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Short Communication

Vision in the 21st Century: Understanding and Reevaluating Acuity Measurement

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Understanding the mechanics of vision, a process largely unaltered over the past 300,000 years, is pivotal to appreciating the intricacies of visual acuity. Central to this process are cone-photoreceptors located in the far rear of the retina, serving as the primary determinants of visual focus. As light traverses the biological lens, it undergoes refraction, causing Blue to focus in front of the retina, Green on the retina, and Red behind the retina. This color disparity in focal depths is then conveyed by color-receptive cone photoreceptors to the neuroganglia layer situated in front of the photoreceptors, essentially functioning as a biological circuit board (refer to Figure 1). This neuroganglia layer not only transmits color perceptions to the brain via optic nerve fibers but also sends regulatory signals to the lens, ensuring precise focus. The resulting regulation forms a Chromatic Triangulation function, aiding the lens in maintaining a sharp focus on the retina (refer to Figure 1) [1].

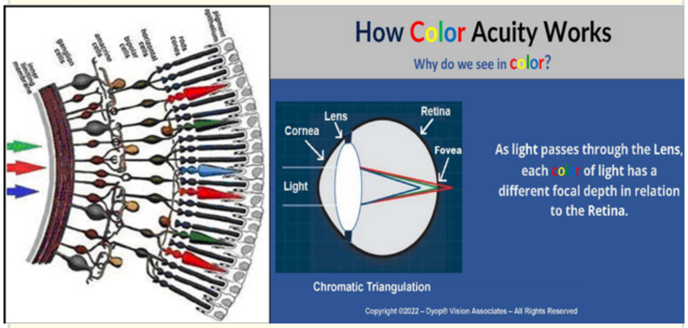

Figure 1: Neuroganglia functioning and chromatic triangulation.

Technological advancements have significantly influenced the understanding of vision, especially in relation to how cone-photoreceptors impact focus. While the evolutionary aspect of vision mechanics remains constant, historical considerations have played a significant role in shaping acuity measurement methodologies. Dr. Hermann Snellen's introduction of the Snellen test in 1862, based on static European letters, became a benchmark for acuity measurement. The emphasis on letter recognition, however, led to an oversight of the physiological reality that vision does not perceive the "back" of letters but focuses on the white (inconsistent and irregular) gaps within them. This method became the "global standard" for acuity measurement, solidifying its status after Snellen's trademark expiration [2].

The Consilium Ophthalmologicum Universale in 1984 further codified the Snellen test, defining it as the Clinical Standard of acuity. While this standardization provided a common metric, it lacked in-depth discussions on the mechanics of vision and strategies for improving acuity measurement in diverse populations. Wolfgang Grimm's 1994 discovery of a disparity in Landolt and Snellen letter configurations added another layer to the discussion [3]. The Consilium acknowledged the evolving nature of standards and recommended periodic reviews for future adjustments, understanding that a standard is not immutable. Nevertheless, over the past four decades, technological advancements have revealed gaps in the 1862 and 1984 concepts, especially in understanding the mechanics of vision and addressing diverse populations, including children, infants, and non-literate individuals [3].

A significant development in recent decades is the emergence of a Global Epidemic of Myopia, particularly in non-European countries and cultures. The prevalence of emitted light from computer displays is identified as a potential contributor to this rise in myopia. The visual response to these displays exhibits discernible differences in acuity measurements compared to traditional Snellen displays. The analogy of a TV monitor to an eye underscores a shift in understanding vision mechanics [4,5].

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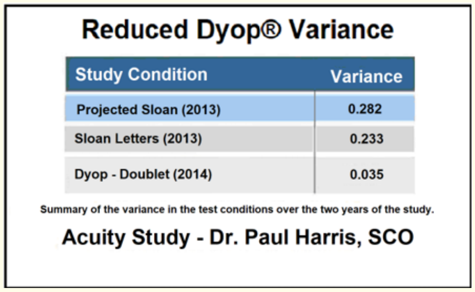
The introduction of a strobic/dynamic optotype known as a Dyop has revolutionized acuity and refraction measurements. The strobic stimulus of a Dyop compensates for the elevated myopic power perception associated with Snellen testing, likely due to the static image depletion response of photoreceptors (refer to Figure) [5,6].

Optotype components

- Visual angular movement/velocity for strobic contrast response (40 RPM optimum) creating Resonance Acuity.
- Moving segmented 0.54 arc minute squared Minimum Area of Resolution (MAR) for dynamically stimulating a 20 photoreceptor cluster for Dynamic Acuity.
- Retinal photoreceptor cell clusters.
- Examples of historic static Recognition Acuity optotypes using gap detection (Landolt) or letter recognition (Snellen).
- Static 1.0 arc minute squared Minimum Area (MAR) of a 40 retina photoreceptor cluster for a historic static optotype.

Consistent findings from comparative Dyop/Snellen refraction studies emphasize a prevalent inclination toward increased myopic power in Snellen, potentially contributing to the Global Epidemic of Myopia [4-6].

Another point of contention in the understanding of vision mechanics comes from Dr. August Colenbrander, one of the leading proponents of Snellen testing. Colenbrander describes variances in acuity and refraction measurement as inherent perception anomalies in visual systems. However, his reverence for the Snellen concept leads to an oversight – vision is not a Black Box regulated by a mysterious force within the brain, but a simple mechanism regulated by the retina where visual stimuli are first perceived [2,3,7]. The crux of the disparity lies in the oversight by both Snellen and Landolt, assuming acuity is a one-dimensional process (Minimum ARC of Resolution) rather than a two-dimensional process with a Minimum Area of Resolution of 1.0 arc minutes squared. The Dyop's empirically determined Minimum Area of Resolution is 0.54 arc minutes squared for 6/6 (20/20) acuity. This consistent and uniform Dyop stimulus area is essentially half the stimulus area of Snellen/Landolt testing, explaining why Dyop testing is more precise, consistent, and efficient (refer to Figure 2) [8].



Reduced Dyop® Variance

Study Condition	Variance
Projected Sloan (2013)	0.282
Sloan Letters (2013)	0.233
Dyop - Doublet (2014)	0.035

Summary of the variance in the test conditions over the two years of the study.

Acuity Study - Dr. Paul Harris, SCO

Figure 2: Dyop/Snellen Variance.

However, Colenbrander's belief that vision is primarily a resolution process adds a distinctive layer to the discourse. Recognition materializes when resolution acuity attains a sufficient level of accuracy. The consistent Dyop stimulus area, being about half the area of Snellen, likely explains the bloated Snellen stimulus and the LogMAR behavior of Snellen optotypes [9]. While the 1862 Snellen test was a significant breakthrough in improving vision measurement, the inherent overestimation of the Snellen gap (Minimum AREA of Resolution) results in Snellen optotypes being inherently inaccurate and imprecise by 21st-century technology standards. The LogMAR concept, based on the Snellen MAR, is not a precise measure of actual visual acuity but a "pious fraud" as taught religiously to Eye Care Professionals [10]. Every Dyop versus Snellen/Sloan refraction study shows that the Snellen/Sloan refraction overcorrects acuity measurement by an average of 3 to 5 lines. This overcorrection is why Snellen predicts more myopia than Dyop with comparable test time – this consistent overcorrection results in 90% of spectacle-wearing persons developing myopia after age 21, as observed in many East Asian countries [9].

More so, the 1984 Consilium Ophthalmologicum Universale's adherence to the Snellen concept as the clinical standard has limited the vision field. The two-dimensional nature of vision as recognized by Dyop is obscured by the letter-centric approach of Snellen. Dyop testing recognizes the essence of recognition, and rather than focusing on isolated letters, considers the physiological dynamics of a retinal 20 photoreceptor cluster when determining visual acuity [9]. Colenbrander's resistance to the notion of the retina determining acuity during his 2020 webinar showcases a steadfast attachment to the 1862 Snellen concept. The stubborn adherence to an archaic model overshadows the advancements made in understanding vision mechanics [9].

Despite the resistance from traditionalists, Dyop testing has garnered support, particularly in research by Dr. Peter Gordon. His comprehensive review emphasizes the precision, accuracy, and efficiency of Dyop testing compared to the Snellen chart [5]. A notable aspect of Dyop testing is its potential to address the Global Myopia Epidemic. By providing a more accurate and consistent measurement of visual acuity, Dyop testing minimizes the risk of myopic overcorrection associated with Snellen testing. The dynamic optotype's ability to adapt to the physiological dynamics of the eye offers a promising solution to a critical global health issue [9].

In addition to acuity, understanding vision mechanics extends to physiological variances in the L/M ratio. The Chromatic Triangulation process, facilitated by foveal cone-photoreceptors, not only regulates acuity but also accommodates the eye to varying lighting conditions. This mechanism becomes crucial in conditions such as dyslexia, migraines, and epilepsy, where anomalies in the L/M ratio contribute to visual disturbances [9].

In the quest for improved vision testing, recent advancements include the Adjustable Oval Dyop, a revolutionary tool that aims to validate prescriptions without the need for a phoropter. This innovation, along with ongoing research, seeks to enhance the accuracy, efficiency, and overall empowerment of patients in vision care [11].

As we navigate the 21st century, a comprehensive understanding of vision mechanics, coupled with advancements in acuity measurement like Dyop testing, promises to reshape the landscape of eye care. Embracing these innovations not only enhances the precision of vision assessments but also addresses global challenges like the Myopia Epidemic, bringing us closer to a future where optimal vision is a reality for all.

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