Analysis of Driving Performace of Drivers Dosed By Cannabis using a Third Order Autoregrssive Time Series Model.

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Data

Driving Simulator Used

Data is from the NADS-1 MiniSim (Driving Saftey Reserch Institute March, 2022).

Subject Characteristics

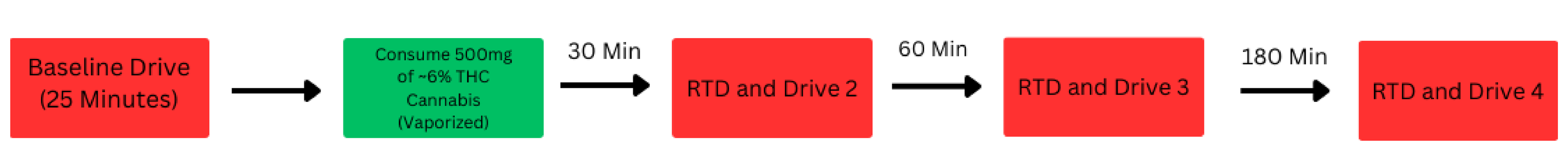
30 Total Subjects: 23 Men, 7 Women.

21 Subjects agreed with the statement: "I can safely drive after consuming cannabis", 14 somewhat, 7 strongly. Of those 21, 4 belive they were better drivers after consuming cannabis.

Table 1: Subject Characteristcs

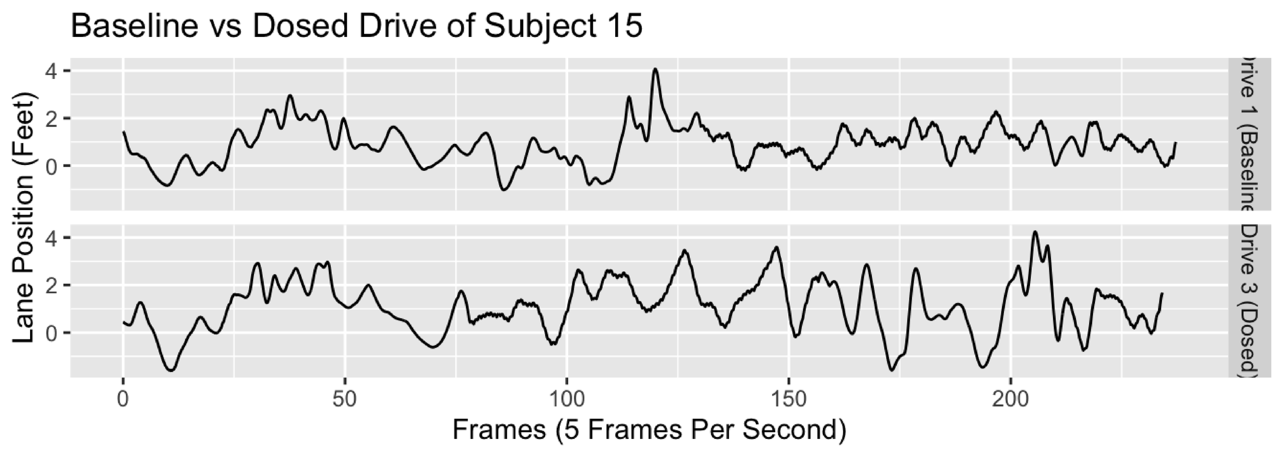
	Mean	Min	Max
Age	35	21	63
Age of First Cannabis Use	20	14	45
Annual Miles Driven	10414	15	28000
Percent of Days with Use (Past 90 Days)	56	11	100

Experiment Procedure



RTD (Readiness to Drive Survey)

Examples of Simulator Drives



Third Order Autoregressive Time Series Model

Let Y_t be position at time t for $t = 1, 2, \ldots, T$. For $t > 3$, we reparameterize the vector $[Y_{t-1}, Y_{t-2}, Y_{t-3}]$ to $[W_{1t}, W_{2t}, W_{3t}]$ with

$$\begin{aligned} W_{1t} &= Y_{t-1} \\ W_{2t} &= Y_{t-1} + [Y_{t-1} + Y_{t-3}]/2 \\ W_{3t} &= 3Y_{t-1} - 3Y_{t-2} + Y_{t-3} \end{aligned}$$

With this reparameteriziation, we specfìcy the third-order autoregressive time series as:

$$Y_t = \beta_1 W_{t1} + \beta_2 W_{2t} + \beta_3 W_{3t} + |e_t| I_t,$$

where $\beta_1 + \beta_2 + \beta_3 = 1$ and $0 \le \beta_1, \beta_2, \beta_3 \le 1$.

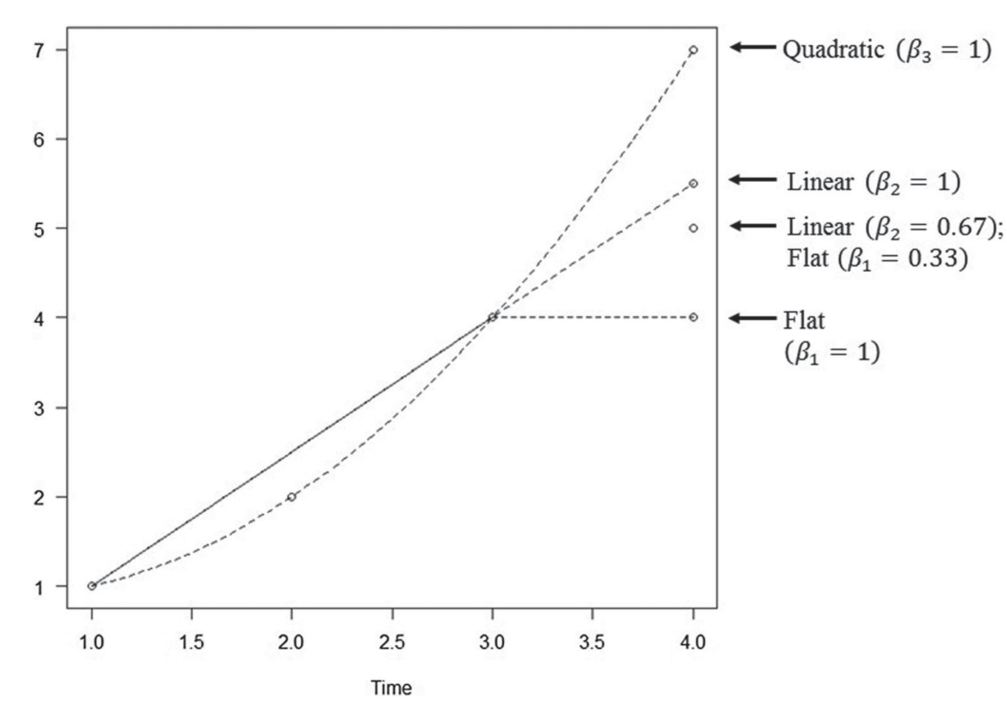
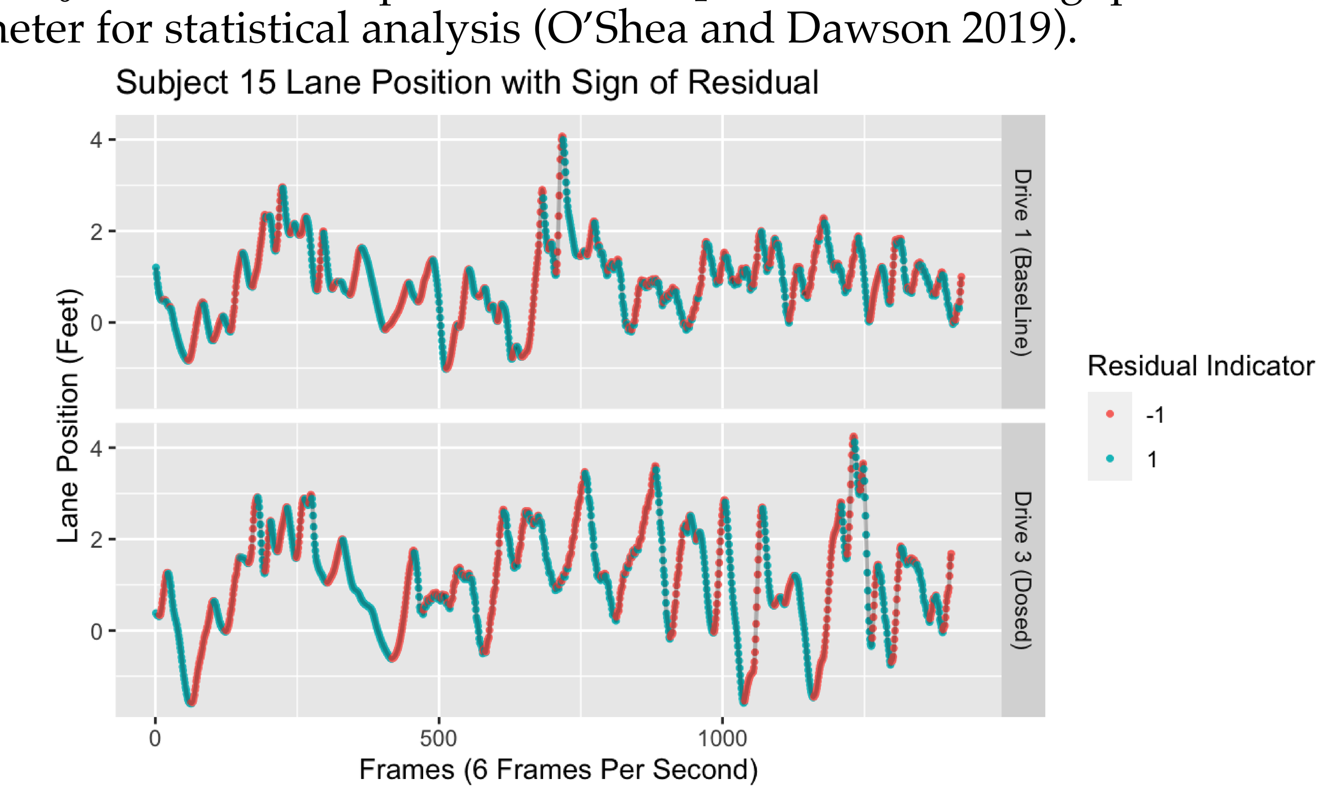


Figure 1: Vizualizaition of Reparameterization

In above model, e_t is assumed to be normally distributed with mean of 0 and variance σ_e^2 and I_t is an indicator variable where $I_t = -1$ when $Y_t < \hat{Y}_t$ with probability p_t and $I_t = 1$ when $Y_t > \hat{Y}_t$ with probability of $1 - p_t$. Dawson et al characterized the functional form of p_t with a logistic regression model:

$$\log\left[\frac{p_t}{(1 - p_t)}\right] = \lambda_0 + \lambda_1 Y_t,$$

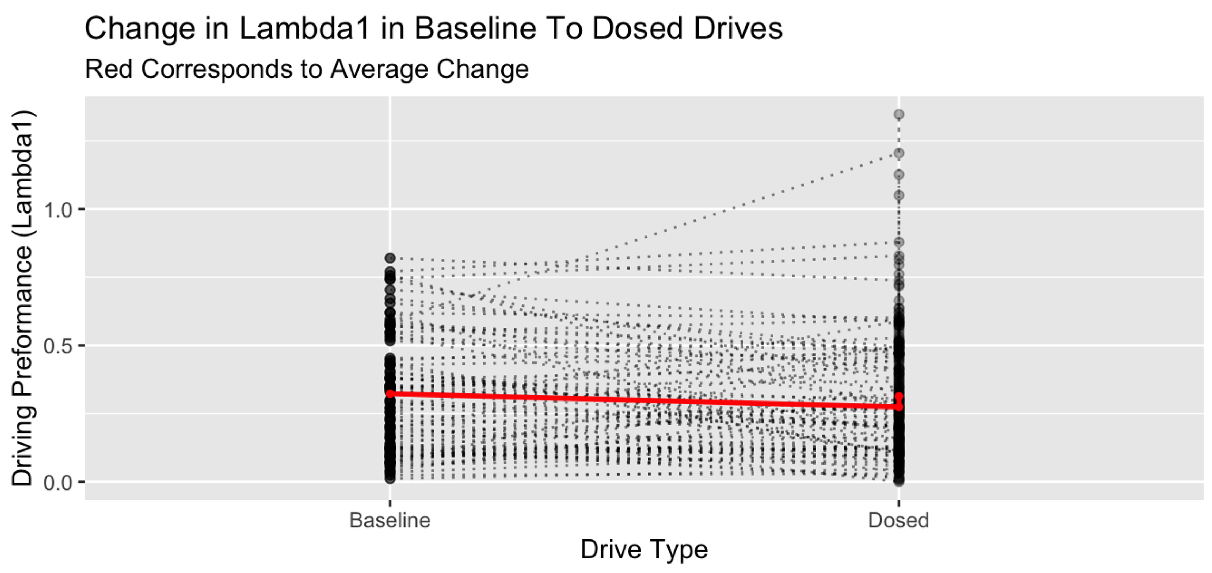
where λ_0 is the intercept term and λ_1 is the reentering parameter, the key parameter for statistical analysis (O'Shea and Dawson 2019).



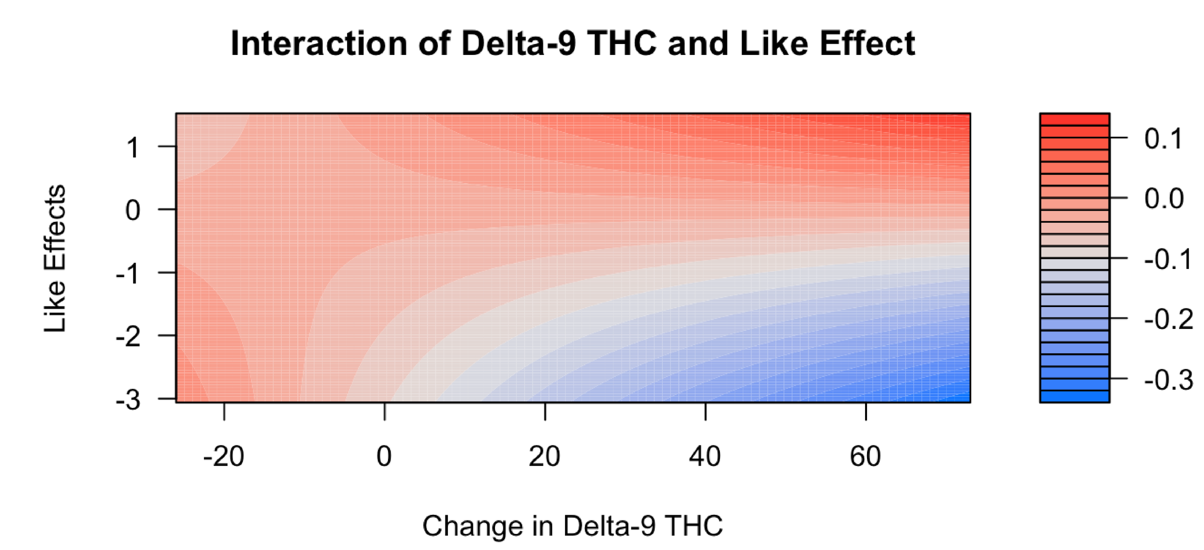
Results

Used Mixed Effects Linear Regression to model change in λ_1 after dosage.

Model 1: $\triangle\lambda_1 = \alpha_i + \beta_1 \text{Ready} + \varepsilon$.



Model 2: $\triangle\lambda_1 = \alpha_i + \beta_1 \triangle\text{THC} + \beta_2 \text{Like} + \beta_3 \triangle\text{THC} \cdot \text{Like} + \varepsilon$.



Discussion

- The intercept only model had $\hat{\beta}_0 = -.03$ with $T < -2$, indicating that drivers preformed worse after consuming cannabis.
- The models above had $F < .2$. All other models, including cannabis use history, driving history, and demographic information (age,sex, etc.), had $F \geq .5$.
- This experiment had a small sample size, but there are plans to increase the experiment to ~500

Acknowledgments

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References

Driving Saftey Reserch Institute. March, 2022. "NADS Mini Sim." https://www.nads-sc.uiowa.edu/minisim/wiki/index.php?title=File:Quarter-cab3.jpg.

O'Shea, Amy M. J., and Jeffrey D. Dawson. 2019. "Modeling Time Series Data with Semi-Reflective Boundaries." *Journal of Applied Statistics* 46 (9): 1636–48. https://doi.org/10.1080/02664763.2018.1561834.