of normal limits. For a more detailed breakdown of raw scores, *z*-scores and percentile ranks for these indices, see Page 4 of the printouts (Figure 4 in this Interpretation Guide).

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).

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                          CALCAP DIFFERENCE SCORES
))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))
        ID #40000   Date of Exam: 25 Aug 1998   Age: 47    Yrs Educ: 16
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                                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
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                                    Notes
  Normative data are not available for Difference Scores.
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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).

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                          CALCAP ACCURACY INDICES
                       (not computed for Simple RT tasks)
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        ID #40000   Date of Exam: 25 Aug 1998   Age: 47    Yrs Educ: 16
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                                        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
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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).

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                              CALCAP REACTION TIMES
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        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.