

Precision Eye Tracking Reveals Saccadic Dysfunction Post-Stroke Not Captured Clinically

Lydia M. Kuhl^{1,2}, Matthew J. Chilvers^{1,2}, Isabelle Poitras^{1,2}, Alexis K.F. Hill^{1,2}, Sean P. Dukelow^{1,2,3}

¹Cumming School of Medicine, University of Calgary ²Department of Clinical Neurosciences, University of Calgary ³Division of Rehabilitation and Physical Medicine, University of Calgary

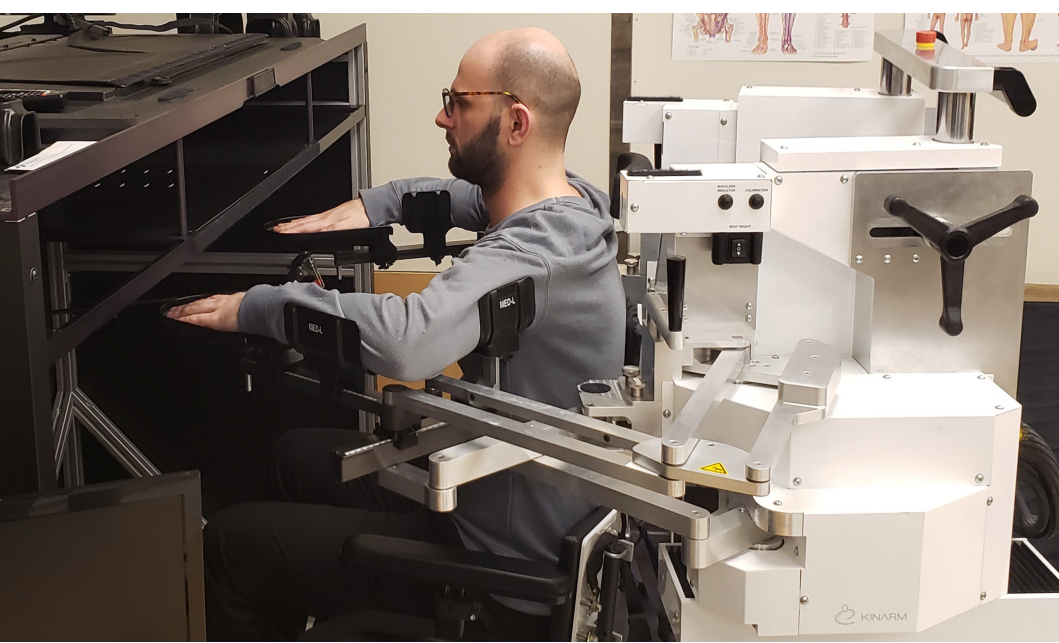


Background

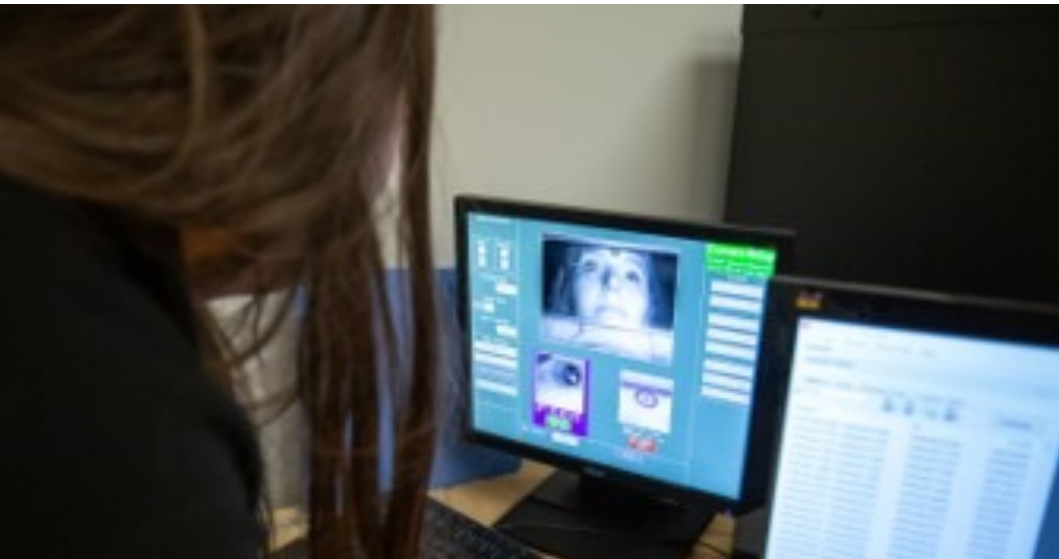
- The ability to make fast, accurate, saccades is important to everyday functioning
- Oculomotor problems are common post-stroke, but clinical assessments of eye movements are crude
- Creating more sensitive and robust assessments for eye movements post-stroke is important for improving rehabilitation outcomes

Aim: To characterize and assess saccades to visual targets in stroke survivors.

Methods

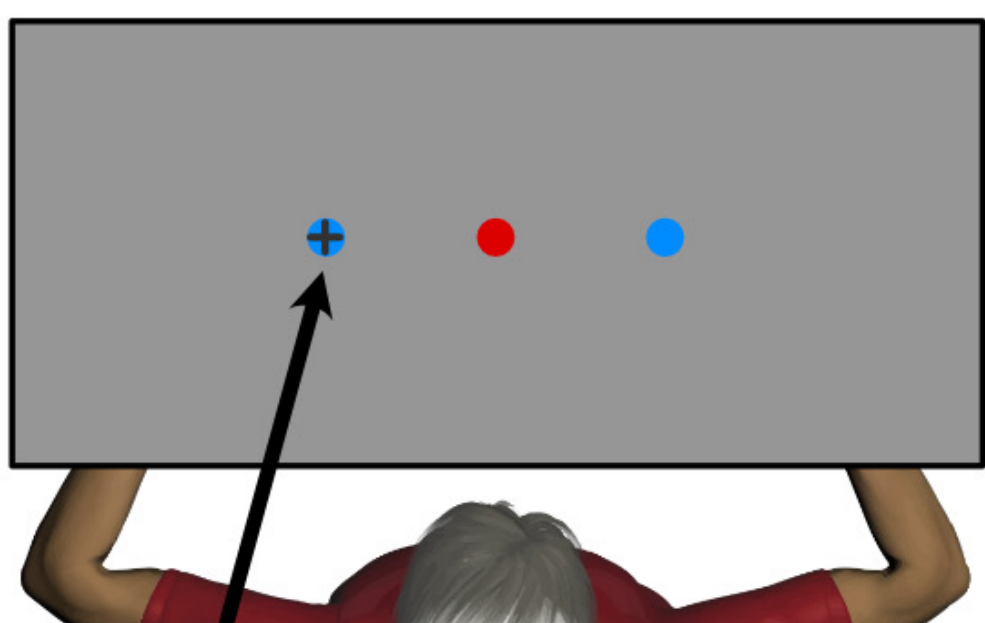


Kinarm exoskeleton.



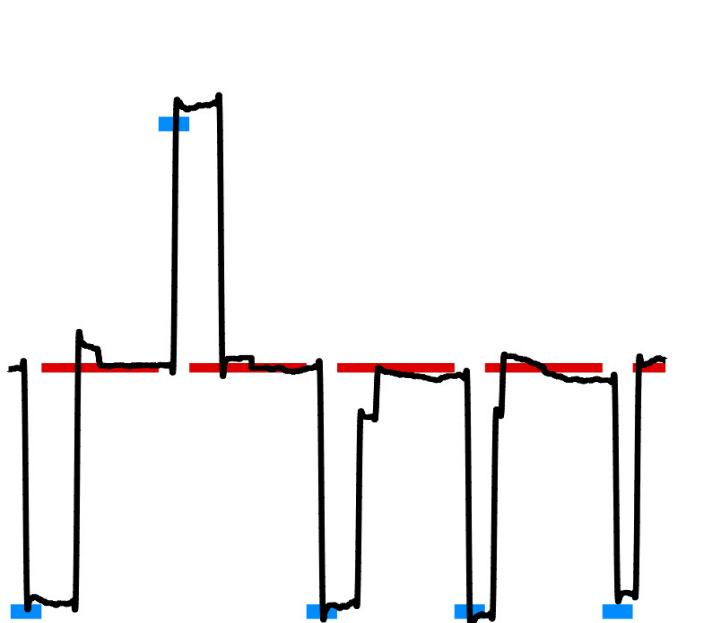
EyeLink1000 video-based eye tracker (sampling at 500Hz).

Saccade task



Participant looks between central and peripheral targets as they turn on/off. Repeated for 60 trials, target order pseudorandomized.

Control



Stroke

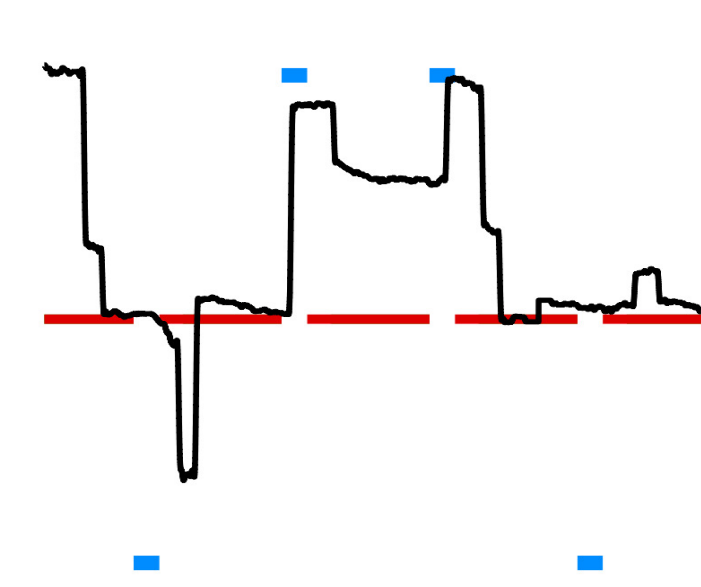


Table 1. Saccade task parameters. A trial begins when the center target turns off and a peripheral target turns on.

Parameter	Description
Accuracy (°)	Accuracy of the first saccade made during a trial.
Corrective Accuracy (°)	Most accurate saccade made during a trial.
Latency (ms)	Time between the peripheral target turning on and the start of the first saccade made during a trial.
Gain	Amplitude of the first saccade made during a trial divided by displacement of the stimulus (10cm).
Peak Velocity (°/sec)	Highest velocity of the first saccade made during a trial.
Amplitude (°)	Angle between the start and end of the first saccade made during a trial.

Control data (N = 109, mean age 47, age range 18-97, sex 43M/66F, handedness 9L/100R) was used to create normative models and calculate z-scores adjusted for age and sex in stroke survivors for all task parameters.

Results

Table 1. Demographics.

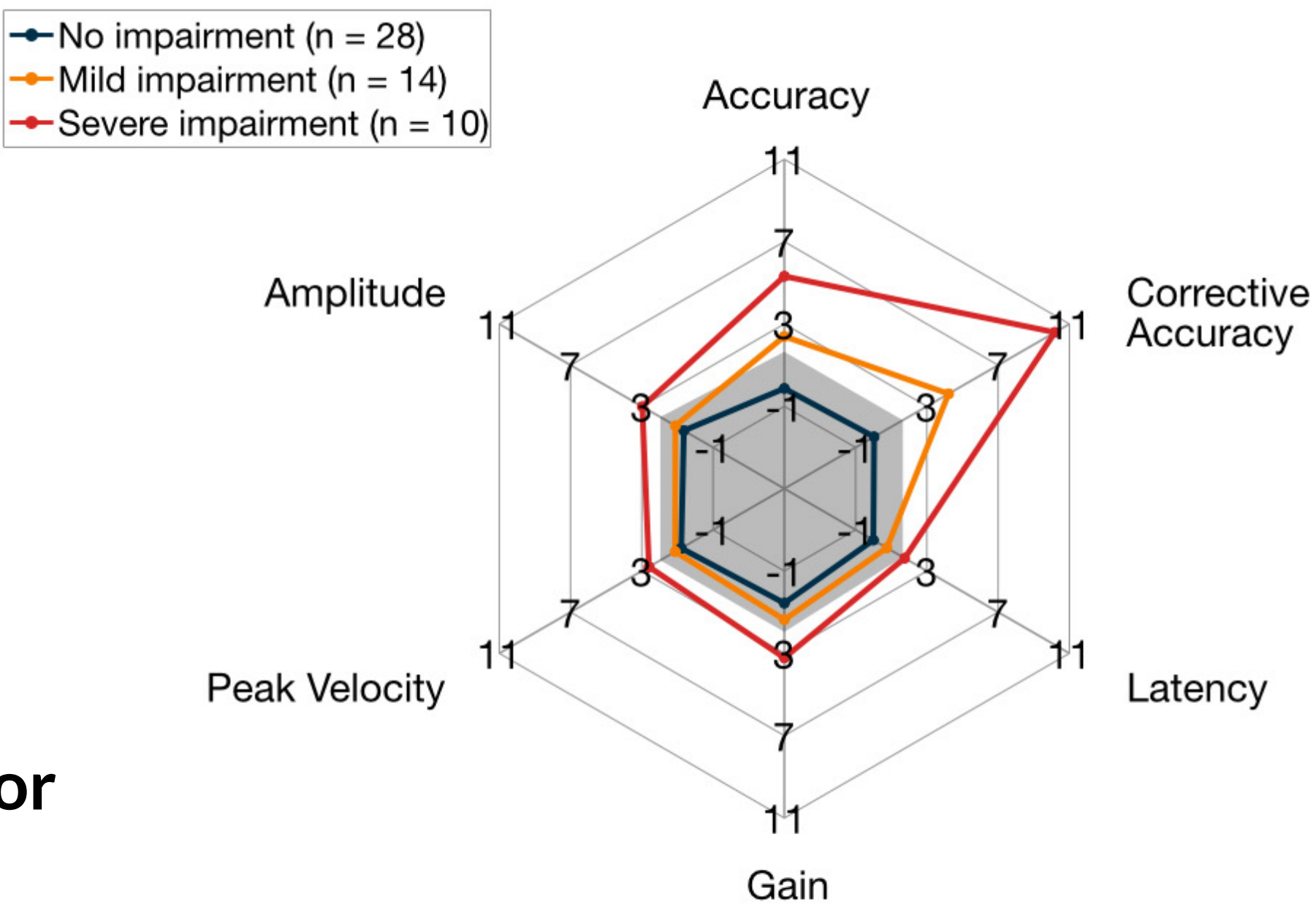
	Stroke (N = 52)
Age (mean, range)	57, 26-83
Sex [M/F]	34/18
Handedness [L/A/R]	4/1/47
Days since stroke (mean, range)	43, 1-254
Stroke type [I/H]	43/9
Lesioned hemisphere [L/B/R]	27/2/23
Affected side [L/B/R]	22/4/26
BIT (median, range)	144, 113-146
Visual field cuts [Y/N]	8 ^a /44
Clinically diagnosed eye movement issues [Y/N]	8 ^a /44

^a2 participants overlap in the field cut group and clinically diagnosed eye movement issues group

Spider plot showing mean z-scores for each impairment group on visual saccade task parameters. Grey shaded area represents the bounds of normal.

Stroke participants were sorted into groups:

- No impairment** → **Abnormal on <2 parameters**
(On average, control participants were abnormal on 0 or 1 parameter)
- Mild impairment** → **Abnormal on 2 or 3 parameters**
- Severe impairment** → **Abnormal on >3 parameters**



UpSet plot showing impairment combinations in stroke survivors on the visual saccade task. Impairments in accuracy and minimum accuracy were the most common, followed by impairments in latency.

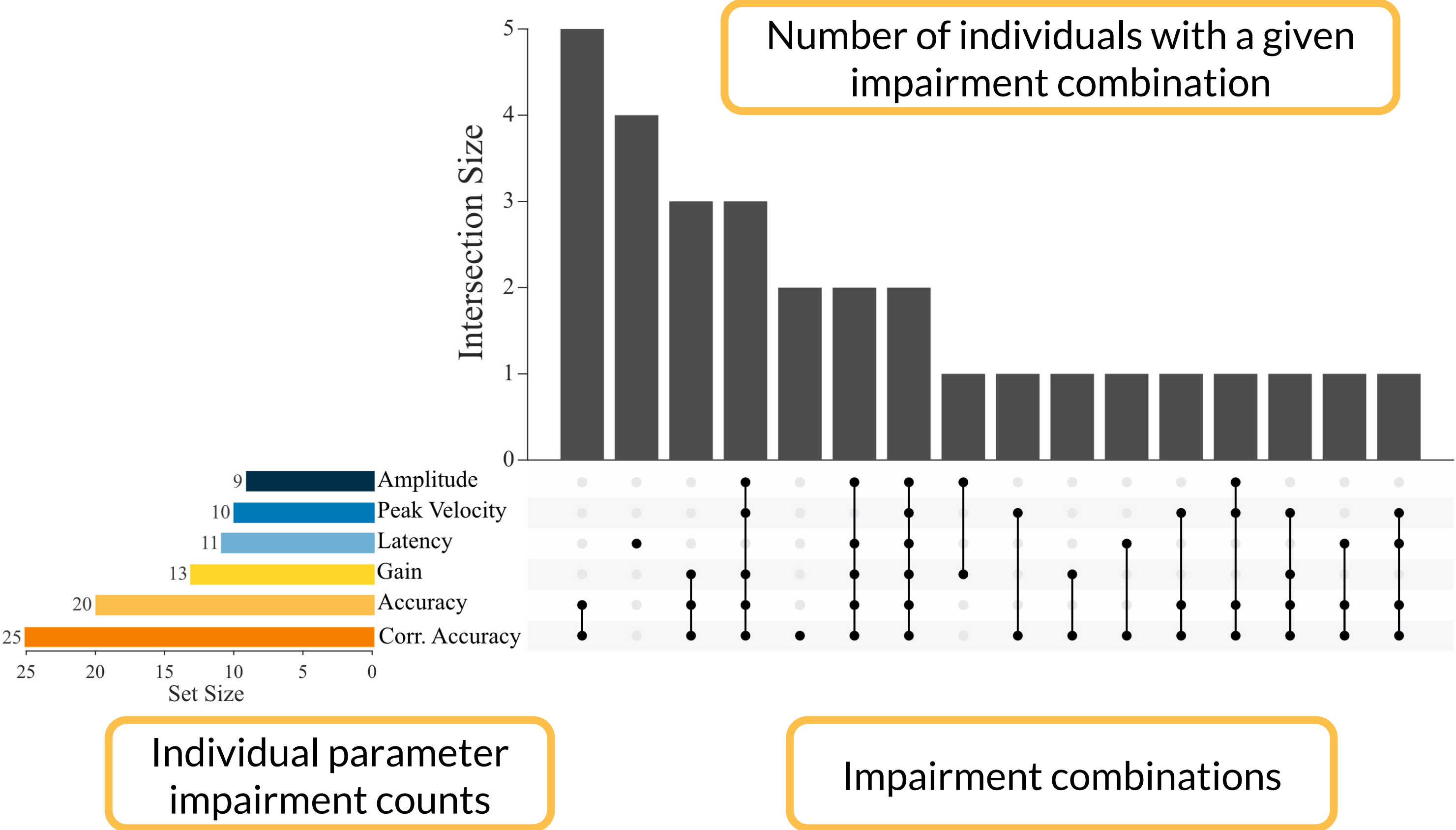


Table 3. Parameter impairment proportions.

Parameter	Proportion of total group abnormal
Accuracy	38%
Corrective Accuracy	48%
Latency	21%
Gain	25%
Peak Velocity	19%
Amplitude	17%

Discussion

- Up to 48% of stroke survivors had saccadic abnormalities, but only 15% were clinically diagnosed with eye movement issues
- Many stroke survivors could not effectively make corrective saccades
- Impairments on multiple saccade parameters was common

Many stroke survivors had impaired saccades to visual targets despite no clinical diagnosis of eye movement issues. Detailed assessment of saccadic deficits post-stroke may help inform how we design and deliver stroke rehabilitation.