

4-2016

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Whorley, Brett and Honaker, Julie A., "Exploring Oculomotor Trends in Collegiate Athletes" (2016). *UCARE Research Products*. 21.
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Exploring Oculomotor Trends in Collegiate Athletes

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Abstract

The Dizziness and Balance Disorders Lab (DBDL) at UNL conducts a simple oculomotor exam on Husker athletes as part of a concussion baseline protocol. Within the broader goal to better understand the causes, signs, symptoms, and prognosis of concussions, researchers desired to further investigate the results of this test. This project analyzed a sample of the data for statistical trends and investigated what predictors may contribute to these trends. We determined that prior diagnosed head injuries and inner ear problems were not a significant predictor, however the small sample size may have affected the results.

Introduction

Background: Over 300,000 sports-related concussions occur annually in the United States.¹ Collaborative efforts to improve player safety without significantly hindering the rules of the games aim to develop a novel system to better measure and diagnose concussions. Provided that common signs of concussions include blurred vision, distant gaze, and dizziness, we believe the oculomotor exam used in this study could be applied to this procedure.

Purpose: To identify and interpret correlations between collegiate athlete performance on an oculomotor exam and a phenomenon known as reset saccades experienced during the task.

Theory: Given the premiere physical fitness levels of athletes and the requirement for above-average hand-eye coordination in collegiate level sports, it is reasonable to hypothesize that athletes would be able to efficiently follow an oscillating LED target with their eyes. However, we believe that the exam data shows significantly different results. We observed considerably large variance in the performances, and many athletes performed below the accepted norms.² For our study, performance on the oculomotor exam was classified by the number of saccades that occurred at each frequency (0.2-0.7 Hz) for which the target oscillated. A saccadic eye movement can be explained by the figure in the background of this poster.

Hypotheses:

- (1) It was hypothesized that athletes with several initial reset saccades would continue to perform comparatively worse throughout the duration of the exam.
- (2) It was hypothesized that athletes who self-reported previous head injury or inner ear problems would perform worse on the oculomotor exam.
- (3) It was hypothesized that there would be a quantifiable difference in performance between football players when categorized by the primary skill sets required by each position (e.g. wide receiver's agility versus offensive lineman's bulk strength).

Methods

This project was a retrospective review of data previously collected at DBDL using Otometrics VNG ICS Chartr 200 Vestibular Software. The exam data along with self-reported case history data for each patient was compiled using Microsoft Excel and analyzed using SAS v.9.2. The data was analyzed using the Glimmix procedure for general linear models using a multilevel model for a Poisson distribution. The Poisson distribution was first tested for overdispersion and was found not to be overdispersed. Chi-square difference tests between models were then performed to determine the best model of the data.

Graphical Results

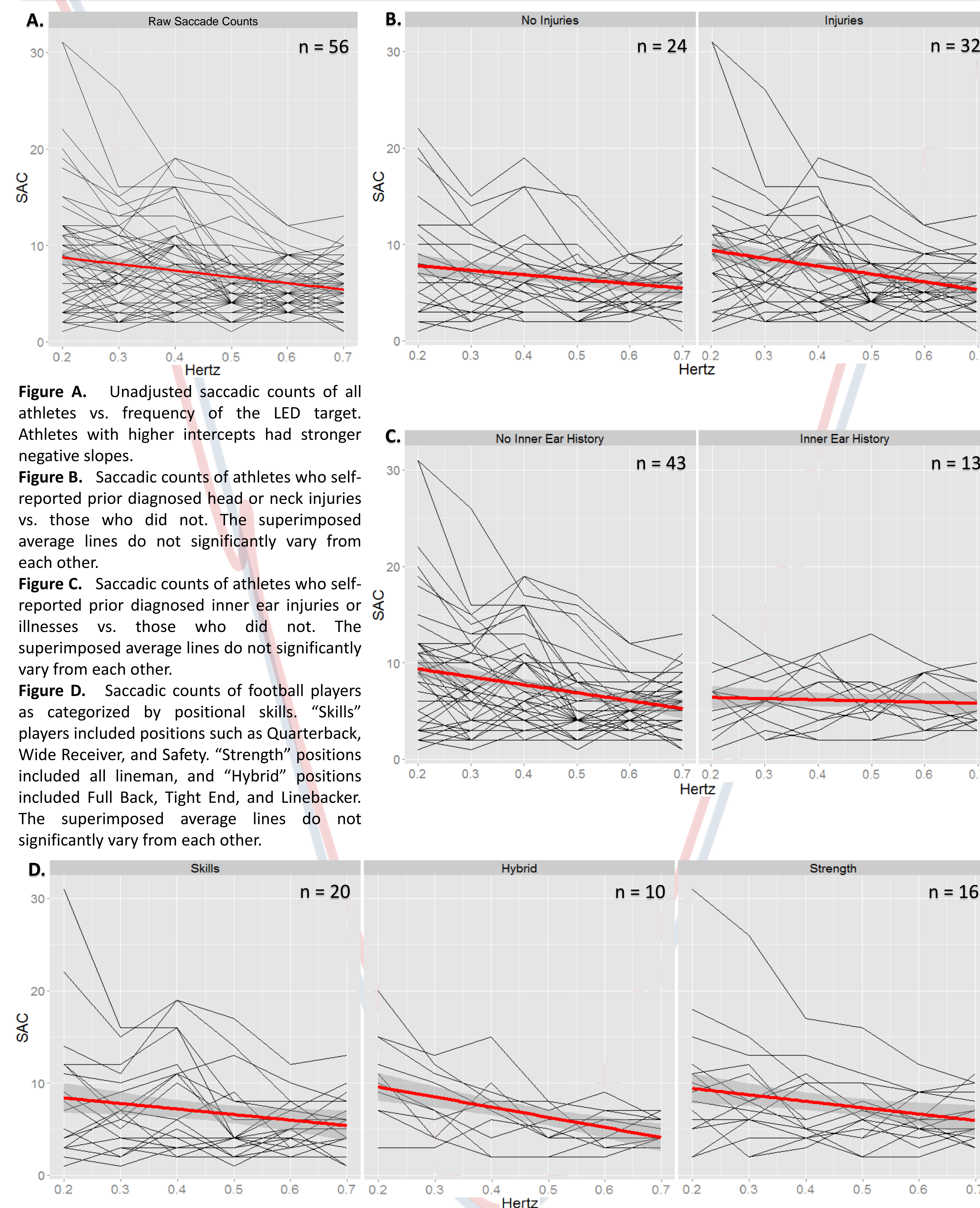


Figure A. Unadjusted saccadic counts of all athletes vs. frequency of the LED target. Athletes with higher intercepts had stronger negative slopes.

Figure B. Saccadic counts of athletes who self-reported prior diagnosed head or neck injuries vs. those who did not. The superimposed average lines do not significantly vary from each other.

Figure C. Saccadic counts of athletes who self-reported prior diagnosed inner ear injuries or illnesses vs. those who did not. The superimposed average lines do not significantly vary from each other.

Figure D. Saccadic counts of football players as categorized by positional skills. "Skills" players included positions such as Quarterback, Wide Receiver, and Safety. "Strength" positions included all lineman, and "Hybrid" positions included Full Back, Tight End, and Linebacker. The superimposed average lines do not significantly vary from each other.

Explanation of Results

- Poisson distribution of saccade counts was not overdispersed. Thus a Poisson distribution fit the data better than a Normal distribution.
- A Chi-square difference test between the model with the unstructured (UN) covariance matrix and the model with the variance components matrix was significant, $UN(2,1) = -0.652, 0.208$. This suggested that the oculomotor data best fit the model with covariance added between the intercept and slope, or more simply, that a dependence exists between the two measures. Thus, higher initial saccade counts corresponded to more negative slopes, which can be seen in *Figure A*. **This does not support Hypothesis 1.**
- Imposing a quadratic effect between saccade count and frequency did not significantly improve the fit. The chi-squared difference value, $\chi^2(1) = 0.10, p < .05$ was less than the critical value ($CV=3.845$).
- Similarly, as additional qualitative variables were imposed on the data, see *Figures B and C*, the chi-squared difference did not exceed the critical value: $\chi^2(3) = 2.80, p < .05$. Thus, it was shown that there was no significant difference in oculomotor performance between athletes who did or did not report histories of these factors. **This does not support Hypothesis 2.**
- When football players were categorized by position as described by the caption of *Figure D*, it was proven by the Test of Fixed Effects that there is no significant differences in oculomotor performance between football players of different skill set groups: $F(1,46) = 17.39, p < .05$. **This does not support Hypothesis 3.**

Discussion

- We propose that the "Learning Curve" effect may explain why athletes who started poorly did not continue to perform relatively worse.
- One of the biggest sources of error in this project was the small sample size. Additional analyses with larger sample sizes should be conducted in the future to validate the results.
- It would also be interesting to compare the performances of athletes versus a sample of non-athletes to determine how any level of exposure to competitive contact sports may affect oculomotor abilities.
- Finally, once the sample size is increased, other non-linear tests should be performed to analyze the possibility of other relationships that may exist between oculomotor abilities and risk-level for concussions.

References

- ¹ "Concussions." *Neurological Surgery*. University of Pittsburgh Brain Trauma & Research Center, Jan. 2015. Web. Mar. 2016.
- ² Stockwell, Charles D. "Clinical Testing of the Pursuit System." Introduction. *The ENG Report Archives*. N.p.: Otometrics ICS Medical, 1983. 1-3. Print. 1983-1999.

Acknowledgements

Special thanks to Jessie Patterson, Au.D., & Alaina Basset, M.S., at DBDL, and to Weldon Zane Smith, B.S., at the UNL NEAR Center for their assistance with this project.

