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ORIGINAL ARTICLE

Correcting Finger Counting to Snellen Acuity

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ABSTRACT
In this paper, the authors describe an online tool with which to convert and thus quantify count finger measurements of visual acuity into Snellen equivalents. It is hoped that this tool allows for the re-interpretation of retrospectively collected data that provide visual acuity in terms of qualitative count finger measurements.

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Count fingers; Snellen; visual acuity

Retrospective chart reviews pose a number of challenges for authors, as the data are often not compiled or collected in a manner that allows for effective mathematical manipulation and interpretation. This is particularly problematic when reviewing worse than 20/400 visual acuity. Ideally, such data would be recorded using Early Treatment Diabetic Retinopathy Study (ETDRS) or Freiburg Visual Acuity Test (FrACT), both of which are capable of quantifying poor visual acuities.[1,2] Unfortunately, these measurements were historically denoted as count fingers (CF), hand motion (HM), light perception (LP), or simply off chart. Although there are published guidelines for the conversion of CF and HM to decimal acuity, they do not consider the distance at which the test was performed.[3] This ignores the fact that CF at 1 ft is worse than CF at 10 ft, a 10-fold difference in Snellen equivalent (approximately 20/4000 to 20/400).

Our Count Fingers Snellen Calculator (www.countfingers.com) makes it possible to calculate Snellen Equivalents for CF measurements recorded in retrospectively collected data. The calculator utilises the width of the examiner's digits and the inter-digit distances when the examiner is holding their hand in the appropriate manner to examine a patient whose vision is worse than 20/400. The finger widths of the index (1st digit), middle (2nd digit), and ring finger (3rd digit) were determined at the distal interphalangeal joint (DIP) as well as inter-digit distances. This distance approximates 5' of arc, which mimics the 5' of arc measured by the Snellen letter E. The Snellen acuity is calculated using geometric optics using the formula presented in Figure 1.

To expand the utility of our calculator, we conducted a survey of 50 males and 50 female hospital employees (39.44 ± 12.14 years old) and calculated an average digit width and inter-digit distances for both males and females (Table 1). The average DIP widths of the index, middle, and ring digits were 14.83, 15.12, and 14.15 mm with standard deviations (SDs) of 1.94, 2.01, and 2.00, respectively. The average inter-digit distance between index and middle digits was 21.20 mm with a SD of 6.19, and the average inter-digit distance between the middle and ring digits was 20.77 mm with a SD of 2.00. The large standard deviations, in particular regarding inter-digit distances, suggest that measuring the examiner's hand can provide a more accurate Snellen equivalent.

To illustrate the application of a customised Snellen acuity value, we reviewed a publication by Dr. William F. Hoyt, the well-known neuro-ophthalmologist who has authored nearly 300 scientific papers. In one of these publications, "Chiasmal gliomas and long-term changes demonstrated by computerized tomography," Dr. Hoyt's group tracked the change in size of chiasmal glioma by computed

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$$\frac{20\,ft}{x} = \frac{(8.75\,mm)\frac{z\,ft}{20\,ft}}{y}$$

Figure 1. Formula for calculating Snellen equivalent acuities, where x represents the Snellen distance in feet, y represents the combined width of the three DIP joints and inter-digit spaces, and z represents the distance in feet that the CF was measured.

Table 1. Finger measurement averages from 100 subjects.

Parameter	Male	SD	Female	SD	Overall	SD
Index finger width (mm)	15.74	1.29	13.93	2.07	14.83	1.94
Index/middle inter-digit distance (mm)	21.56	6.86	20.83	5.48	21.20	6.19
Middle finger width (mm)	16.09	1.24	14.16	2.18	15.12	2.01
Middle/ring inter-digit distance (mm)	22.04	8.06	19.51	6.50	20.77	2.00
Ring finger width (mm)	15.00	1.10	13.30	2.32	14.15	2.00
Age (years)	39.33	11.57	39.56	12.79	39.44	12.14

tomography (CT) scans and correlated them with changes in visual acuity.[4] In one of 22 patients included in the study, CT-documented tumor growth was noted alongside a loss in visual acuity over 4 years. In the initial publication, the change was recorded as a drop from 20/100 to CF 10 ft, two visual acuities recorded in two different modalities. Using our Count Finger Snellen Calculator, this can be re-interpreted and re-understood as a change from a logMAR of +0.70 to a logMAR of +1.306. By measuring Dr. Hoyt's digits and inter-digit spaces, we provide a cipher with which to re-interpret the prolific neuro-ophthalmology literature published based upon his clinical finger counting examinations (Figure 2, Table 2).

By converting the CF measurement to logMAR, Snellen equivalent, or decimal equivalent, changes in visual acuity are better quantified for direct comparison. In addition, it allows for comparisons to be made between CF values measured by different physicians in different publications and for combining data sets in systematic reviews. CF has long been considered a qualitative, user-dependent mode of visual acuity evaluation. We recognise that this calculator does not correct for the variability in the measuring process (3 ft might not be exactly 3 ft, variability in the spread of fingers of the examiner, variability in contrast between the fingers and background, etc.), and we do not mean to imply too great a precision. Ideally, prospective visual acuity data would be collected using a method that accounts for these factors even in very low vision situations. However, this calculator still offers reasonable quantification for retrospective studies, when more accurate data were not obtained, provided that the person or persons who measured the vision are still available to have their hands measured. With this converter, the ophthalmologist's most basic and most readily available tool for visual acuity measurement becomes quantifiable and can be standardised between users. We anticipate this will be a useful tool for retrospective research.

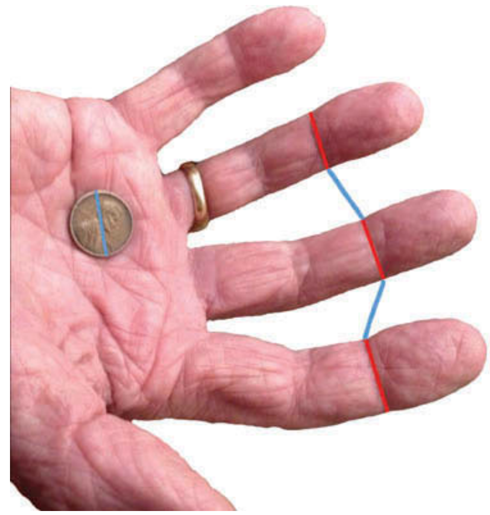

Figure 2. Image of Dr. Hoyt's hand and a penny as a scale reference.

Table 2. Dr. William F. Hoyt's right hand finger measurements,

Index finger width (mm)	22.07
Index/middle inter-digit distance (mm)	17.42
Middle finger width (mm)	17.42
Middle/ring inter-digit distance (mm)	15.10
Ring finger width (mm)	16.49

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Declaration of Interest

Disclosures: Dr. Rustum Karanjia has worked in the past as a consultant for Stealth Biotechnologies and is not currently a consultant for Stealth; Dr. Alfredo A. Sadun received unrestricted grant support from Stealth Biotechnologies and Edison Pharmaceuticals. There was no funding from Stealth Biotechnology or Edison Pharmaceuticals for this project. The authors alone are responsible for the content and writing of the paper.

References

[1] Schulze-Bonsel K, Feltgen N, Burau H, Hansen L, Bach M. Visual acuities "hand motion" and "counting fingers" can be quantified with the freiburg visual acuity test. *Invest Ophthalmol Vis Sci* 2006;47:1236–1240.

[2] Klein R, Klein BE, Moss SE, DeMets D. Inter-observer variation in refraction and visual acuity measurement using a standardized protocol. *Ophthalmology* 1983;90: 1357–1359.

[3] Holladay JT. Proper method for calculating average visual acuity. *J Refract Surg* 1997;13:388–391.

[4] Fletcher WA, Imes RK, Hoyt WF. Chiasmal gliomas: appearance and long-term changes demonstrated by computerized tomography. *J Neurosurg* 1986;65:154–159.