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.