Measuring Visual Acuity Using a Novel OKN-like Stimulus

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Disclosure

- Nothing to disclose

Optokinetic Nystagmus – The beginnings

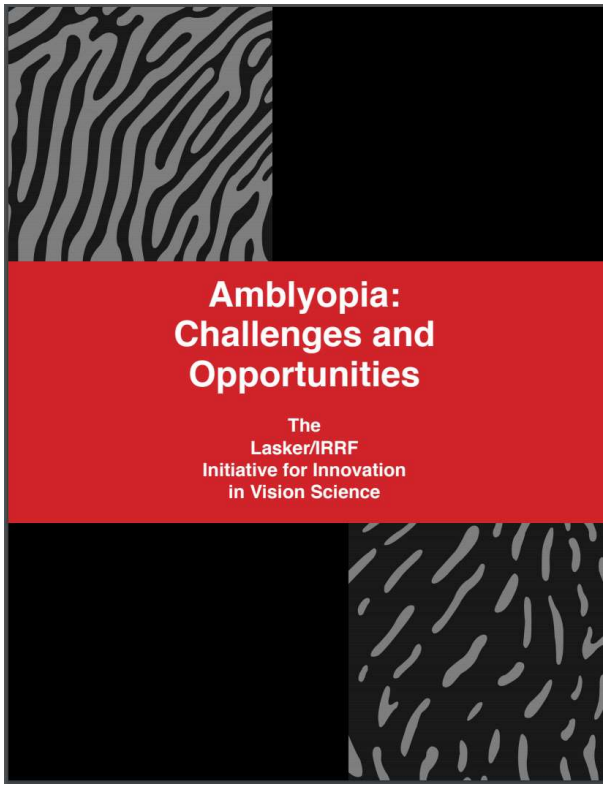
Opto-Kinetic Nystagmus (OKN)

Opto-Kinetic Nystagmus (OKN)

OKN Testing

(C) OEPF2006

I meet Ben Thompson



OBJECTIVE ACUITY

ADAM PODMORE
CEO

CRAIG BROWN
CFO

PROFESSOR BENJAMIN THOMPSON
CO-FOUNDER & CSO

MEHRDAD SANGI
CO-FOUNDER

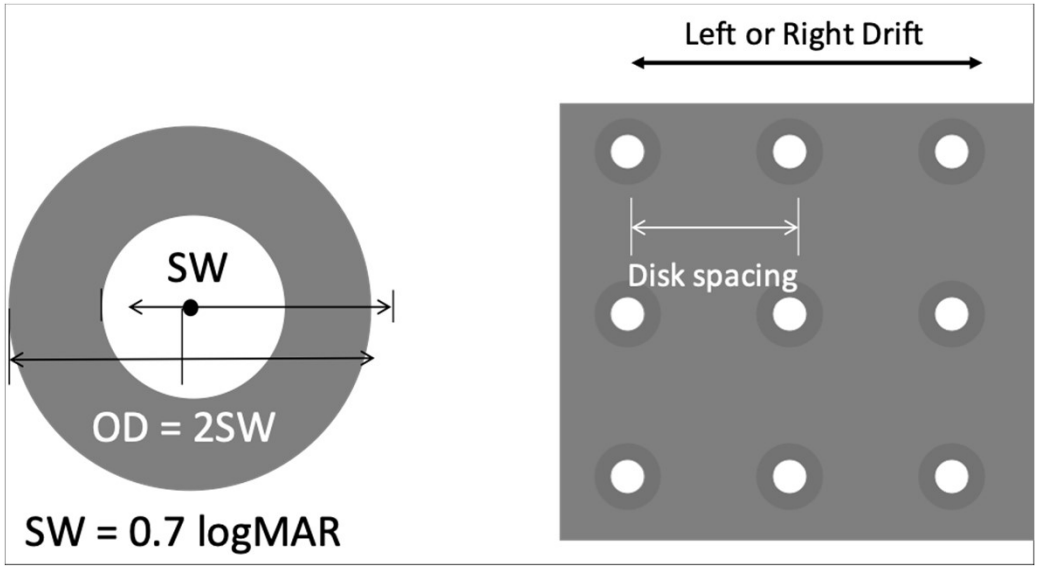
DR JASON TURUWHENUA
CO-FOUNDER & ADVISOR

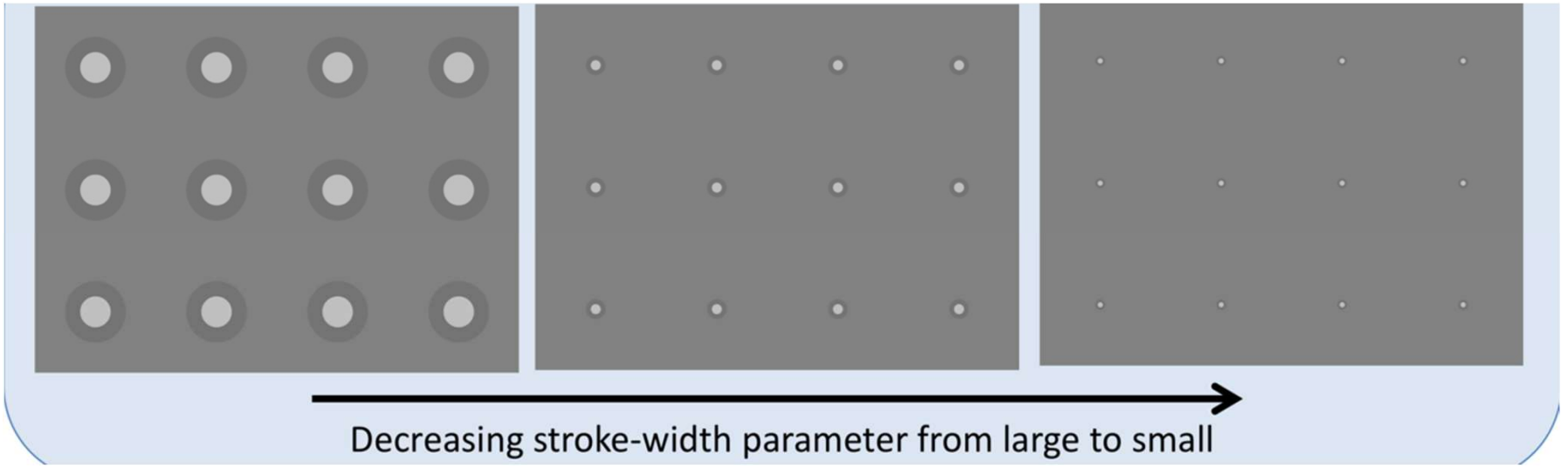
BOAZ KONIG
SENIOR SOFTWARE ENGINEER

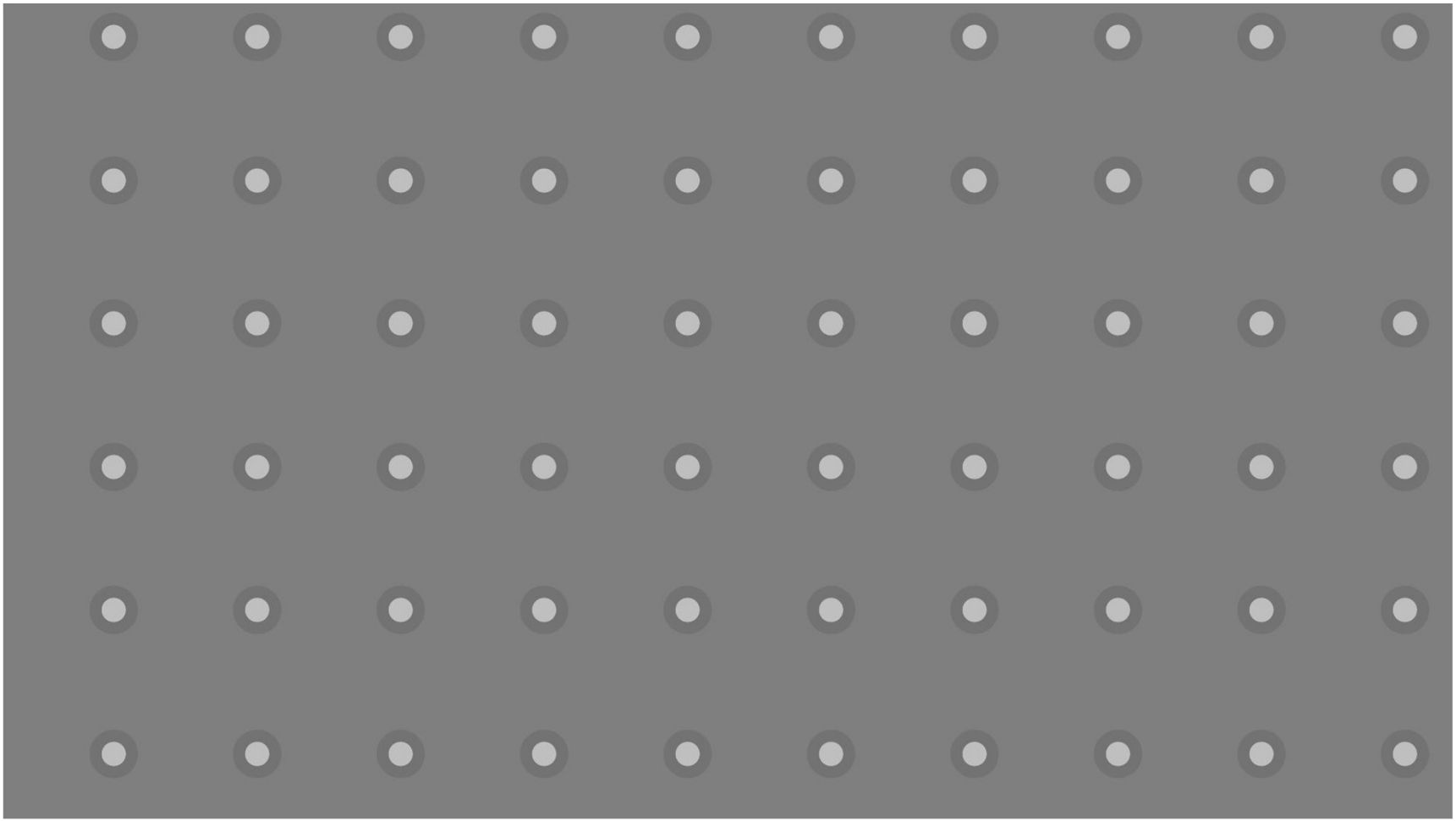
They ask for help with a study

- We assessed the level of agreement between three monocular visual acuity measures: a novel optokinetic nystagmus (OKN) induction and assessment instrument that requires no verbal or subjective responses, an Automated ETDRS (A-ETDRS) chart and the Harris VA chart.
- Monocular visual acuity (VA) data for 86 uncorrected neurotypical adults are reported in logMAR.

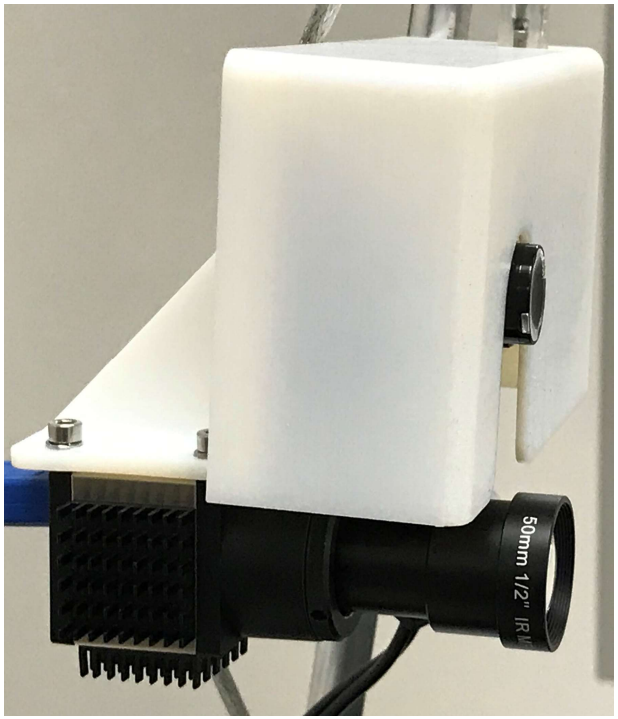
The Stimulus





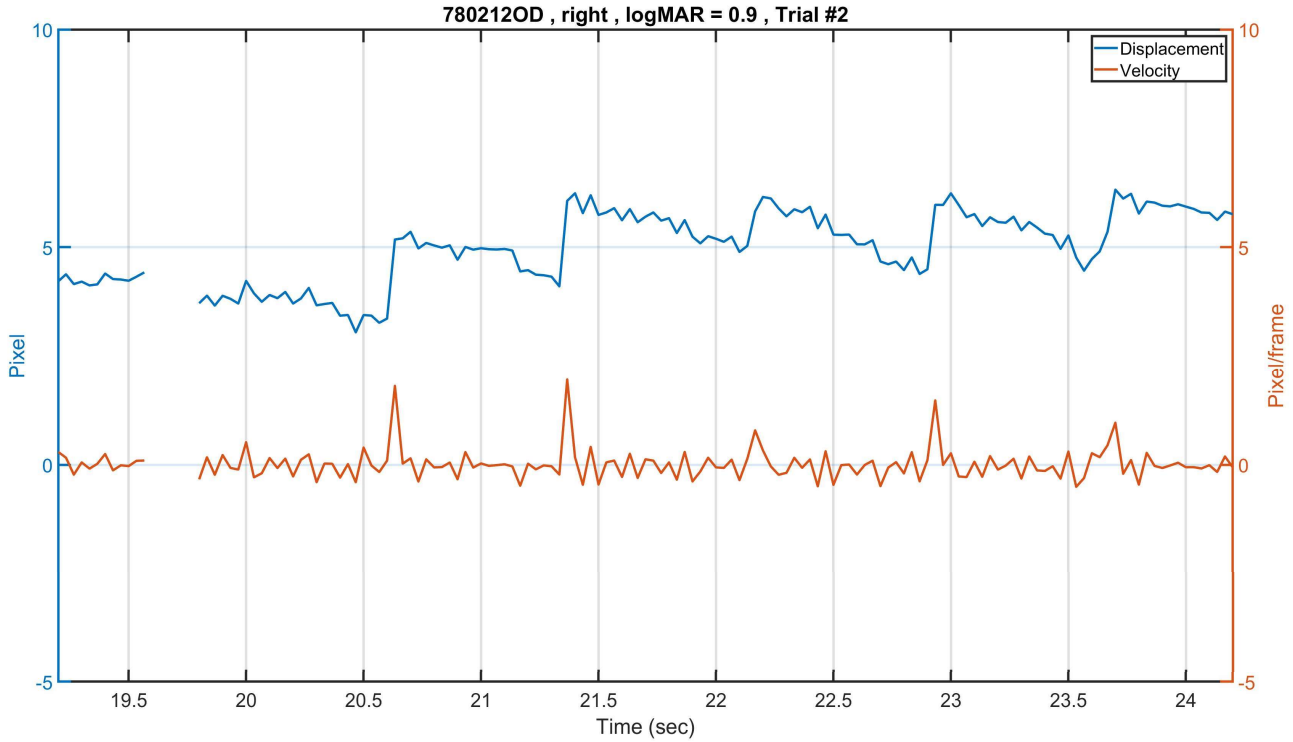


IR Illumination and Camera for Recording

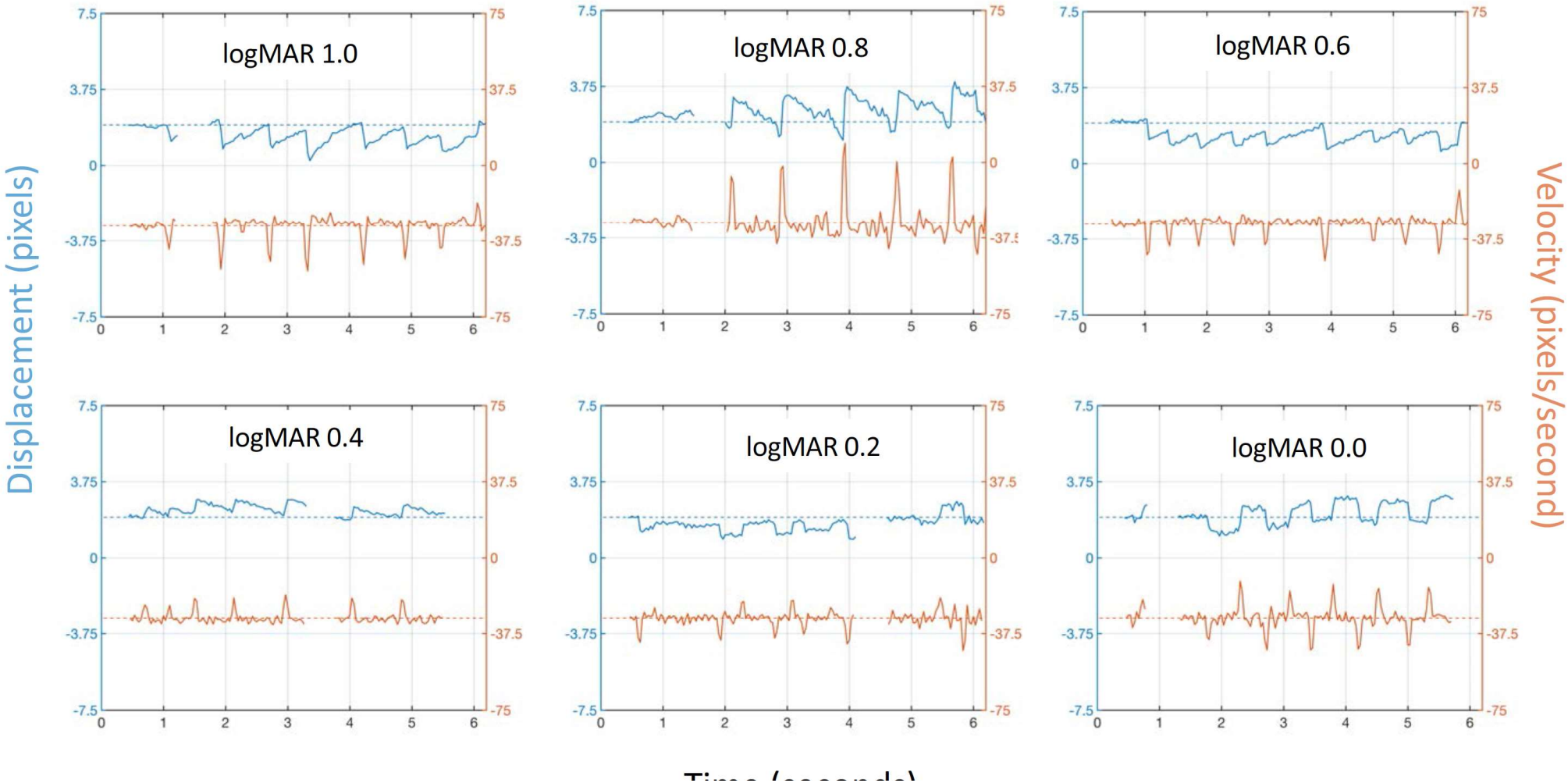


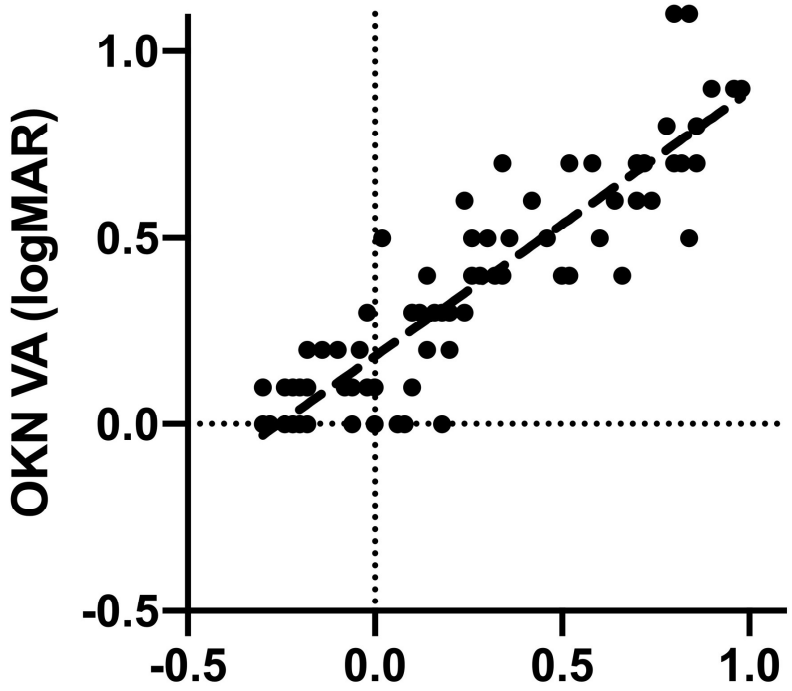
What does it see?

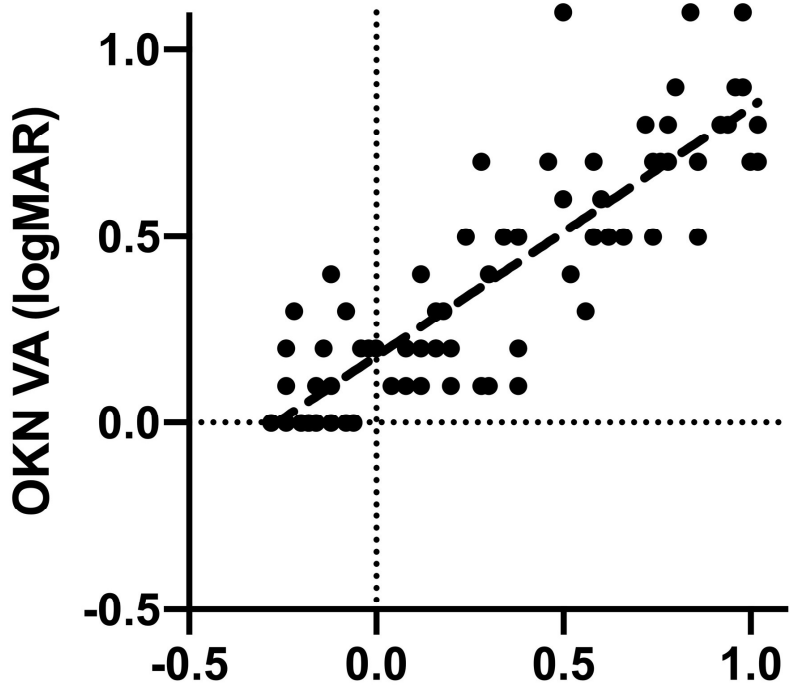
Early Analysis



Eye tracking data as a function of SW parameter
(logMAR 1.0 – logMAR 0.0)







So? How did the data look?

- A-ETDRS measurements ranged from -0.3-1.02. OKN VA thresholds were positively correlated with A-ETDRS measurements for both the right eyes (R^2 = 0.82) and left eyes (R^2 = 0.76)

ARVO Poster 2019

SOUTHERN COLLEGE OF OPTOMETRY
MEMPHIS, TENNESSEE

Visual Acuity Assessment in Adults Using Optokinetic Nystagmus

Harris, Paul A;[1] Garner Torrie;[2] Sangi, Mehrdad;[3] Guo, Peng;[3] Turuwhenua, Jason;[3] Thompson, Ben[3]

INTRODUCTION

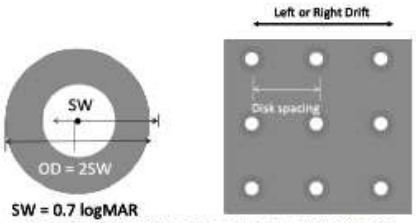
Visual acuity assessment is extremely challenging in non-verbal populations. We assessed the level of agreement between three monocular visual acuity measures: a novel optokinetic nystagmus (OKN) induction and assessment instrument that requires no verbal or subjective responses, an Automated ETDRS (A-ETDRS) chart and the Harris VA chart.[1,2]

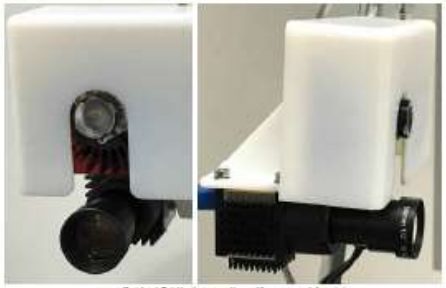
METHODS

Monocular visual acuity (VA) data for 86 uncorrected neurotypical adults are reported in logMAR. Test sequence and first eye tested were randomized.

During the OKN-based test, subjects viewed an array of horizontally drifting (5°/s, randomized left/right, 6 s duration) vanishing optotypes from 3 m. Optotypes were constructed from an outer dark annulus and an inner light circle presented on a grey background (Figures 1 and 2). Stroke width varied from 0.0 to 1.0 logMAR to measure acuity thresholds. Each logMAR level was presented twice. Presence of OKN on either of the two trials indicated a pass for that logMAR level. A prototype device (Objective Acuity Ltd. Auckland, New Zealand) displayed the stimuli and recorded eye movements for offline analysis, which included detection and tracking of the face and pupil center along eye displacement and velocity estimation for OKN detection (Figures 3 to 5). Inter-optotype spacing and density remained constant across trials, only size varied.

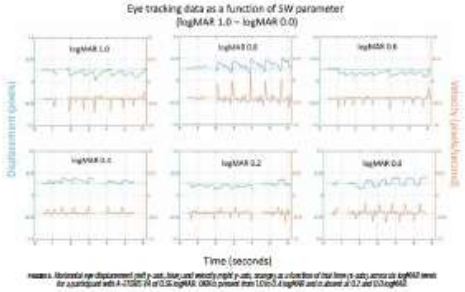
Monocular Visual Acuity was measured both with an A-ETDRS system (tablet-controlled computerized ETDRS chart) from 3 m, and the Harris Visual Acuity Chart from 6 m (both devices M&S Technologies Chicago, Illinois). The Harris VA chart is computer based and uses 10 randomly sequenced Sloan letters, which vary continuously in size. A staircase algorithm varies letter size from non-seeing to seeing to identify VA threshold.

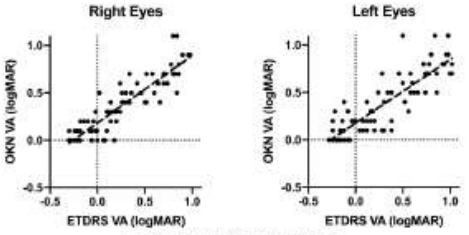


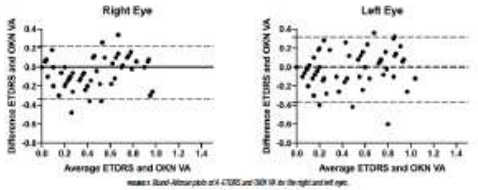


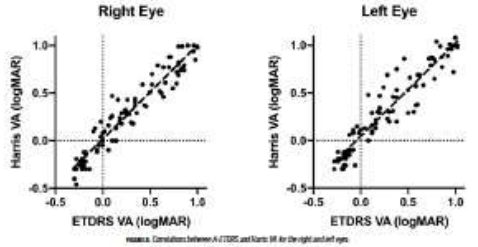
RESULTS

A-ETDRS measurements ranged from -0.3-1.02. OKN VA thresholds were positively correlated with A-ETDRS measurements for both the right eyes (R^2 = 0.82) and left eyes (R^2 = 0.76) (Figure 6). Bland-Altman analysis indicated 95% limits of agreement between A-ETDRS and OKN VA of 0.22 to -0.34 logMAR with a bias of -0.06 for the right eye and 0.32 to -0.37 with a bias of -0.03 for the left eye (Figure 7). OKN VA was positively correlated with the Harris Visual Acuity measurements (right eyes R^2 = 0.78, left eyes R^2 = 0.77). The A-ETDRS and Harris Visual Acuity measurements were also positively correlated (right eyes R^2 = 0.92; left eyes R^2 = 0.89) (Figure 8).









CONCLUSIONS

OKN induction and measurement has the potential to provide an objective visual acuity test for use in all clinic populations, including where verbal communication and/or English alphabet letter recognition is limited. Further development of the OKN-based visual acuity measurement technique is justified based on these promising initial results.

REFERENCES

1. Harris PA, Roberts LC, Grant R, Comparison of Backlit and Novel Automated ETDRS Visual Acuity Charts. Optometry & Visual Performance 2016;4(2):67-68.
3. Sangi M, Thompson B, Turuwhenua J. An Optokinetic Nystagmus Detection Method for Use With Young Children. IEEE J Transl Eng Health Med 2015;3:1800810.
5. Turuwhenua J, Yu TY, Mazharullah Z, Thompson B. A method for detecting optokinetic nystagmus based on the optic flow of the limbus. Vision Res 2014;103:75-82.

COMMERCIAL RELATIONSHIPS DISCLOSURE
Paul Harris and Torrie Garner: None
Mehrdad Sangi, Peng Guo, Jason Turuwhenua and Ben Thompson: Consultant to Objective Acuity
Ben Thompson: (Patent): Objective Acuity

Limitations

- Not in real time – analysis was done post hoc
- Had to measure multiple times and different sizes.
- Lights had to be off.
- Subjects could get distracted.

But: It was a proof of concept and it worked!!!

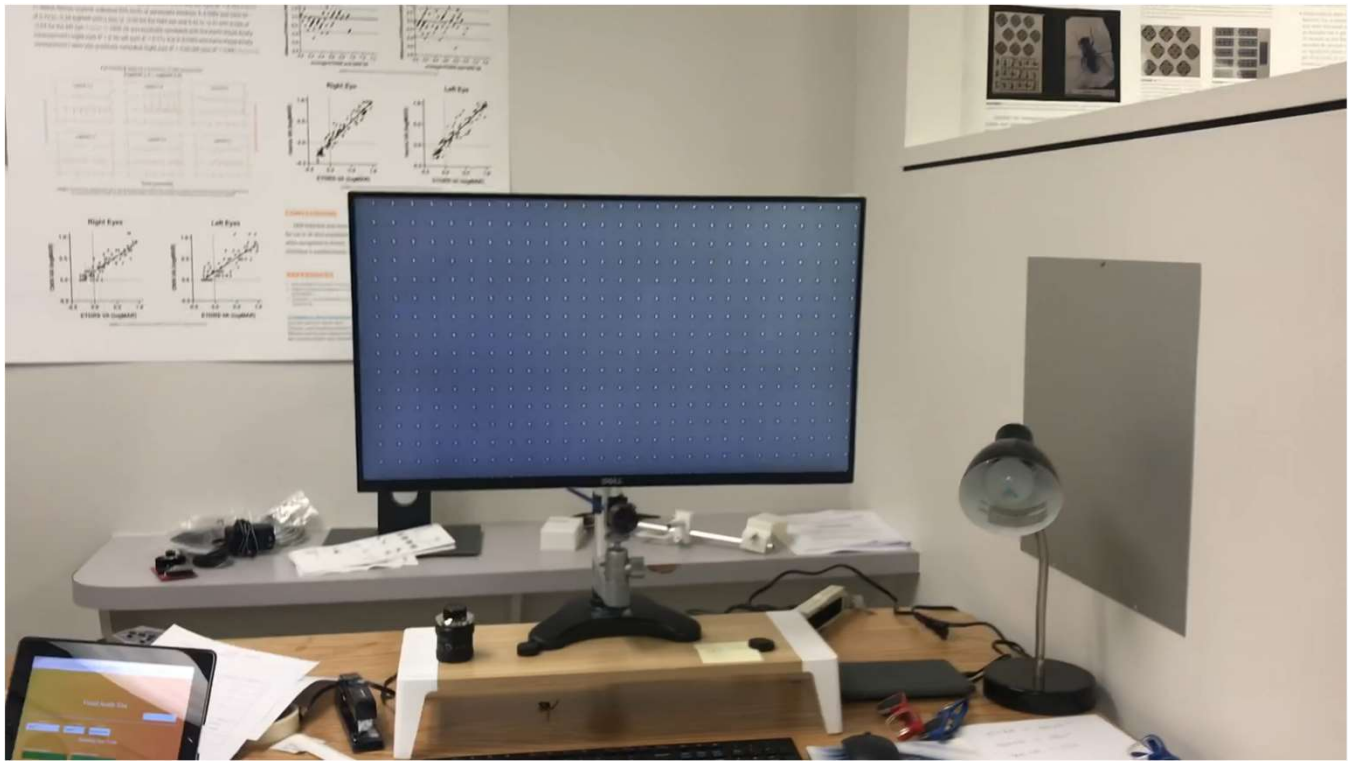
Major Innovations

- Real-time analysis
- Test sequence driven by prior result – allows for quick assessment of threshold.
- Facial recognition now allows for the lights to be on.
- Two systems under validation:
  - iPad Pro Version
  - Windows PC Based-Version

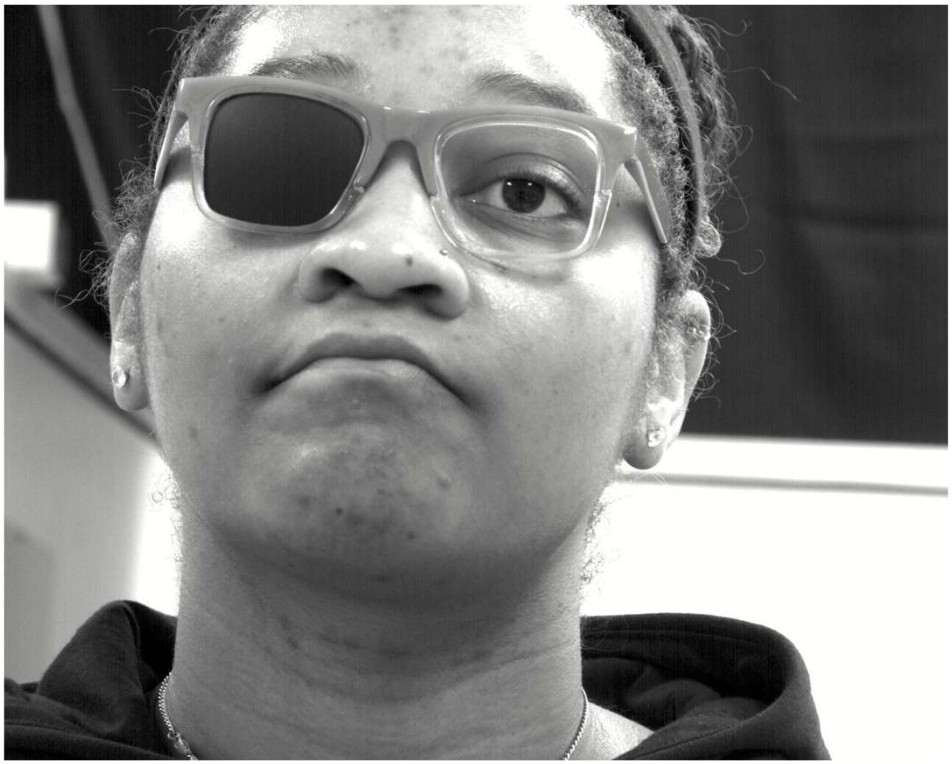
Retina Foundation of the Southwest

Eileen Birch, PhD

Our Setup



What do the Videos Look Like?

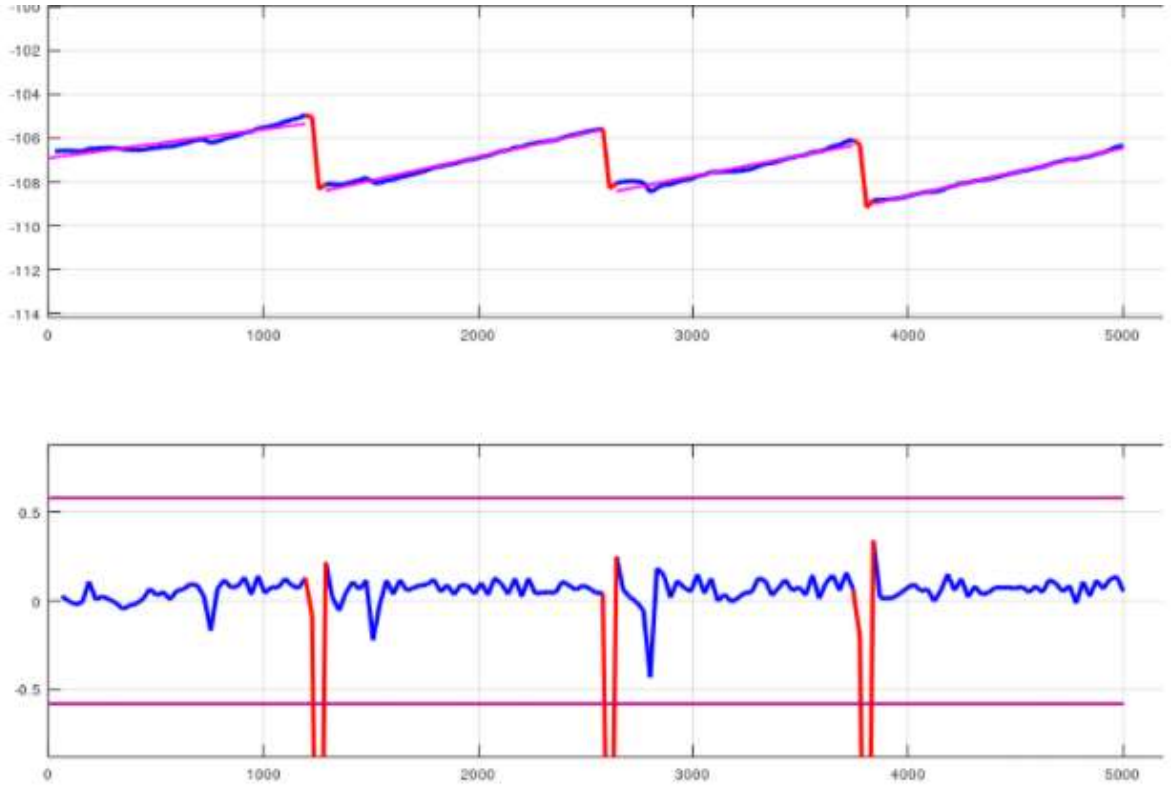


And the data?

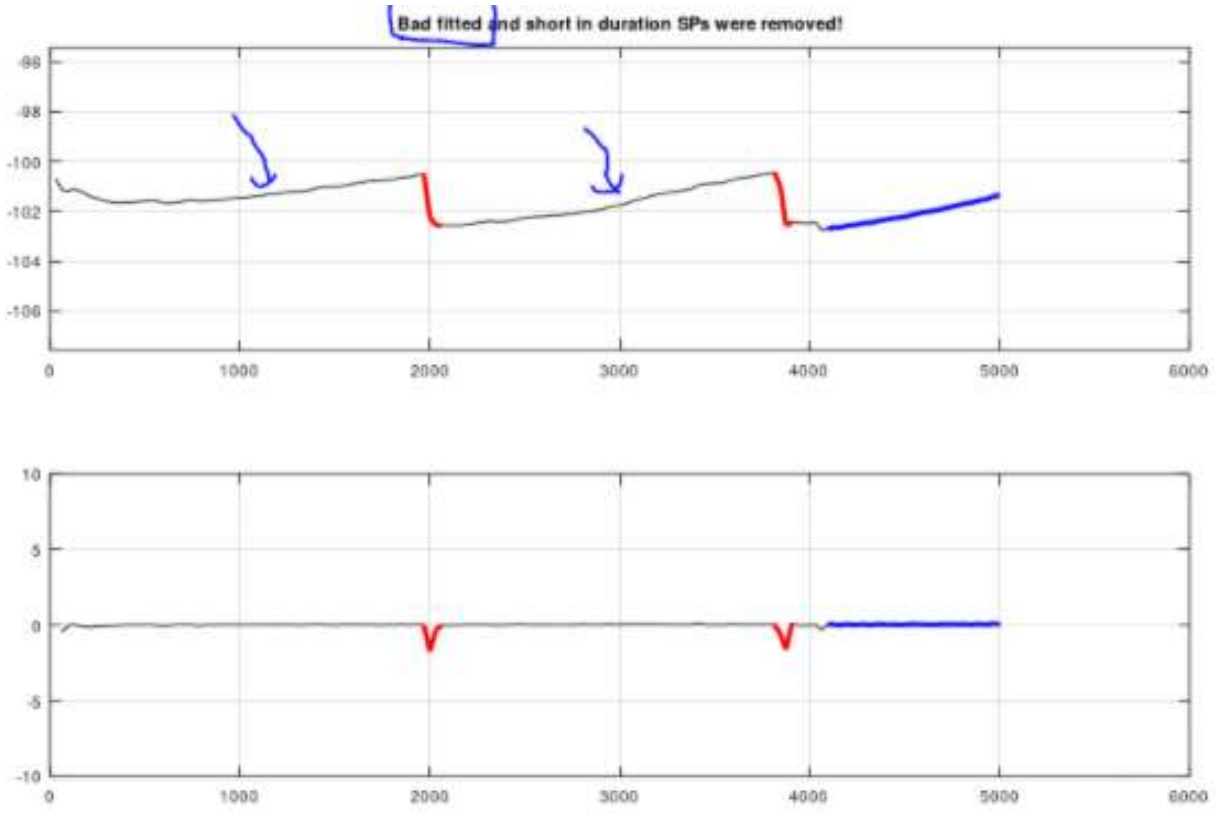
	A	B	C	D	E	F	G	H	I	J	
1	FrameNumber	TrialNumber	Direction	logMAR	FrameTime(n	Head X	Head Y	Head Stat	Left X	Left Y	Lef
2	0	0	1	0.8	0	#NAME?	#NAME?	40	703.741	255.268	
3	1	0	1	0.8	32.0764	511.742	383.745	4	704.056	255.363	
4	2	0	1	0.8	64.1529	512.574	384.195	4	704.901	255.952	
5	3	0	1	0.8	96.2293	513.079	384.364	4	705.403	256.143	
6	4	0	1	0.8	128.306	514.381	384.707	4	706.698	256.56	
7	5	0	1	0.8	160.382	515.028	384.986	4	707.377	256.682	
8	6	0	1	0.8	192.459	516.424	385.758	4	708.812	257.068	
9	7	0	1	0.8	224.535	517.568	386.259	4	709.898	257.617	
10	8	0	1	0.8	256.611	517.977	386.422	4	710.264	257.741	
11	9	0	1	0.8	288.688	518.636	386.616	4	710.943	257.904	
12	10	0	1	0.8	320.764	518.904	386.652	4	711.218	257.912	
13	11	0	1	0.8	352.841	519.414	386.933	4	711.719	258.044	
14	12	0	1	0.8	384.917	519.767	387.326	4	712.809	258.424	
15	13	0	1	0.8	416.994	519.953	387.38	4	713.445	258.518	
16	14	0	1	0.8	449.07	520.255	387.393	4	713.774	258.469	
17	15	0	1	0.8	481.146	520.42	387.325	4	713.89	258.337	
18	16	0	1	0.8	513.223	520.909	387.461	4	714.155	258.312	
19	17	0	1	0.8	545.299	521.365	387.722	4	714.433	258.514	
20	18	0	1	0.8	577.376	521.569	387.832	4	714.547	258.618	
21	19	0	1	0.8	609.452	521.991	388.018	4	715.003	258.775	
22	20	0	1	0.8	641.529	522.188	388.076	4	715.502	258.817	
23	21	0	1	0.8	673.605	522.465	388.14	4	715.562	258.794	
24	22	0	1	0.8	705.682	522.537	388.129	4	715.446	258.736	
25	23	0	1	0.8	737.758	522.308	388.182	4	714.978	258.601	
26	24	0	1	0.8	769.834	521.797	388.124	4	714.295	258.412	
27	25	0	1	0.8	801.911	521.55	388.049	4	713.995	258.312	
28	26	0	1	0.8	833.987	521.18	387.965	4	713.57	258.294	
29	27	0	1	0.8	866.064	521.093	387.923	4	713.435	258.274	
30	28	0	1	0.8	898.14	521.278	387.923	4	713.427	258.396	
31	29	0	1	0.8	930.217	521.422	387.768	4	713.485	258.366	
32	30	0	1	0.8	962.293	521.819	387.217	4	713.664	258.062	
33	31	0	1	0.8	994.369	522.047	387.004	4	713.754	257.944	
34	32	0	1	0.8	1026.45	522.386	386.537	4	713.96	257.676	
35	33	0	1	0.8	1058.52	522.79	386.159	4	714.242	257.538	
36	34	0	1	0.8	1090.6	523	385.94	4	714.416	257.419	

The protocol for this video?

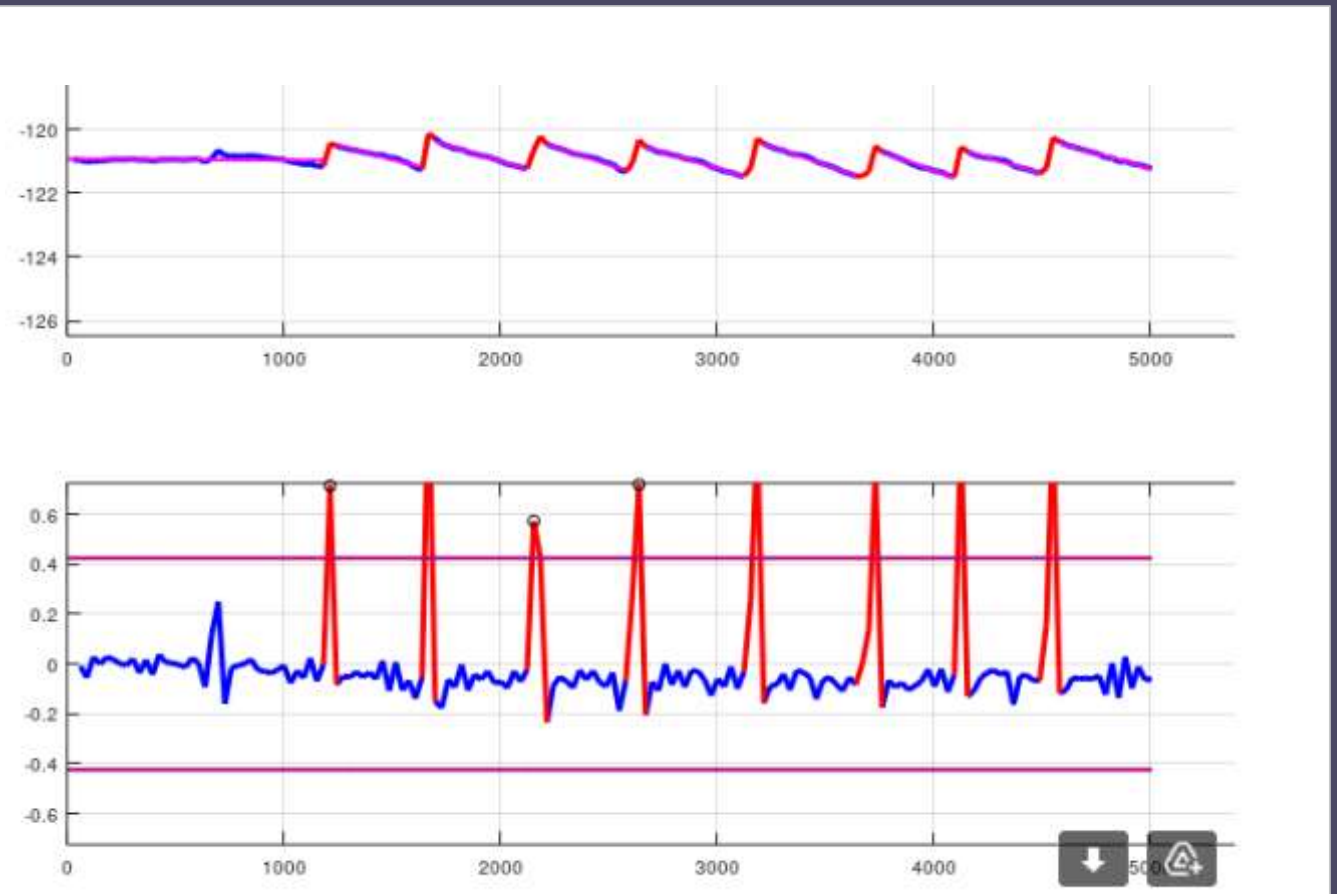
```
Patient Id: Sco001
Test Id: Sco001_left_20201217-1010
Test protocol: adult_visual_acuity
Test Type: Adult test protocol for Visual Acuity testing
Total Duration: 49.108
Test Result: Success
     Visual Acuity Threshold: 0.0 logMAR, 6/6.0 meter, 20/20 foot
Test notes:


 Trial: #1
===========
   logMAR = 0.8
   Direction = right
   Ave Focus = 102
   Trial result = OKN
   OKN Confidence =  102.225

 Trial: #2
===========
   logMAR = 0.5
   Direction = left
   Ave Focus = 101
   Trial result = OKN
   OKN Confidence =  354.389

 Trial: #3
===========
   logMAR = 0.2
   Direction = right
   Ave Focus = 101
   Trial result = OKN
   OKN Confidence =  237.057

 Trial: #4
===========
   logMAR = -0.1
   Direction = left
   Ave Focus = 101
   Trial result = NO_OKN
   OKN Confidence =  0

 Trial: #5
===========
   logMAR = 0.0
   Direction = right
   Ave Focus = 101
   Trial result = OKN
   OKN Confidence =  101.506
```



Some Early Tweaking – Good/Normal



Some Long and Slow



Short and Fast

Current Study

- To look at 100 subjects, 200 eyes with OKN, Harris VA, & A-ETDRS all uncorrected with the aim to increase the range from logMAR 0.00 to 2.0.

Q&A Thank You

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