Article ▶ Test-Retest Reliability of the Sanet Vision Integrator

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ABSTRACT

Background: The visual system plays a crucial role in successfully accomplishing most sports activities, not only for professional athletes but also at lower levels of competition. The Sanet Vision Integrator (SVI) evaluates the visual guidance of motor performance by assessing the speed of motor response to visual stimuli. While the SVI is widely used clinically, the reliability and validity of the device has not been established. The purpose of this investigation was to determine the test-retest reliability of the Proaction, Reaction, and Hand Speed programs of the SVI using a control group.

Methods: Twenty students at the Illinois College of Optometry (ICO), ages 22-31, performed the eye-hand tests of the SVI: Proactive, Reactive, and Hand Speed. Each subject was tested one at a time using the SVI on two consecutive visits. Visit 2 took place at least two weeks after visit 1, using identical protocols. Testing was performed under normal room illumination using a white size-50 stimulus on a black background with the subjects standing one meter away and the screen centered at chest level. Reliability was measured with the intraclass correlation coefficient (ICC).

Results: The ICC was statistically significant for the Upper Left quadrant, as well as for the reaction latency of the Proactive test, the percent correct on the Reactive test, and the reaction time and hand speed of the Hand Speed test. The ICC for the Upper Right, Lower Right, and Lower Left quadrants of the Proactive test and the percent correct of the Hand Speed test were statistically insignificant.

Conclusion: The Proactive, Reactive, and Hand Speed tests of the Sanet Vision Integrator can reliably measure eye-hand coordination, while other aspects of the tests are not as reliable.

Keywords: eye-hand coordination, Sanet Vision Integrator, sports vision, test-retest reliability, visuomotor

Introduction

Numerous studies have analyzed the role of visual function in sports performance.[1,2] Abernethy determined that the level of visual information processed is limited by the "physical characteristics of the visual information-processing system." Training and expanding on these limitations would allow one substantially to improve sports performance.[2] Aside from enhancing sports performance, evidence strongly suggests a direct correlation between concussive injuries and eye-hand coordination impairment.[3,4] It is important to find a reliable test to measure visual function for training as well as for establishing pre-concussive baselines. To achieve this goal, we plan to implement the use of the Sanet Vision Integrator (SVI), developed by Robert B. Sanet and Rodney K. Bortel. The SVI is used to evaluate visual guidance of motor performance and offers five primary programs used for vision training. These programs include: Eye Hand, Rotator, Saccades, Tachistoscope, and Metronome.[5] For the purpose of our investigation, we focused exclusively on the eye-hand section, using the Proactive, Reactive, and Hand Speed programs. These programs assess the speed of motor response to visual stimuli.

During the Proactive program, a lighted stimulus appears at random locations and remains present until the stimulus target is touched. For the Reactive program, a lighted stimulus appears at random locations and then moves to a different location after a specified period of time, even if it is touched late or not touched at all. The Hand Speed program begins with the subject keeping their hand on a central target until a lighted stimulus appears either in the superior field or laterally in the right or left field. No targets appear in the lower field because the position of the hand on the central target makes it difficult to see targets below.[5]

One of the most important factors in visual skills testing is that tests are reliable. Due to the recent emergence of the SVI in 2010, no studies have been conducted that evaluate the test-retest reliability of programs offered by the SVI. The purpose of this investigation was to determine the test-retest reliability of the Proaction, Reaction, and Hand Speed programs of the SVI in a sample of young adults.

Methods

Twenty students at the Illinois College of Optometry (ICO), ages 22-31 (mean 26.11, SD=2.1 years), performed
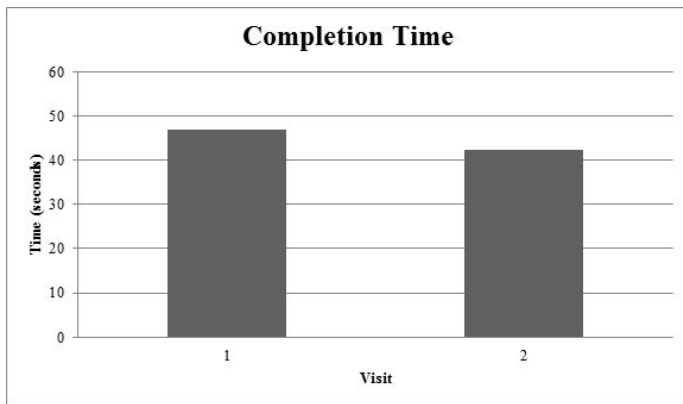
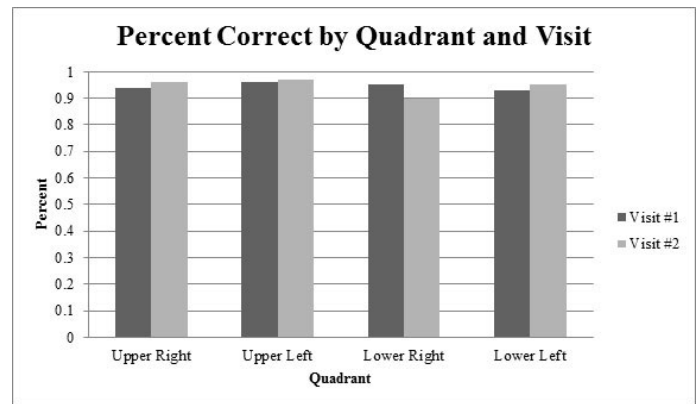*Figure 1. Mean completion time on the Proactive test*

Figure 2. Mean percent correct by quadrant on the Proactive test

the eye-hand tests of the SVI: Proactive, Reactive, and Hand Speed. Each subject was tested one at a time on the SVI at two consecutive visits spaced at least two weeks apart.

The test stimulus was a white circle displayed on a black background, set at a size of 50. Testing was performed under normal room illumination using a white size-50 stimulus on a black background with the subjects standing one meter away and the screen centered at chest level. The independent variables for the Proactive program were the number of test stimuli in each trial and their locations. In this case, that included 50 stimuli located centrally and peripherally. The independent variables for the Reactive program were the number of test stimuli per trial (50 stimuli), the amount of time the stimuli remained on the screen (0.7 seconds), and the locations of the stimuli (centrally and peripherally). For the Hand Speed program, the independent variables were the number of sets per trial (a series of seven stimuli) and the location of the stimulus series (centrally and peripherally). The dependent variables for all three subtests included the number of correctly selected stimuli and the amount of time taken to complete the test.

The tests were performed in the same order (Proactive, Reactive, and Hand Speed) for all subjects. The number of trials conducted for each subtest was determined by Baas et al. In that study, subjects performed ten consecutive trials on each subtest at two different visits in order to determine whether a learning curve was present and, if so, how many trials were needed for a plateau in performance to occur.[6] As a result of these data, four trials were performed on the Proactive subtest, and only the data from the fourth trial was used. The Reactive program did not demonstrate a learning curve; thus, only one trial was used. For the Hand Speed program, three trials were performed, and only the data from the third trial was used. Subjects stood one meter from the SVI screen, with the screen centered at chest level so that they could reach all four corners of the screen with ease and comfort. The subjects were instructed to press the stimulus quickly and accurately once it was presented using one finger of their dominant hand (not including their thumb). The finger chosen was dependent on the subject but could not be altered once the test had begun.

For the Proactive program, the total completion time, the total number of test stimuli that appeared in each quadrant of the screen, and the number of correctly identified stimuli in each quadrant were recorded. For the Reactive program, the overall completion time for each trial, the average reaction time to hit each stimulus, the total number of correct hits, and the total number of stimuli displayed to the subject were recorded. For the Hand Speed program, the mean reaction latency period, the mean hand speed, the total number of stimuli successfully hit, and the total number of stimuli displayed to the subject were recorded.

Statistical analysis of the data was performed using the analyses of variance and paired t-tests. The intraclass correlation coefficient (ICC) was calculated for each subtest in order to assess its test-retest reliability. This study was approved by the Institutional Review Board (IRB) of the Illinois College of Optometry.

Results

The results of the Proactive test are shown in Figure 1 and Figure 2. There was a statistically significant difference in average completion time between visit 1 and visit 2 ($F=3.55$, $p=0.002$), with visit 2 showing a faster average completion time of 44.25 seconds versus 46.95 seconds ($t=3.55$, $p=0.002$). For percent correct, there was no effect of quadrant ($F=1.68$, $p=0.81$) or visit ($F=1.17$, $p=0.29$). There was no interaction quadrant x visit ($F=0.76$, $p=0.55$).

Figures 3 and 4 show the results obtained from the Reaction test. The subjects demonstrated a statistically significant difference in reaction time ($t=2.89$, $p<0.001$) and percent correct ($t=2.63$, $p=0.02$) between visit 1 and visit 2. There was no statistically significant difference in completion time ($t=0.21$, $p=0.83$) between visit 1 and visit 2.

The results of the Hand Speed test are shown in Figure 5. The mean value and standard deviation for the third trial were calculated and compared between consecutive visits.

A 3-way analysis of variance (overall, central, peripheral) was used to determine the effect of retinal locus between visit 1 and visit 2. The retinal locus was not statistically different between central, peripheral, and overall targets in visit 1 and
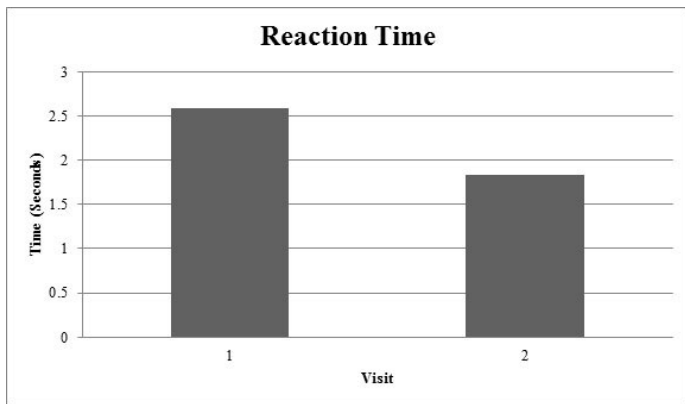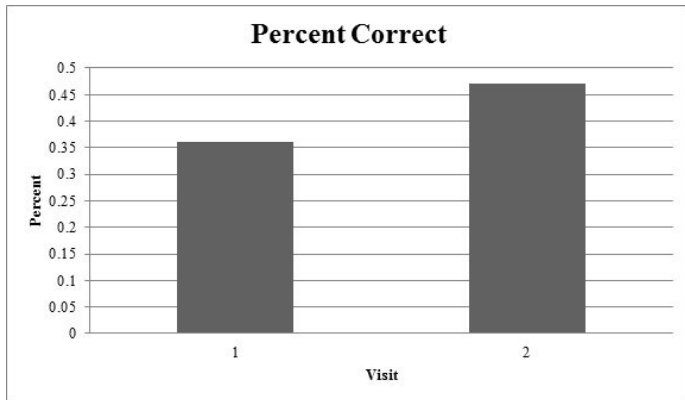
Reaction Time

Figure 3. Mean reaction time on the Reactive test

Percent Correct

Figure 4. Mean percent correct on the Reactive test

Hand Speed

Figure 5. Mean results for reaction latency, hand speed, and percent correct

Table 1. Vision Training results – Initial and at the End of Training

Test	ICC
Proactive	
Upper Right Visit 1 vs. Visit 2	0.42 (p=0.03)
Upper Left Visit 1 vs. Visit 2	0.67 (p<0.001)
Lower Right Visit 1 vs. Visit 2	0.24 (p=0.14)
Lower Left Visit 1 vs. Visit 2	0.29 (p=0.10)
Reactive	
Reaction Time	0.8 (p<0.001)
Percent Correct	0.57 (p=0.001)
Hand Speed: Overall Data Only	
Reaction Time Visit 1 vs. Visit 2	0.64 (p=0.001)
Hand Speed Visit 1 vs. Visit 2	0.83 (p<0.001)
Percent Correct Visit 1 vs. Visit 2	0.24 (p=0173)

visit 2 (F=1.14, p=0.33). Furthermore, there was no significant effect of visit for any of the three variables: reaction latency (t=0.32, p=0.75), hand speed (t=1.2, p=0.23), and percent correct (t=0.27, p=0.79). Therefore, the overall data was used for reliability analysis.

The ICCs comparing the results obtained from visits 1 and 2 are listed in Table 1. This coefficient can range from 0 to 1.0, and the closer the coefficient is to 1.0, the better the reliability. The ICC for the Upper Left Quadrant of the Proactive test was statistically significant from zero, as were the ICC values obtained for the reaction time of the Reactive test and the reaction latency and hand speed of the Hand Speed test.

Discussion

The purpose of this study was to determine the test-retest reliability of the eye-hand coordination programs of the SVI. While subjects showed an improvement in completion time of the Proactive test between visits, there was no effect of quadrant or visit for percent correct. This improvement in completion time could be due to a learning curve and familiarity with the test, as well as the motivation of a student group to improve upon their initial results. In terms of reliability, one would prefer to use a test that shows no learning effect between visits; thus, completion time is not recommended as a test to monitor subject performance over time.

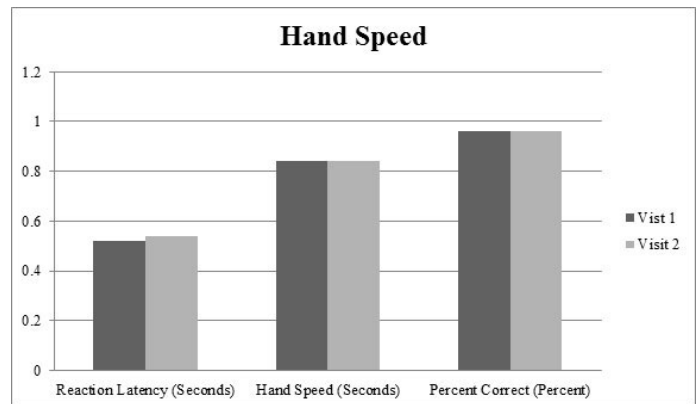The measurement of the percent correct did not show a learning effect, and thus its reliability is more promising, although the percent correct differed significantly by quadrant. Subjects performed best when tested in the upper left quadrant, which may be because the upper quadrants are closer to eye level, and subjects are accustomed to reading from right to left. The upper left quadrant also yielded the highest ICC between visit 1 and visit 2 compared to other quadrants. This implies that this quadrant has the best reliability between visits and thus could be used to monitor subjects' performance over time.

None of the three variables measured by the Reactive test showed a practice or learning effect. These variables include completion time, reaction time, and the percent correct. The ICC for completion time and percent correct demonstrated ICC values that were relatively high (0.67 and 0.57, respectively), while the ICC for reaction time did not differ statistically from zero. Thus, completion time and percent correct could also be used to monitor patient performance over time.

Of the three subtests that comprise the Hand Speed test, none demonstrated a practice effect, but only two of them had ICC values significantly different from zero. However, the ICC values for average overall hand speed and average overall reaction time are high and thus could potentially be used to monitor patient performance over time.

We note that there is no definitive range of ICC values defined as excellent, good, fair, or poor, and in fact, even the definition of reliability is not agreed upon. As pointed out by Weir, reliability refers to the consistency of a test or measurement, but this simple concept is fraught with different definitions and different methods of calculation.[7] As a result, quantifying reliability in the medical literature and in the sports science literature is difficult. We have followed the recommendations proposed in 2011 by Kottner et al., who published guidelines for how to design, to analyze, and to report reliability and agreement studies. The ICC is recommended for use when the data under investigation are continuous in nature, which is what we have in the present study and when test-retest reliability is the measure of interest.[8] We are assuming that an ICC value of 0.83, which was the highest we obtained, is an indication of good reliability. Our results indicate that there are a number of subtests of the SVI which have ICC values of about 0.7 or higher, indicating that at least for this sample, there are a number of reliable subtests of the SVI. We note that our sample was small and that our subjects were of a highly specific cohort in that they were all optometry students who are trained to make accurate observations and who are well aware of the benefits of research. Additional reliability assessments should be considered with a larger sample size of healthy, young adults who form a more heterogeneous group.

Conclusion

There are subtests of the Proactive, Reactive, and Hand Speed tests of the Sanet Vision Integrator that can reliably measure eye-hand coordination. Although not all tests are reliable, many can be used with confidence.

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