

**A REPORT ON THE STATISTICAL CHARACTERISTICS  
of the  
Highlands Ability Battery CD**

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## Introduction

Emanuel Ventures, LLC d/b/a The Highlands Company contracted with the Chauncey Group to perform a statistical audit of the 19 work assignments that contribute to a person's overall measurement in the Highlands Ability Battery. Each work assignment requires the person to perform a separate task. Our audit and evaluation were limited to the CD-Rom version of the Highlands Ability Battery, which is administered to examinees on the computer. All complete examinee records between the introduction of the CD-based test in March 2000 and September 2002 were included in the analyses. In all, 4,307 individual records were evaluated.

## Data Determination and Edit

The data retrieved from the scoring history files were loaded into excel and cleaned to ensure that all examinees included had complete records. Also, after conferring with Emanuel Ventures staff, individuals who could not be placed adequately in age groups due to suspicious age designations were eliminated from further analyses. In all, less than 200 records were deleted for missing or incorrect information.

The 19 ability work assignments (comprising 23 scores) evaluated were as follows:

|      |                                   |
|------|-----------------------------------|
| vs5  | = Visual Speed 5 minutes          |
| vs6  | = Visual Speed 6 minutes          |
| va5  | = Visual Accuracy 5 minutes       |
| va6  | = Visual Accuracy 6 minutes       |
| w2   | = Typing Speed                    |
| w3   | = Generalist/Specialist (Written) |
| w4   | = Spatial Relationship Theory     |
| w5   | = Idea Productivity               |
| w6   | = Verbal Memory                   |
| w7   | = Design Memory                   |
| w8   | = Tonal Memory                    |
| w9   | = Rhythm Memory                   |
| w10  | = Pitch Discrimination            |
| w11  | = Spatial Relations Visualization |
| w12  | = Observation                     |
| w13  | = Concept Organization            |
| w14  | = Number Memory                   |
| w15  | = Time Frame Orientation          |
| w16  | = Classification Ability          |
| w17  | = Generalist/Specialist (Oral)    |
| gv30 | = Vocabulary 30 Items             |
| v13  | = Vocabulary 130 Items            |

w19 = Alternate E/I

Each score was assessed for the four age groups [ages 15-21; 22-30; 31-39; and 40 and older] described in the Highlands Ability Battery literature as important for score reporting.

## **Comparison of Norms for the CD-Based Test to Existing Norms**

The 19 work assignments on the Highlands CD yield 23 separate scores. The Chauncey Group computed sample sizes, means, standard deviations and complete norms tables for each of the 23 CD-based scores for four groups of examinees ages 1) 15-21; 2) 22-30; 3) 31-39; and 4) 40 and older. Each norms table provided the percentile rank and the raw score for that age group at that percentile rank. Tables were provided that included the comparison of these data among each other and, where available, to the norms assigned by Highlands in the CD-Based Highlands Ability Battery.

An examination of the 23 different percentile norms tables across the different age groups reveals a substantial correspondence for most groups in many test scores. Also, many total group scores appear to be identical to norms assigned by Highlands, with the exception of the lower-bound 5<sup>th</sup> percentile score. In the Highlands norms, any score in this percentile is always assigned a zero, but in our tables the score is usually greater than zero but below the minimum for the next percentile. Only two of the twenty-three tests, Visual Accuracy and Visual Speed, appear to present norms which are somewhat different from the norms presented on the Highlands norms sheets.

The 30-word vocabulary test (gv30) appears far too easy, given the number of people tested in the sample. Looking at the distributions, most groups reach the 99<sup>th</sup> percentile rank at 25 words correct. This result may be a function of timing and word difficulty and may have been intended by Highlands. The scores on the 130-word vocabulary test (v13) were distributed more evenly among the assigned percentages.

## **Comparison of the Score Intercorrelations**

### ***Indirect Reliability Estimates***

The correlations among the 23 scores were evaluated for the four age groups as a way to gauge the score reliability without having to undertake a special study, since many of the tests in the Highlands Ability Battery are speeded. Tests that are speeded (i.e., tests where the time limit restricts many examinees from completing all items in the test) require special studies for reliability estimation purposes.

Correlations are descriptive statistics that inform the reader to what extent two things are related, to what extent variations in the one go with variations in the other. Correlations range from 1.00 (perfect relationship) through 0.0 (no relationship) to -1.00 (perfect

negative relationship). Correlations above  $\pm 0.12$  are significantly different from 0.00 (no relationship) and those greater than  $\pm 0.12$  were so identified by shading the correlation on the tables. The level of significance used for this treatment was 0.01 for the likelihood of finding a significant correlation and finding that by chance was less than 1/100 tests.

What is important is the magnitude of the correlations observed. Very high correlations between scores, such as 0.70 to 1.00 could be considered to be an estimate of alternate form reliability since the test scores have such a strong relationship they could be said to be reliable estimates of each other. Instead, some test scores should exhibit low correlations while others higher correlations. This can be thought of as a demonstration of construct validity in that a test should correlate high with test scores with which it should theoretically correlate, such as written vocabulary with oral vocabulary. On the other hand, scores should not correlate significantly with other scores from which they should or may be expected to differ. The idea behind administering a test battery is that the test battery measures the polymorphic traits ranging as described above. For example, scores like tonal memory (W8) might be expected to correlate with Spatial Relations Visualization scores (W11), but not with Visual Accuracy (VA5, VA6) scores. Such relationships in a test battery lend to the overall measurement of the person by evaluating different aspects or traits.

The reliability of each test score affects the upper limit possible for the observed correlation coefficient. For example, the following table shows the observed maximum correlation possible given a reliability of each score where the reliabilities for each score are provided in **bold** type along the margins of the table.

Maximum Observed Correlation Given the Score Reliability of Two Variables

|             | <b>0.10</b> | <b>0.20</b> | <b>0.30</b> | <b>0.40</b> | <b>0.50</b> | <b>0.60</b> | <b>0.70</b> | <b>0.80</b> | <b>0.90</b> |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| <b>0.10</b> | 0.10        | 0.14        | 0.17        | 0.20        | 0.22        | 0.24        | 0.26        | 0.28        | 0.30        |
| <b>0.20</b> | 0.14        | 0.20        | 0.24        | 0.28        | 0.32        | 0.35        | 0.37        | 0.40        | 0.42        |
| <b>0.30</b> | 0.17        | 0.24        | 0.30        | 0.35        | 0.39        | 0.42        | 0.46        | 0.49        | 0.52        |
| <b>0.40</b> | 0.20        | 0.28        | 0.35        | 0.40        | 0.45        | 0.49        | 0.53        | 0.57        | 0.60        |
| <b>0.50</b> | 0.22        | 0.32        | 0.39        | 0.45        | 0.50        | 0.55        | 0.59        | 0.63        | 0.67        |
| <b>0.60</b> | 0.24        | 0.35        | 0.42        | 0.49        | 0.55        | 0.60        | 0.65        | 0.69        | 0.73        |
| <b>0.70</b> | 0.26        | 0.37        | 0.46        | 0.53        | 0.59        | 0.65        | 0.70        | 0.75        | 0.79        |
| <b>0.80</b> | 0.28        | 0.40        | 0.49        | 0.57        | 0.63        | 0.69        | 0.75        | 0.80        | 0.85        |
| <b>0.90</b> | 0.30        | 0.42        | 0.52        | 0.60        | 0.67        | 0.73        | 0.79        | 0.85        | 0.90        |

The correlation between Visual Speed at 5 minutes and Visual Speed at 6 minutes appears to show each as a reliable estimate of the other since the correlations range between 0.97 and 0.98 regardless of age group. This correlation may be influenced by the fact that the first 5 minutes performance is included in the 6 minutes performance score.

Examining the correlation matrices for Ages 15-21, 22-30, 31-39, and 40+ it appears that every score correlates with at least one other score in each matrix at the level of significance or higher. The number of significant correlations is similar across the different age groups, providing evidence that the relationships observed are consistent (reliable). The percentage of correlations among the 253 within each numbered age group is as follows:

1. Ages 15-21 45%
2. Ages 22-30 49%
3. Ages 31-39 41%
4. Ages 40+ 43%

Examining the correlation matrices for each age grouping, it is apparent that while the correlations are not high, for the most part they show that each test has at least a significant relationship to other test scores so as to imply indirectly that the scores are sufficiently reliable for their use in a battery and yet measure different aspects of an examinee's ability. One exception may be the Generalist/Specialist (Written) score, exhibiting a strong correlation with Generalist/Specialist (Oral), but with little else for the first three age groups. Similarly, the Visual Accuracy 6 Minutes score shows a strong correlation with Vocabulary 30 items for age groups 1 and 4, but not for groups 2 and 3. Individual relationship descriptions are beyond the scope of this report.

## Conclusion

In general, the analysis of the score distributions revealed that many of the 23 scores appear to be identical to current norms with the exception of the lower bound 5<sup>th</sup> percentile score, which in the norms tables are always assigned a zero, but in our recently computed tables using the total group are usually bigger than zero. Also, two tests appear to have different norms than those presented on the norms sheets: Visual Accuracy and Visual Speed do not appear to agree with the norms provided by the Highlands Company to the extent that the other test scores do for the total group of candidates tested on the CD-based battery. The norms for most of these tests appear to be virtually perfect and have no need of change.

Overall, the data from the CD-based Highlands Ability Battery shows that each test score in the battery correlates sufficiently so as to provide indirect evidence that the tests in the Highlands Ability Battery are sufficiently reliable for their use in the test battery for feedback purposes, since the feedback report provides a combination of the scores for personal growth purposes.

Also, examination of the frequency distributions among the four age groups shows consistent similarities for scores at the different percentiles regardless of age group. Those differences in scores by age group that did exist were consistent across the different age groups.



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## Appendix A: Norms Table Comparisons

### Visual Speed 5 minutes (vs5)

| Score VS5: Visual Speed 5 minutes |      |       |          |  |
|-----------------------------------|------|-------|----------|--|
| Age                               | N    | Mean  | St. Dev. |  |
| 15 to 21                          | 462  | 91.68 | 16.75    |  |
| 22 to 30                          | 854  | 93.79 | 17.66    |  |
| 31 to 39                          | 1272 | 92.91 | 16.9     |  |
| 40 and above                      | 1719 | 88.88 | 16.25    |  |
| Total                             | 4307 | 91.34 | 16.9     |  |

  

| Centile Scores by Age Group |       |         |          |          |          |              |     |
|-----------------------------|-------|---------|----------|----------|----------|--------------|-----|
| Percentile                  | Norms | Total N | 15 to 21 | 22 to 30 | 31 to 39 | 40 and above |     |
| 5                           | 0     | 66      | 66       | 66       | 67       | 66           | 63  |
| 10                          | 69    | 72      | 72       | 72       | 73       | 73           | 70  |
| 15                          | 73    | 75      | 75       | 75       | 78       | 76           | 73  |
| 20                          | 76    | 78      | 78       | 77       | 81       | 80           | 76  |
| 25                          | 80    | 81      | 81       | 80       | 84       | 82           | 79  |
| 30                          | 83    | 83      | 83       | 82       | 85       | 84           | 82  |
| 35                          | 84    | 85      | 85       | 84       | 88       | 87           | 84  |
| 40                          | 86    | 87      | 87       | 86       | 90       | 89           | 85  |
| 45                          | 89    | 89      | 89       | 89       | 92       | 91           | 87  |
| 50                          | 90    | 91      | 91       | 90       | 95       | 93           | 89  |
| 55                          | 92    | 94      | 94       | 92       | 96       | 96           | 91  |
| 60                          | 96    | 96      | 96       | 95       | 99       | 97           | 93  |
| 65                          | 98    | 98      | 98       | 98       | 100      | 99           | 95  |
| 70                          | 100   | 100     | 100      | 100      | 103      | 101          | 96  |
| 75                          | 102   | 102     | 102      | 102      | 105      | 104          | 99  |
| 80                          | 105   | 105     | 105      | 106      | 107      | 106          | 101 |
| 85                          | 107   | 108     | 108      | 110      | 110      | 109          | 105 |
| 90                          | 110   | 112     | 112      | 113      | 114      | 113          | 108 |
| 95                          | 117   | 118     | 118      | 121      | 122      | 119          | 114 |
| 99                          | 133   | 132     | 132      | 134      | 136      | 134          | 127 |

## Visual Speed 6 minutes (vs6)

Score VS6: Visual Speed 6 minutes

| Age          | N    | Mean   | St. Dev. |
|--------------|------|--------|----------|
| 15 to 21     | 462  | 106.89 | 18.73    |
| 22 to 30     | 854  | 109.39 | 20.06    |
| 31 to 39     | 1272 | 108.59 | 18.42    |
| 40 and above | 1719 | 103.93 | 18.47    |
| Total        | 4307 | 106.7  | 18.95    |

Centile Scores by Age Group

| Percentile | Norms | Total N | 15 to 21 | 22 to 30 | 31 to 39 | 40 and above |
|------------|-------|---------|----------|----------|----------|--------------|
| 5          |       | 0       | 76       | 77       | 79       | 78           |
| 10         |       | 81      | 83       | 83       | 86       | 84           |
| 15         |       | 84      | 88       | 86       | 91       | 90           |
| 20         |       | 89      | 92       | 91       | 94       | 94           |
| 25         |       | 93      | 95       | 94       | 97       | 96           |
| 30         |       | 97      | 97       | 97       | 100      | 99           |
| 35         |       | 99      | 100      | 99       | 103      | 101          |
| 40         |       | 101     | 102      | 101      | 106      | 104          |
| 45         |       | 104     | 105      | 104      | 108      | 106          |
| 50         |       | 106     | 107      | 106      | 110      | 108.5        |
| 55         |       | 108     | 109      | 109      | 113      | 111          |
| 60         |       | 111     | 112      | 110      | 115      | 114          |
| 65         |       | 115     | 114      | 113      | 117      | 117          |
| 70         |       | 118     | 117      | 117      | 119      | 119          |
| 75         |       | 120     | 119      | 120      | 122      | 121          |
| 80         |       | 122     | 122      | 124      | 125      | 124          |
| 85         |       | 126     | 126      | 128      | 129      | 127          |
| 90         |       | 131     | 131      | 132      | 133      | 132          |
| 95         |       | 138     | 138      | 140      | 142      | 139          |
| 99         |       | 150     | 150      | 150      | 150      | 150          |



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## Visual Accuracy 5 minutes (va5)

Score VA5: Visual Accuracy 5 minutes

| Age          | N    | Mean | St. Dev. |
|--------------|------|------|----------|
| 15 to 21     | 463  | 2.83 | 5.9      |
| 22 to 30     | 854  | 3.19 | 4.29     |
| 31 to 39     | 1272 | 4.01 | 6.4      |
| 40 and above | 1721 | 4.42 | 6.46     |
| Total        | 4310 | 3.89 | 6.04     |

### Centile Scores by Age Group

| Percentile | Norms  | Total N | 15 to 21 | 22 to 30 | 31 to 39 | 40 and above |
|------------|--------|---------|----------|----------|----------|--------------|
| 5          | 150.00 | 23      | 14       | 18       | 26       | 25           |
| 10         | 7.36   | 13      | 9        | 10       | 14       | 14           |
| 15         | 6.22   | 9       | 6        | 7        | 9        | 10           |
| 20         | 5.36   | 7       | 5        | 6        | 7        | 7            |
| 25         | 4.44   | 6       | 4        | 5        | 6        | 6            |
| 30         | 3.56   | 5       | 3        | 4        | 5        | 5            |
| 35         | 3.11   | 4       | 3        | 3        | 3        | 4            |
| 40         | 2.90   | 4       | 3        | 4        | 4        | 5            |
| 45         | 2.55   | 3       | 2        | 2        | 3        | 3            |
| 50         | 2.35   | 3       | 2        | 3        | 3        | 4            |
| 55         | 2.00   | 2       | 1        | 1        | 2        | 2            |
| 60         | 1.83   | 2       | 2        | 2        | 2        | 2            |
| 65         | 1.37   | 2       | 2        | 2        | 2        | 3            |
| 70         | 1.19   | 1       | 0        | 0        | 1        | 1            |
| 75         | 1.08   | 1       | 1        | 1        | 1        | 1            |
| 80         | 0.00   | 1       | 1        | 1        | 1        | 2            |
| 85         | 0.00   | 1       | 1        | 1        | 1        | 2            |
| 90         | 0.00   | 0       | 0        | 0        | 0        | 0            |
| 95         | 0.00   | 0       | 0        | 0        | 0        | 0            |
| 99         | 0.00   | 0       | 0        | 0        | 0        | 1            |



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## Visual Accuracy 6 minutes (w2)

Score VA6: Visual Accuracy 6 minutes

| Age          | N    | Mean | St. Dev. |
|--------------|------|------|----------|
| 15 to 21     | 463  | 1.34 | 6.14     |
| 22 to 30     | 853  | 1.05 | 1.11     |
| 31 to 39     | 1272 | 1.18 | 1.58     |
| 40 and above | 1721 | 1.42 | 3.82     |
| Total        | 4309 | 1.27 | 3.3      |

Centile Scores by Age Group

| Percentile | Norms  | Total N | 15 to 21 | 22 to 30 | 31 to 39 | 40 and above |
|------------|--------|---------|----------|----------|----------|--------------|
| 5          | 150.00 | 6       | 7        | 6        | 6        | 7            |
| 10         | 8.20   | 3       | 2        | 2        | 2        | 3            |
| 15         | 6.52   | 3       | 3        | 3        | 4        | 4            |
| 20         | 5.65   | 2       | 2        | 1        | 2        | 2            |
| 25         | 4.84   | 2       | 2        | 2        | 2        | 2            |
| 30         | 4.35   | 2       | 2        | 2        | 2        | 2            |
| 35         | 3.81   | 1       | 1        | 1        | 1        | 1            |
| 40         | 3.33   | 1       | 1        | 1        | 1        | 1            |
| 45         | 3.03   | 1       | 1        | 1        | 1        | 1            |
| 50         | 2.68   | 1       | 1        | 1        | 1        | 1            |
| 55         | 2.45   | 1       | 1        | 1        | 1        | 1            |
| 60         | 2.20   | 1       | 1        | 1        | 1        | 1            |
| 65         | 1.97   | 1       | 1        | 1        | 1        | 1            |
| 70         | 1.75   | 1       | 1        | 1        | 1        | 2            |
| 75         | 1.51   | 0       | 0        | 0        | 0        | 0            |
| 80         | 1.14   | 0       | 0        | 0        | 0        | 0            |
| 85         | 0.95   | 0       | 0        | 0        | 0        | 0            |
| 90         | 0.83   | 0       | 0        | 0        | 0        | 0            |
| 95         | 0.00   | 0       | 0        | 0        | 0        | 0            |
| 99         | 0.00   | 0       | 0        | 0        | 0        | 1            |



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## Typing Speed (w2)

### Score W2: Typing Speed

| Age          | N    | Mean   | St. Dev. |
|--------------|------|--------|----------|
| 15 to 21     | 462  | 279.17 | 87.44    |
| 22 to 30     | 854  | 297.3  | 77.23    |
| 31 to 39     | 1271 | 302.78 | 84.22    |
| 40 and above | 1721 | 279.66 | 86.37    |
| Total        | 4308 | 289.92 | 84.76    |

### Centile Scores by Age Group

| Percentile | Norms | Total N | 15 to 21 | 22 to 30 | 31 to 39 | 40 and above |
|------------|-------|---------|----------|----------|----------|--------------|
| 5          | 0     | 155     | 136      | 178      | 167      | 146          |
| 10         | 164   | 183     | 166      | 199      | 200      | 170          |
| 15         | 187   | 203     | 189      | 220      | 216      | 188          |
| 20         | 196   | 219     | 206      | 238      | 234      | 205          |
| 25         | 203   | 234     | 218      | 248      | 247      | 220          |
| 30         | 218   | 247     | 231      | 261      | 259      | 234          |
| 35         | 232   | 259     | 243      | 271      | 271      | 245          |
| 40         | 246   | 270     | 255      | 281      | 283      | 258          |
| 45         | 258   | 280     | 266      | 289      | 295      | 268          |
| 50         | 271   | 291     | 278.5    | 297.5    | 306      | 280          |
| 55         | 285   | 302     | 289      | 309      | 315      | 290          |
| 60         | 292   | 313     | 303      | 317      | 324      | 302          |
| 65         | 299   | 323     | 313      | 325      | 337      | 315          |
| 70         | 312   | 334     | 326      | 336      | 349      | 326          |
| 75         | 326   | 346     | 337      | 346      | 359      | 337          |
| 80         | 341   | 359     | 351      | 360      | 374      | 351          |
| 85         | 370   | 376     | 370      | 377      | 389      | 366          |
| 90         | 389   | 395     | 390      | 395      | 406      | 387          |
| 95         | 414   | 428     | 427      | 420      | 436      | 421          |
| 99         | 484   | 483     | 473      | 468      | 494      | 482          |



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## Generalist Specialist (Written) (w3)

### Score W3: Generalist/Specialist (Written)

| Age          | N    | Mean  | St. Dev. |
|--------------|------|-------|----------|
| 15 to 21     | 462  | 10.8  | 6.96     |
| 22 to 30     | 854  | 11.88 | 7.34     |
| 31 to 39     | 1271 | 14.17 | 7.92     |
| 40 and above | 1720 | 16.98 | 13.18    |
| Total        | 4307 | 14.48 | 10.44    |

### Centile Scores by Age Group

| Percentile | Norms | Total N | 15 to 21 | 22 to 30 | 31 to 39 | 40 and above |
|------------|-------|---------|----------|----------|----------|--------------|
| 5          | 0.0   | 2.5     | 1.5      | 2        | 2.5      | 3.5          |
| 10         | 4.0   | 4       | 2.5      | 3        | 4        | 5            |
| 15         | 5.0   | 5       | 3.5      | 4        | 5        | 7            |
| 20         | 6.5   | 6.5     | 4        | 5        | 6.5      | 9            |
| 25         | 8.0   | 7.5     | 5        | 6        | 8        | 10           |
| 30         | 9.0   | 9       | 6        | 7        | 9        | 11.5         |
| 35         | 10.0  | 10      | 7        | 8        | 10       | 13           |
| 40         | 11.5  | 11.5    | 8        | 9        | 11       | 14.5         |
| 45         | 13.5  | 12.5    | 9        | 9.5      | 12.5     | 15.5         |
| 50         | 15.0  | 13.5    | 9.75     | 10.5     | 13.5     | 16.5         |
| 55         | 16.0  | 15      | 11       | 12       | 14.5     | 17.5         |
| 60         | 17.0  | 16      | 12       | 13       | 16       | 19           |
| 65         | 18.5  | 17.5    | 13       | 14       | 17.5     | 20.5         |
| 70         | 19.5  | 19      | 14       | 15       | 18.5     | 21.5         |
| 75         | 20.5  | 20.5    | 15.5     | 16.5     | 20       | 23           |
| 80         | 22.0  | 22      | 17       | 18.5     | 21.5     | 24.5         |
| 85         | 24.0  | 23.5    | 18       | 20.5     | 23.5     | 26           |
| 90         | 25.5  | 26      | 20.5     | 23       | 25       | 28.25        |
| 95         | 28.0  | 29      | 23       | 25.5     | 28.5     | 30           |
| 99         | 33.0  | 32.5    | 28       | 31       | 32.5     | 33.5         |



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