

MicroCog™: Assessment of Cognitive Functioning

Technical Report 1

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Timing Study and Modifications to Program

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MicroCog™: Assessment of Cognitive Functioning (MicroCog) is a computer-administered cognitive screening instrument that was originally developed for a disk operating system (DOS). Normative data was collected using the DOS version. Recently, Pearson Education, Inc. developed a version of MicroCog that operates in a Windows operating system (OS) environment. The original subtest stimuli, scoring, and administration sequence in DOS have been maintained in the Windows OS version. However, there may be small differences in timing between the two versions. MicroCog measures performance accuracy and speed and yields an overall performance proficiency score. For most cognitive measures, differences in the range of 10 to 90 milliseconds have no impact on the scaled score obtained; however, response time differences in this range may affect the scaled score obtained for the MicroCog pure reaction time subtests.

Study 1

Purpose

Windows and DOS use different procedures for controlling and recording time. The accuracy of timing may be affected by elements that can be controlled by programming and providing users with information on running programs in the Windows background environment. It was hypothesized that for most subtests, there would be very slight differences in the recording of response time, having no impact on conversion of raw scores to scaled scores. It was also hypothesized that if small differences in timing did exist, these differences would be reflected in reaction time measures.

To determine if differences in timing affected performance on MicroCog subtests, a small study was conducted to compare scores obtained from the two versions running on the same computer under the same operating conditions.

Participants

Ten individuals between the ages of 26 and 56 ($X = 36.6$, $SD = 10.1$) completed selected subtests from the DOS and Windows OS versions of MicroCog. Five participants were male and 5 were female. Eight participants were Caucasian and 2 were African American. The mean education of all participants was 18 years, with all having obtained at least a bachelors degree.

Method

Five participants completed the DOS version first, followed immediately by the Windows version; and 5 completed the Windows version first, followed by the DOS version. This counterbalance served as a control for potential practice effects, which may have influenced the scores obtained on the MicroCog assessments. Four subtests from MicroCog were included in the study: Numbers Forward, Numbers Reversed, Clocks, and Timers. These subtests were chosen due to the possible influence of the Windows operating system on the length of stimulus presentation time and the Windows operating systems potential for greater precision in measuring examinee response times—both factors that have the potential to affect examinee performance and the subsequent derivation of scaled scores. The Timers subtest served as a

direct measure of simple reaction time; while, the Clocks and Numbers subtests measured response time in the context of performing a cognitive task. The participants received standard instructions for completing the MicroCog subtests. All participants completed testing on a Dell Optiplex GX1, P-III 750MHZ Intel Processors with 128 MB of RAM. The OS system for the computer was Windows 2000 professional version.

Measures

Timers: The examinee presses the ENTER key as quickly as he or she is able when the examinee sees a square appear on the screen. The second condition requires the examinee to press the ENTER key as quickly as possible when the examinee hears a tone. The third condition alternates between the visual image and the tones.

Numbers Forward: The examinee is presented with a series of single digits on the computer screen. Each digit is presented sequentially in the center of the screen. The examinee must enter the digits in correct order using the computer number pad. The number of digits to be recalled varies from 2 to 9.

Numbers Backward: The examinee is presented with a series of single digits on the computer screen. Each digit is presented sequentially in the center of the screen. The examinee must enter the digits in reverse order using the computer number pad. The number of digits to be recalled varies from 2 to 9.

Clocks: The examinee is presented with seven clock items. The examinee must determine the correct time from five possible selections for each item.

Results

Data were analyzed for outliers within the task and between tasks. Participants who did not complete both the DOS and Windows versions for various subtests were only included in the analyses for which they had complete data. The scores were analyzed using SPSS version 11.5. Table 1 provides the variables included in Study 1.

Table 1. Variables in Study 1 Analysis by Scaled Score and Average Response Time

Score	Subtest Variables
Scaled Score	<p>Timers 1 Auditory Average Response Time Visual Average Response Time Cued Audio/Visual Average Response Time Total Average Response Time</p> <p>Timers 2 Auditory Average Response Time Visual Average Response Time Cued Audio/Visual Average Response Time Total Average Response Time</p> <p>Numbers Forward Average Response Time Numbers Reversed Average Response Time Clocks Average Response Time</p>
Average Response Time (raw scores in sec.)	<p>Timers 1 Auditory Average Response Time Visual Average Response Time Cued Audio/Visual Average Response Time Total Average Response Time</p> <p>Timers 2 Auditory Average Response Time Visual Average Response Time Cued Audio/Visual Average Response Time Total Average Response Time</p> <p>Numbers Forward Average Response Time Numbers Reversed Average Response Time Clocks Average Response Time</p>

Repeated measures ANOVAs were conducted on each variable, with the operating system as the independent variable. For final comparisons, the data obtained from two participants were excluded due to extreme differences between subtest performance on the Windows and DOS versions. The Timers 1 data obtained from one additional participant was not included for final comparison due to a computer administration error that occurred during that particular subtest.

The results indicated no significant differences between the mean scores on the DOS and Windows versions for raw and scaled scores on the Numbers Forward, Numbers Reversed, or Clocks subtests. As expected, measures utilizing response time in the context of a cognitive process were unaffected by possible differences in the timing as measured by DOS versus Windows. Table 2 provides descriptive statistics and results of the ANOVA analysis for each subtest. The Timers subtests yielded several measures with trends toward statistical significance and several that were statistically significant. Table 3 summarizes descriptive data for statistically different DOS and Windows scores on the Timers subtest. Average response time means are presented in seconds. The differences in scores on Timers can be attributed to differences in response time; response time as measured by Windows is faster than response time measured by DOS.

Table 2. Mean Subtest Scores for Variables with Non-Significant Differences

Variable	Score	DOS Mean	Windows Mean	F	Significance
Timers 1	Auditory Average Response Time	.401	.365	1.55	.260
	Auditory Average Response Time Scaled Score	12.43	13.14	1.39	.283
	Visual Average Response Time	.379	.322	1.79	.229
	Visual Average Response Time Scaled Score	8.43	9.86	1.23	.310
	Cued Audio/Visual Average Response Time Scaled Score	12.00	12.43	2.08	.200
	Total Average Response Time	.367	.326	5.96	.050
	Total Average Response Time Scaled Score	11.00	11.71	3.95	.094
Timers 2	Auditory Average Response Time	.369	.332	3.58	.100
	Auditory Average Response Time Scaled Score	11.88	12.75	3.94	.087
	Visual Average Response Time	.365	.322	5.38	.053
	Cued Audio/Visual Average Response Time	.310	.284	2.26	.177
	Cued Audio/Visual Average Response Time Scaled Score	9.75	10.25	.78	.407
Numbers Forward	Average Response Time	8.00	5.38	1.56	.252
	Average Response Time Scaled Score	8.88	10.50	2.47	.160
Numbers Reversed	Average Response Time	11.13	8.75	1.04	.342
	Average Response Time Scaled Score	12.12	13.12	.70	.430
Clocks	Average Response Time	7.25	5.50	.61	.462
	Average Response Time Scaled Score	10.88	11.75	.38	.557

Table 3. Mean Subtest Scores for Variables Demonstrating Significant Differences

Variable	DOS Mean	Windows Mean	F	Significance
Timers 1 Cued Audio/Visual Average Response Time	.323	.289	6.12	.048
Timers 2 Visual Average Response Time Scaled Score	8.38	9.88	10.50	.014
Timers 2 Total Average Response Time Scaled Score	9.88	11.38	21.00	.003
Timers 2 Average Response Time	.348	.313	10.74	.014

Discussion

The following hypothesis was rejected: Scoring differences between cognitive measures that integrate both response time and accuracy do not yield significantly different raw and scaled scores between the DOS and Windows versions. Differences at the raw score and scaled score level were observed on the Timers subtests. These differences were found to be in the range of 30 to 35 milliseconds; faster times were recorded for the Windows version than the DOS version. These results were based on a small sample of cases, so a second study was proposed to evaluate specific differences between the Timers subtests on the DOS and Windows versions.

Study 2

Purpose

The second study was conducted to gather additional information on the differences in the Timers subtest response times and to determine the appropriate adjustment factor for the Windows version of MicroCog. The goal was to determine the degree of difference between the two versions and to create an adjustment factor to account for the ability of Windows to more precisely record elapsed time. The adjustment factor would be applied to the Timers subtest only.

Participants

Twenty-four additional participants completed both versions of MicroCog using the same design as employed in the first study. The 24 participants from the second study were combined with the 8 original participants. Three participants from the second study were excluded due to extreme performance differences (≥ 5 scaled score points) between the two versions. In addition, the data obtained from the participant in Study 1 who did not complete both Timers tasks was excluded from the second study. Therefore, data obtained from 28 participants were included in Study 2. All participants were between the ages of 26 and 62 ($X = 42.6$, $SD = 11.7$). All participants had at least a high school education, with 22 (78.6%) having obtained a bachelor's degree or higher. Nine participants were male and 19 were female. Eighteen participants were Caucasian, 5 were Hispanic, 2 were African American, and 2 were Asian American.

Method

Of the 28 participants, 14 completed the DOS version first followed immediately by the Windows version, and 14 completed the Windows version first followed by the DOS version. This counterbalance increased control over the influence of practice effects on results. Only the Timers subtest was administered and included in the study. The participants were provided the standard instructions for the MicroCog subtests used in this study.

All participants completed testing on a Dell Optiplex GX1, P-III 750MHZ Intel Processors with 128 MB of RAM. The OS system for the computer was Windows 2000 professional version.

Results

Repeated measures ANOVAs were conducted on each variable, with operating system as the independent variable. A total of 28 participants were used in each analysis. The dependent measures used in the analysis are listed below. Data analysis was completed with SPSS version 11.5. The following response time variables were analyzed for Study 2:

- Timers 1:** Auditory Average Response Time
 Visual Average Response Time
 Cued Audio/Visual Average Response Time
 Total Average Response Time
- Timers 2:** Auditory Average Response Time
 Visual Average Response Time
 Cued Audio/Visual Average Response Time
 Total Average Response Time

No significant differences were found on the Timers 1 Auditory Average Response Time, Timers 1 Cued Audio/Visual Average Response Time, and Timers 2 Auditory Average Response Time. Significant differences were found on all other measures. One of the reasons the versions produced disparate results is the API call difference between the DOS and Windows operating systems. The Windows API is accurate to within 1 millisecond, while the precision used on the DOS product was only accurate to within 10 milliseconds. This disparity created increased precision with the Windows API call. In addition to the added precision, a consistent lag in the DOS product was detected. Table 4 summarizes the DOS and Windows raw score means for the Timers scores.

Table 4. Variable Mean Subtest Scores (in seconds) and *F* Values

Variable	DOS Mean	Windows Mean	<i>F</i>	Significance
Timers 1 Auditory Average Response Time	.427	.392	3.05	.092
Visual Average Response Time	.380	.345	7.35	.011
Audio/Visual Average Response Time	.347	.321	1.19	.286
Total Average Response Time	.384	.352	6.71	.015
Timers 2 Auditory Average Response Time	.403	.360	3.06	.092
Visual Average Response Time	.380	.337	20.65	.000
Cued Audio/Visual Average Response Time	.317	.292	4.42	.045
Total Average Response Time	.366	.330	14.85	.001

Based on the results summarized in Table 5 and the consistent lag time detected, an adjustment factor of 30 milliseconds or .030 seconds was added to the average response times for Timers 1 Auditory, Timers 1 Visual, Timers 1 Cued Audio/Visual, Timers 1 Total, Timers 2 Auditory, Timers 2 Visual, Timers 2 Cued Audio/Visual, and Timers 2 Total in the Windows version of MicroCog. In some cases larger differences were observed, but in order to keep from over-correcting the results, a small rather than large adjustment was made. This equivalency approach ensures consistency of the Windows product with the DOS norms. Subsequent analysis of the raw score differences between the DOS average response times and the corrected Windows average response times demonstrated no significant differences. Table 5 provides subtest means for the Timers variables, in addition to the *F* values for the repeated measures ANOVAs. The associated scaled scores for the DOS and Windows corrected subtests are presented in Table 6.

Table 5. Mean Subtest Scores and *F* Values After Application of the Adjustment Factor

Variable	DOS Mean	Windows Mean	<i>F</i>	Significance
Timers 1 Auditory Average Response Time	.427	.422	.07	.795
Visual Average Response Time	.380	.375	.16	.689
Audio/Visual Average Response Time	.347	.351	.04	.848
Total Average Response Time	.384	.382	.02	.903
Timers 2 Auditory Average Response Time	.403	.390	.29	.593
Visual Average Response Time	.380	.367	1.94	.175
Cued Audio/Visual Average Response Time	.317	.322	.22	.646
Total Average Response Time	.366	.360	.48	.493

Table 6. Mean Subtest Scaled Scores and *F* Values After Application of the Adjustment Factor to the Windows Version

Variable	DOS Mean	Windows Mean	<i>F</i>	Significance
Timers 1 Auditory Average Response Time Scaled Score	12.64	12.82	.38	.545
Visual Average Response Time Scaled Score	9.46	9.43	.01	.926
Audio/Visual Average Response Time Scaled Score	12.04	11.96	.04	.841
Total Average Response Time Scaled Score	11.11	11.21	.20	.656
Timers 2 Auditory Average Response Time Scaled Score	11.71	11.86	.13	.726
Visual Average Response Time Scaled Score	8.12	8.97	3.51	.070
Cued Audio/Visual Average Response Time Scaled Score	10.00	9.93	.07	.798
Total Average Response Time Scaled Score	10.39	10.54	.21	.655

Discussion

Consistent with Study 1, statistically significant differences in recorded response time were observed between DOS and Windows versions of the MicroCog. These differences occur at a level that would result in participants having higher scaled scores on the Windows version compared to the DOS version. To limit the impact of response recording times on normative data, each participant's reaction time score on the Windows version for the Timers subtest was adjusted by the addition of 30-milliseconds. This adjustment eliminated the significant differences between the versions at the raw and scaled score level.

Summary

A series of studies was conducted to determine if the two versions of MicroCog, DOS and Windows OS, produce similar results in response time data. The results of Numbers Forward, Numbers Reversed, and Clocks subtests in Study 1 supported the equivalency of the two forms. These results are not unexpected, as recorded differences in the 10–90-millisecond range are unlikely to have an impact on normative data for subtests involving cognitive processes.

A significant difference was found between the two versions for the Timers subtest. This test serves as a direct measure of reaction time, as little cognitive processing is required to complete the task. Given the nature of the task, it was anticipated that small differences in measured response time in the range of 10–90 milliseconds might have an impact on normative data. The results indicated a timing difference of about 30–35 milliseconds, with Windows recording faster response times than DOS.

Additional information was gathered in Study 2 to identify an adjustment factor that would make recorded response times for the Windows version comparable to the original DOS version. The results of Study 2 confirmed the findings of Study 1. Based upon the raw score response-time differences between versions, a small adjustment factor of 30 milliseconds was derived and subtracted from the Windows version response times. The scores between versions did not significantly differ after the adjustment was made.