A simpler test of Eye-Hand Coordination using an iPad

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Introduction

The easily accessible Lee-Ryan Eye-Hand Coordination (L-R EHC) Test iPad app was developed to overcome the difficulties inherent in other EHC tests including use of upper arm musculature, objectivity, standardisation, and ease of use in clinical environments.[1,2,3] The L-R EHC test comes in the format of a game whereby participants trace along a straw as it draws the milkshake up out of a glass (Fig.1). At the end, total error score and total time are displayed for clinicians, but additional data for deeper shape-by-shape analysis can be emailed (Fig.2). Population norms for all 19 items in the L-R EHC Test have been established [ARVO 2017 #5427]. However, with testing taking between 6.4 to 15.8 minutes depending on age, two condensed versions of the test would be more clinically useful and provide for pre/post testing.

Purpose

- **To develop two subtests of the Lee-Ryan Eye Hand Coordination test app, each with 6 plates that range in difficulty, and equivalent with respect to total errors made and total time taken.**

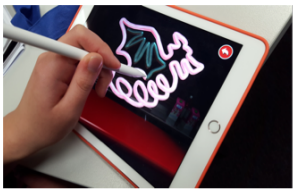

Figure 1: Example of Dragon trace in progress with the Lee-Ryan EHC Test using an Apple iPencil®

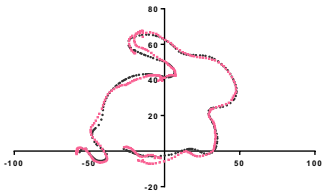

Figure 2: One participant's deviations (pink) against the original Rabbit shape (grey).

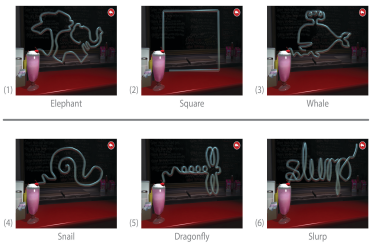

Figure 3A: Subset A of the Lee-Ryan EHC Test (elephant/square/whale/snail/dragonfly/slurp)

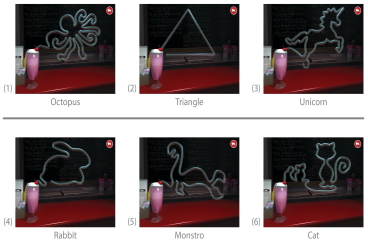

Figure 3B: Subset B of the Lee-Ryan EHC Test (octopus/triangle/unicorn/rabbit/monster/cat)

Methods

HARDWARE AND SOFTWARE

- iPad® Pro and Apple iPencil® [Apple Inc., Cupertino, CA, USA, Ipad Pro Model A1674; 9.7 inch, Apple Pencil Model A1603] using Bluetooth technology
- The original software (Lee et al.[3]) was re-developed by Chaos Theory Games to provide more appealing rendered figures, improved sound effect options, and improved data download functionality. The current version was downloaded from iTunes® where it is available for a token fee
- As no order effect had been found previously [ARVO 2017/#5427], 4 easy, 4 medium and 4 difficult tracing plates were assigned across two subsets (A & B) such that previous data for those items (within a 19-plate testing protocol) yielded comparable total errors and total time taken.

SUBJECTS

- 65 participants, age range 12 - 68 years, mean 31.6±16.8 years.
- No history of motor, visual or psychological or cognitive impairment; nor fitted with an electronic medical device.

METHODS

- Participants were seated at a desk at 33-40cm, wearing habitual near correction viewing binocularly and used their preferred hand while they traced using a stylus pen and the iPad flat on the desk
- A common first plate (castle) was used for practice, and the warning sound option was activated to alert when a mistake had been made. Participants were encouraged to start tracing within 5 seconds of each new shape appearing
- Each participant completed both Subset A and Subset B (Fig.3) starting randomly with either Set A or B, but then tracing each plate in the same order
- Instructions given: *"Sitting still, and starting from the cherry on top of the milkshake, do your best to trace within the straw as fast as you can without lifting the stylus off the iPad and taking care on tight corners. The number of mistakes you make and your time will be saved by the program. You will be able to take a rest in between each shape if you want."*
- Output data were emailed from the iPad to the researcher and analysed using non-parametric methods.

STUDY MEASUREMENTS

- Output data included (i) time taken to complete each trace, (ii) total errors made for each trace, and (iii) spatial accuracy of the stylus placement from the centre of the straw (Figure 2).

STATISTICAL ANALYSIS

- Participants were split into 10-year age groups. ANOVAs were undertaken to compare data from subsets A and B, and the influence of age and shape complexity.

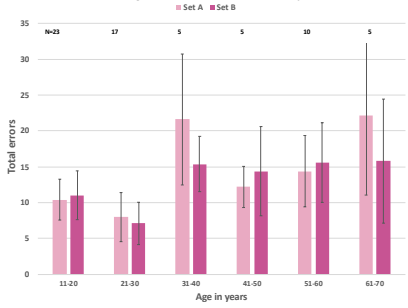

Figure 4: Average total number of errors on subtests A and B according to age. Error bars 95% CI.

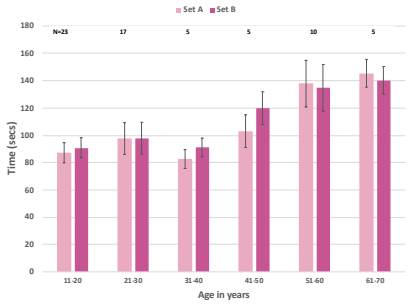

Figure 5: Average total time taken on subtests A and B according to age. Error bars 95% CI.

Results

- **No significant difference in total errors between Set A (12.3±8.8) or Set B (11.7±8.1) was found (Fig.4). Similarly, no difference in the total time taken was found between Set A (103.4±29.1 secs) or Set B (105.5±28.8) (Fig.5)**
- **For both sets A and B a small positive correlation was found between total errors and age (r=0.26/p=0.04; r=0.27/p=0.03 respectively)**
- **For both sets A and B a moderate positive correlation was found between total time taken and age (r=0.63/p<0.0001; r=0.59/p<0.0001 respectively)**
- **With increasing shape complexity, the time taken to trace individual shapes increased disproportionately with age, especially for those over the age of 50 years.**

Discussion

- **This large sample of both young and older participants has validated that subsets A (elephant, square, whale, snail, dragonfly, slurp) and B (octopus, triangle, unicorn, rabbit, monster, cat) of the L-R EHC Test yield similar total error scores and total time taken in all age groups**
- **Hence subtests A (elephant et al) and B (octopus et al) represent equivalent mini-versions of the L-R EHC Test that can be used in pre-/post testing situations**
- **As testing time has been reduced to less than 2 minutes for most people, the convenience of the L-R EHC iPad app has expanded for optometrists and other healthcare professionals such as psychologists, paediatricians, neurologists, rehabilitation specialists and educationalists.**

Conclusion

Two subtests of the the Lee-Ryan Eye-Hand Coordination Test app have been created and validated to provide equivalent pre-/post-intervention EHC testing options for those who are interested in quantifying EHC performance[4] in clinical and research settings when evaluating ophthalmic conditions such as amblyopia[5], post-traumatic brain injury, or other medical and developmental conditions which may affect EHC performance.

References

1. Ruff R PS. Gender and Age-specific changes in Motor speed and Eye-hand coordination in adults: Normative values for the Finger tapping and Grooved Pegboard tests *Perceptual and motor skills* 1993; 76: 1219-1230.
2. Vesia M EJ, Prime S, Klavora P. Correlations of selected psychomotor and visuomotor tests with initial Dynavision performance. *Perceptual and motor skills* 2008; 107: 14-20
3. Lee K, Junghans BM, Ryan M, Khuu S, Suttle CM. Development of a novel approach to the assessment of eye-hand coordination. *Journal of neuroscience methods* 2014; 228: 50-56.
4. Van Halewyck F, Lavrysen A, Levin O, Boisgontier MP, Elliott D, Helsen WF. Both age and physical activity level impact on eye-hand coordination. *Human movement science* 2014; 36: 80-96.
5. Suttle CM, Melmoth DR, Finlay AL, Sloper JJ, Grant S. Eye-hand coordination skills in children with and without amblyopia. *Invest Ophthalmol Vis Sci* 2011; 52: 1851-1864.

Acknowledgements

The L-R EHC Test app is available from iTunes® for a small fee. The authors were involved in the development of the software, but have no financial interest. Test A/B graphics courtesy of SooJin Nam.