



## How is Reflex Score Calculated?

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Pupillary reflex scoring systems, like the NPi® Score generated by Neuroptics' devices, do not disclose how their score is calculated. In many cases this score is used as a correlator for diagnostic decision making. Yet, the fundamental link is trust that the score is calculated in a reliable way with no reasonable indication that it is.

Reflex was recently updated with a new feature called Reflex Score. Reflex Score is a composite score of all calculated rate-determinate pupillary values as part of the constrict & full spectrum test types. Our mission is transparency to deliver the best possible product we can. So, here is how Reflex Score is calculated.

### Cosine Similarity

Reflex Score utilizes a mathematical notion called Cosine Similarity. Mathematically this is represented as:

$$A \cdot B = \|A\| \|B\| \cos \theta$$

$$\text{similarity} = \cos \theta = \frac{A \cdot B}{\|A\| \|B\|}$$

$$\frac{A \cdot B}{\|A\| \|B\|} = \frac{\sum_{i=1}^n A_i B_i}{\sqrt{\sum_{i=1}^n A_i^2} \sqrt{\sum_{i=1}^n B_i^2}}$$

Where  $A$  is a vector of the patient's baseline parameters and  $B$  is a vector of the patient's current test parameters that are being scored. Vector  $A$  will remain the same until a new baseline of the same test type and parameters are taken. This calculation has continuity from  $-1$  to  $1$ . Where  $-1$  is exactly opposite and  $1$  meaning they are identical. In this case, the negative range is an unreconcilable conclusion given the parameters cannot be opposite in sign. This narrows the true range from  $0$  to  $1$ .

Continuity is quantized into whole values from 0 to 5. Where 5 is most similar and 0 is most dissimilar. Thus, a score of 1 is inherently quite different from baseline (vector  $A$ ) while a score of 4 is reasonably close.

Our goal is to deliver the best product possible which comes with refinement. Our intent is to increase the utility of this calculation. Looking forward, we're working on population averages that are age bracketed to make Reflex Score calculable when no baseline exists. Further opening the opportunity to unlock the diagnostic power of the pupil.

Note: Only rate-determinate parameters are used in vectors  $A$  and  $B$ . This includes latency, time to minimum diameter, average constriction velocity, maximum constriction velocity, and amplitude for the constrict test type. Full spectrum adds dilation velocity and 75% recovery time.