



Follow Up Objective Pupil Function Measurements in Collegiate Athletes

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Financial Disclosures

- None





Background



- 3.8 million sports related mTBI in USA (CDC)
- Traumatic Brain Injury
 - Visual Symptoms
 - Blurring, Loss of Vision, Double Vision, Photophobia, and Focus Problems
 - Objective Abnormalities
 - Visual Acuity
 - Pupillary Size, Shape, and Response to light
 - Accommodation and Convergence
 - Extraocular Motility
 - Stereoacuity
 - Nystagmus
 - Pursuit
 - Saccades
- The visual system involves roughly half of the brains circuits



Background-Infrared Pupillometry



- Mild traumatic brain injury is known to result in **impaired** pupil function with changes that are likely subtle.
- Identify subtle pupillary changes
- Applications
 - Critical Care/ICU
 - Severe/Moderate TBI
 - Strokes
 - Extension of the Neurological Exam



Background



- 2016-17 study by Dr. John Jones
 - 186 Division I athletes across eight sports
 - 4/186 (2.3%) NPi < 3
 - Substantial variation in all measured parameters except constriction latency. (p=0.21)
 - Degree of Pupil Constriction Highest amongst FB players
 - 25% more compared to other sports p(<0.0001)



Research Objective



- Objectively evaluate pupil function in NCAA Division I collegiate athletes participating in various sports.
- Objectively evaluate pupil function in concussed athletes, compare findings to their baselines, and determine if a difference exists.
- Determine if 2016-17 pilot pupillometry findings are reproducible.



Methods-Non-Concussed



- 385 NCAA Division I athletes across 18 sports were consented to participate.
- Pupil function testing was done indoors in sports medicine facilities.
- Each measure was repeated twice with results averaged.



Methods-Concussed Athletes



- 12 participants with concussions were scanned in a similar method on each day of follow up.
- Pupil function testing was done indoors in sports medicine facilities.
- Data obtained was compared to previous baselines.



Methods

- Pupil function testing with Neuroptics Npi 200 Infrared Pupilometer
- During measurement, a short duration light is flashed and a three second video of the pupil is captured.
- 8 parameters were assessed
 - Neurological Pupil Index (NPI)
 - Maximum and Minimum Pupil Size
 - Maximum Constriction Velocity
 - Average Constriction Velocity
 - Percent Constriction
 - Constriction Latency
 - Inflation Velocity





Methods

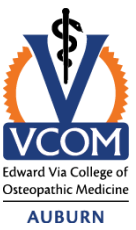
- NPi < 3.0 is abnormal (per NeuroOptics)
- Statistical Analysis and Charts
 - Dr. Swanson at UAB School of Optometry



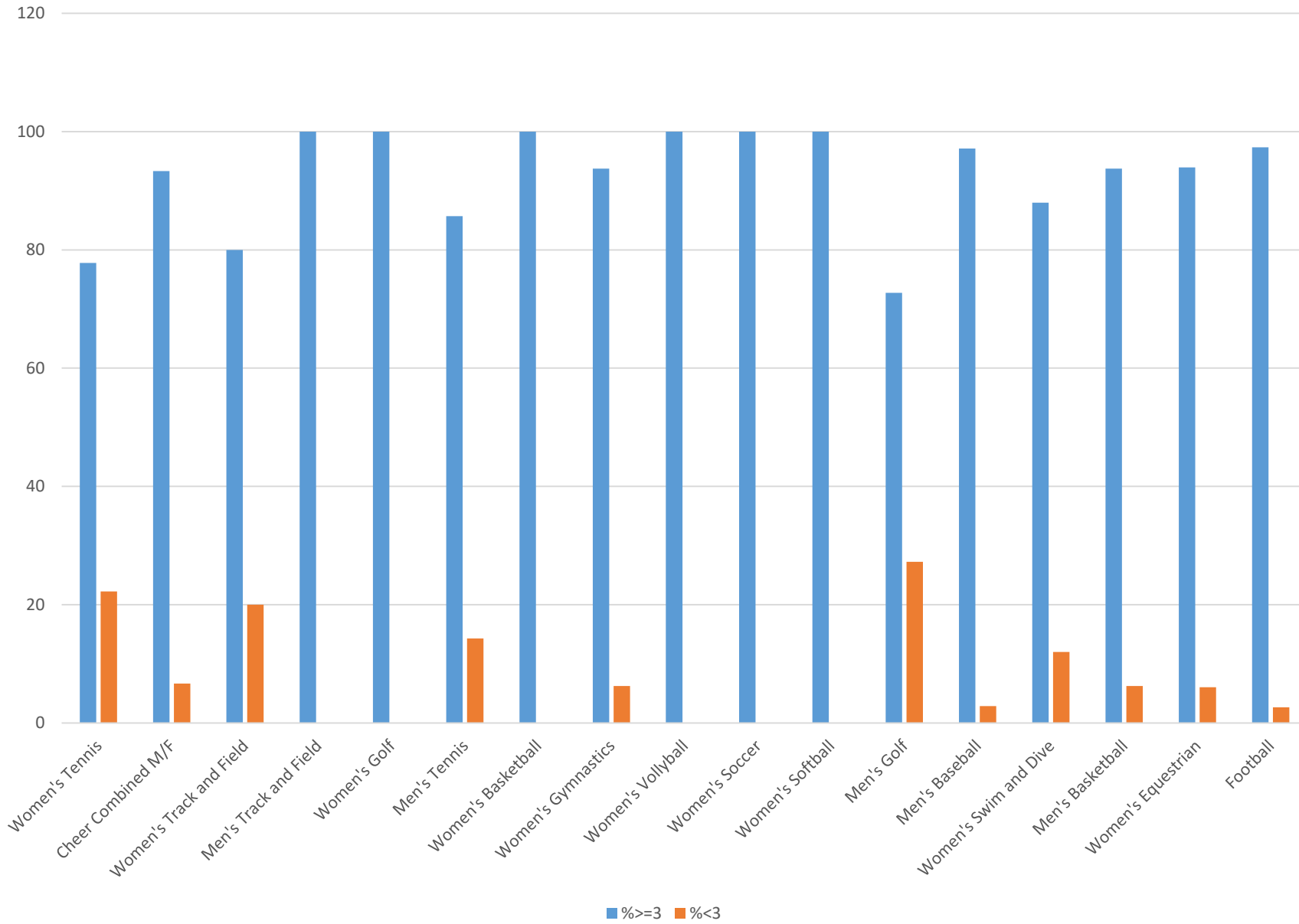
Results Non-Concussed Athletes



- Pupil function measures varied substantially between non-concussed individual athletes and by sports. Except NPi and dilation latency.



PERCENT OF ATHLETES WITH NPI <3 BY TEAM





Results



	2017-18 (Current)	2016-17 (Dr. Jones)
Number in Study (n)	385	186
% Abnormal NPi (< 3)	22/385 (5.7%)	4/186 (2.2%)
History of Concussion	1/22 (4.5%)	Unknown
History of corrective lenses/contacts	6/22 (27.3%)	Unknown
Contact vs. Non Contact Sports	>50% Abnormal were non-contact	Unknown



Constriction Velocity Football versus other Athletes



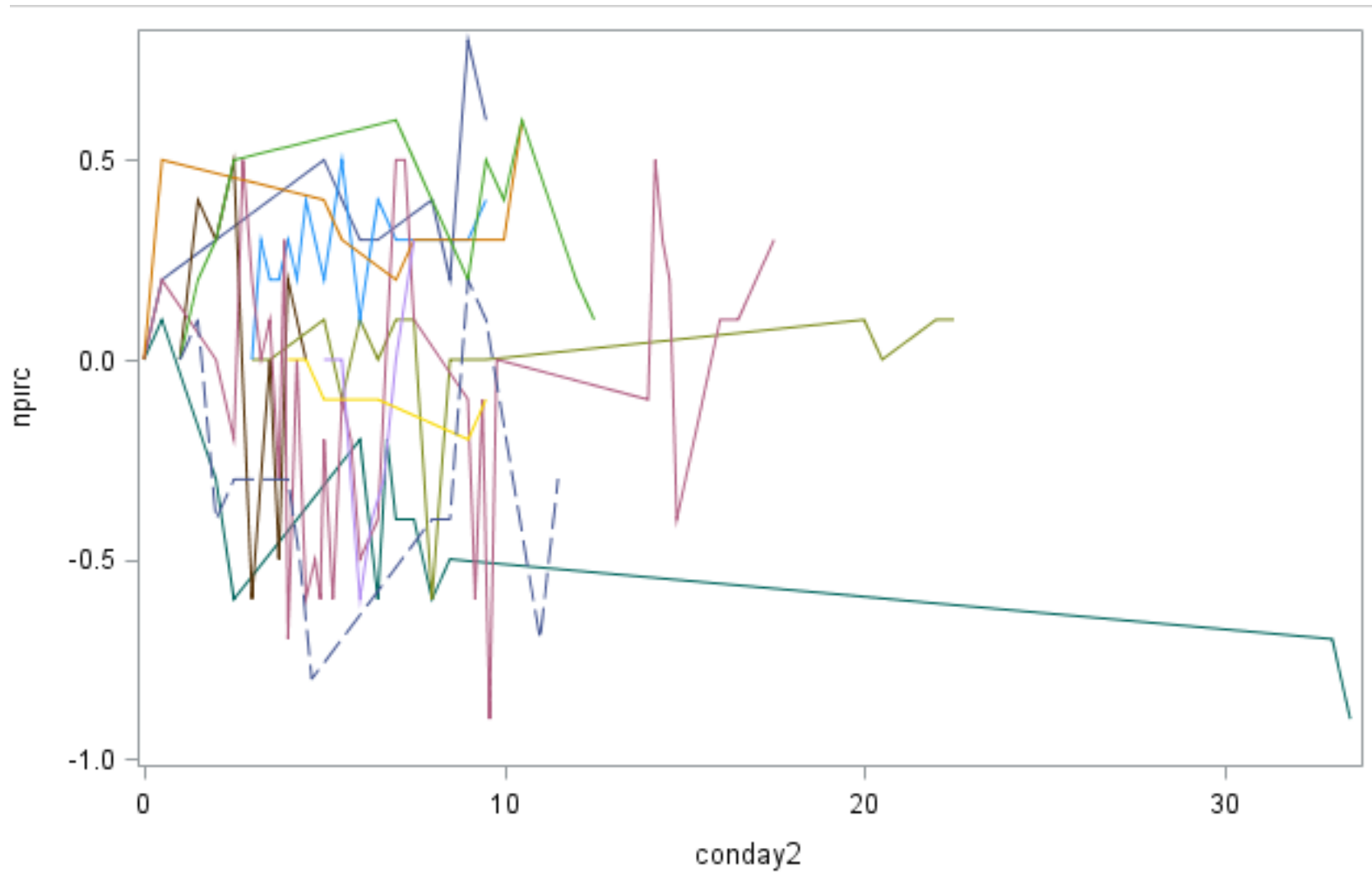
	Est	SE	t-value	p
Women's Track and Field	1.295	0.208	-4.43	<.0001
Men's Track and Field	1.710	0.449	-1.12	0.2617
Women's Softball	2.177	0.191	-0.2	0.8417
Football	2.215	0.059		
Women's Gymnastics	2.215	0.168	0	0.9994
Women's Tennis	2.218	0.218	0.01	0.9894
Men's Golf	2.315	0.199	0.5	0.6165
Cheer Combined M/F	2.385	0.173	0.99	0.3252
Women's Golf	2.400	0.632	0.29	0.7699
Men's Tennis	2.454	0.245	0.98	0.3296
Women's Swim and Dive	2.648	0.139	3.11	0.002
Women's Soccer	2.765	0.131	4.2	<.0001
Women's Volleyball	2.771	0.191	2.91	0.0039
Men's Swim and Dive	2.950	0.142	5.19	<.0001
Men's Baseball	3.054	0.122	6.89	<.0001
Women's Equestrian	3.102	0.125	7.12	<.0001
Men's Basketball	3.119	0.168	5.38	<.0001
Women's Basketball	3.241	0.178	5.75	<.0001



	Est	SE	t-value	p
Women's Track and Field	1.254	0.215	-4.35	<.0001
Women's Gymnastics	1.793	0.174	-2.27	0.0238
Men's Track and Field	1.915	0.464	-0.59	0.5583
Women's Softball	2.141	0.198	-0.23	0.8157
Cheer Combined M/F	2.175	0.179	-0.07	0.9455
Women's Tennis	2.220	0.225	0.15	0.8833
Football	2.187	0.061		
Men's Golf	2.326	0.206	0.68	0.4978
Women's Golf	2.390	0.654	0.31	0.7561
Men's Tennis	2.484	0.253	1.17	0.2413
Women's Soccer	2.656	0.135	3.47	0.0006
Women's Swim and Dive	2.680	0.144	3.43	0.0007
Men's Swim and Dive	2.872	0.146	4.68	<.0001
Women's Equestrian	2.897	0.129	5.51	<.0001
Women's Basketball	2.905	0.184	3.9	0.0001
Women's Volleyball	3.009	0.198	4.16	<.0001
Men's Baseball	3.091	0.126	7.18	<.0001
Men's Basketball	3.221	0.174	5.95	<.0001

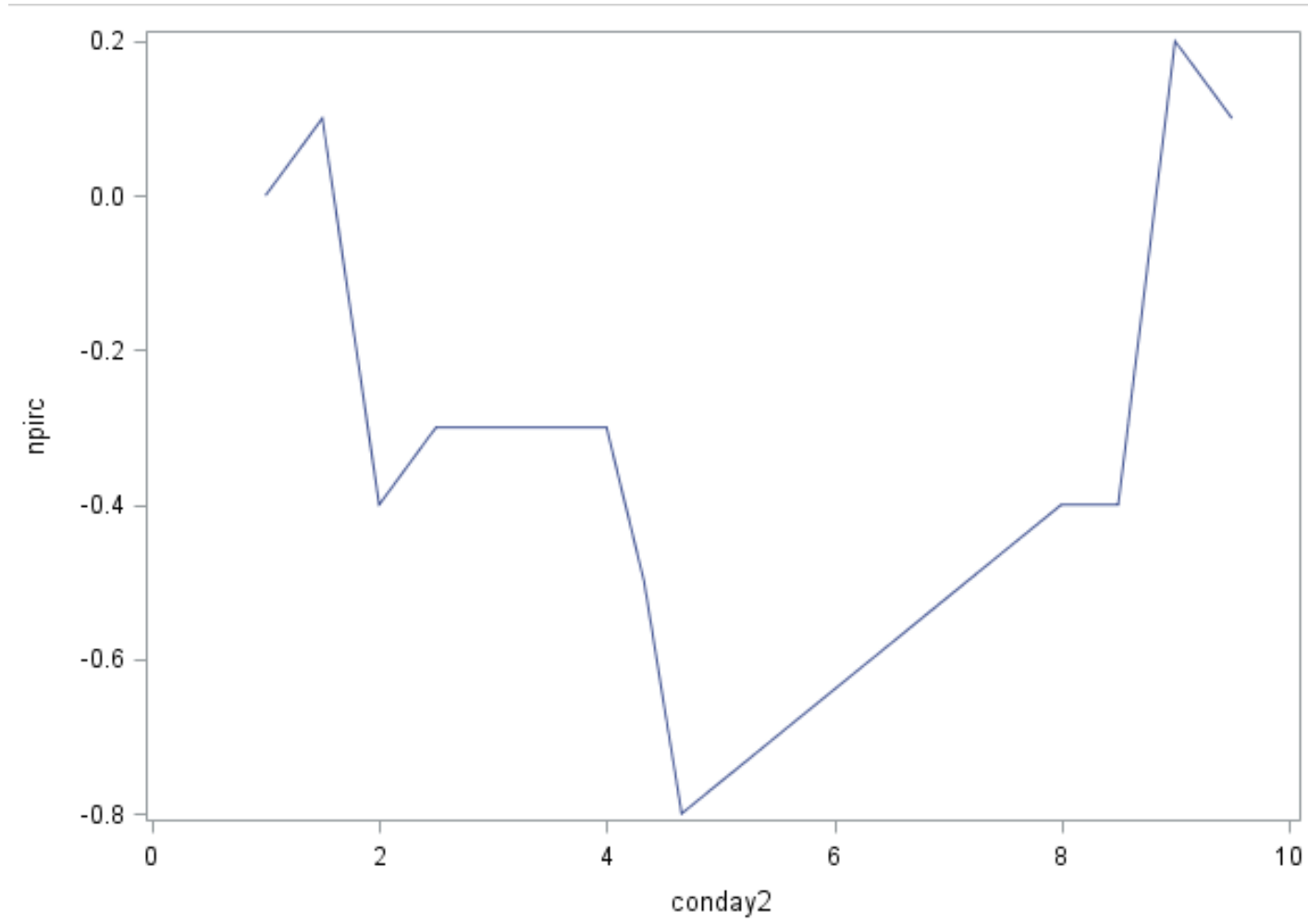


All Concussed Athletes L Eye NPI to Recovery



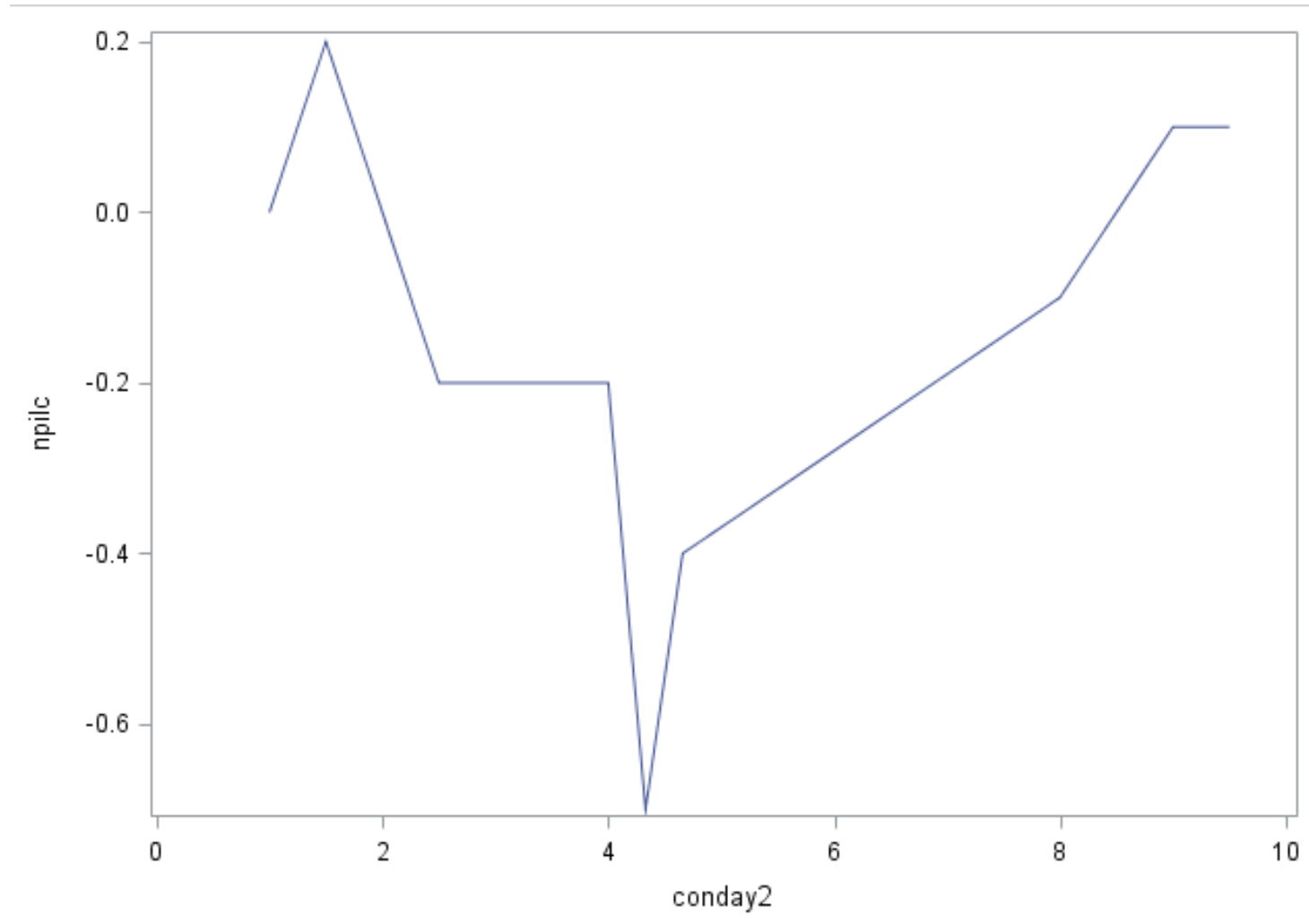


Pattern of NPI over 10 days for a single athlete-Right Eye





Pattern of NPI over 10 days for a single athlete-Left Eye





Conclusions

- Pupil Dynamic Measures are highly repeatable in student athletes
- Velocity and Constriction Dynamics show a better ability to account for differences by sport than does the NPi index.
- Pupil Velocity dynamics do not appear to show an immediate decline after concussion but rather appear to follow a pattern of decline in the first week with a rapid improvement to baseline.
- Pupillometry is reproducible and could be used as a tool for concussion management but more research is still needed.



Future Research



- Is there a reason why football players pupils are amongst the most sluggish?
- Whether quantitative pupillary dynamic can serve as an objective tool in the evaluation of concussions.



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