

Definition of terms

Raw data

What can be considered raw data? How should we handle smoothing in terms of a system's accuracy and precision? At what level do we need to be able to log data in order to carry out measurements?

Accuracy

Accuracy is calculated as the average angular offset (distance) θ_i (in degrees of visual angle) between n fixations locations and the corresponding locations of the fixation targets.

$$\text{Offset} = \frac{1}{n} \sum_{i=1}^n \theta_i$$

Although accuracy is straightforward to calculate given the position of a fixation, there is little consensus on exactly how to define a fixation.

Spatial Precision

Precision is calculated as the Root Mean Square (RMS) of the angular distance θ_i (in degrees of visual angle) between successive samples (x_i, y_i) to (x_{i+1}, y_{i+1}) .

$$\text{RMS} = \sqrt{\frac{1}{n} \sum_{i=1}^n \theta_i^2}$$

System latency

The eye-tracker latency is defined as the average end-to-end delay from an actual movement of the tracked eye until the recording computer signals that a movement has taken place.

Temporal precision

Temporal precision is defined as the standard deviation of eye-tracker latency. A high temporal precision means that even if the samples arrive with a latency, the interval between successive samples remains almost constant. If the temporal precision is low, you have a variable latency and a variable delay in the synchronisation to external software such as stimulus programs or auxiliary recordings such as EEG.

System-, oculomotor-, and environmental noise

System-inherent noise: Best possible precision you can get with a given eye-tracker, also known as spatial resolution. This is typically measured with artificial eyes, which are absolutely still, so we know for certain that spatial variance comes from the eye tracker itself.

Oculomotor noise: Traditionally refers to the fixational eye-movements tremor, microsaccades and drift, even though microsaccades have been linked to cognitive functions (Martinez-Conde et al., 2009). Oculomotor noise is often called jitter (Martinez-Conde et al., 2004; Jacob, 1991).

Average system noise: The average precision as measured from a large participant population with a wide spectrum of eye physiologies and iris colours. The average system noise is the real-life precision that can be expected of a system.

Optic artifacts: False, i.e. physiologically impossible, high-speed movements, often with a much larger amplitude than other types of noise, and caused by interplay between the optical situation (such as glasses, contact lenses, additional reflexes and shadows, and varying ambient light conditions) and the gaze estimation algorithm.

Environmental noise: Variation in the gaze position signal caused by external disturbances in the recording environment.

Noise (general): The combination of system-inherent, oculomotor, and environmental noise and sometimes also including optic artifacts.

Resolution is a common term related to precision, usually referring “the smallest movement that can be detected”. It is sometimes operationalised as the standard deviation of the pupil position in the eye video, but to the vast majority of users, this is less relevant than precision in gaze position.

Both accuracy and precision can – after some training – easily be seen in data visualisations such as scanpath plots with raw data, and space-time diagrams where gaze coordinates are plotted against time.