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).

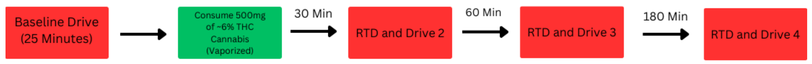
Subject Characteristics

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

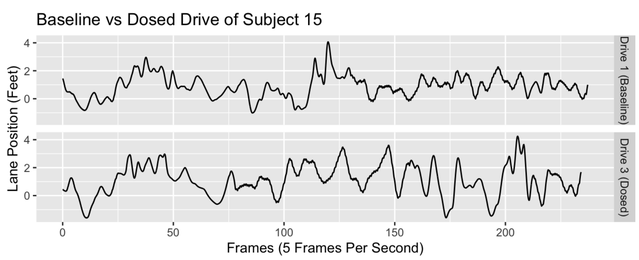
30 Total Subjects: 23 Men, 7 Women. 21 Subjects agreed with the statement: "I can safely drive after consuming cannabis", 14 somewhat, 7 strongly. Of those 21, 4 believe they were better drivers after consuming cannabis.

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 specficy 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 $0 \leq \beta_1, \beta_2, \beta_3 \leq 1$.

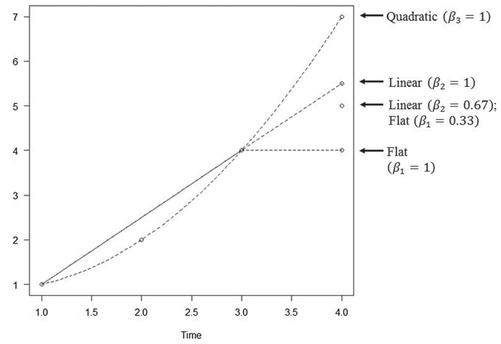
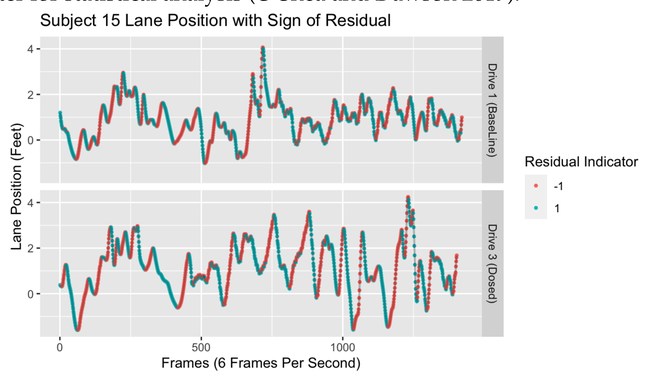


Figure 1: Vizualizaition of Reparameterization

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:

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

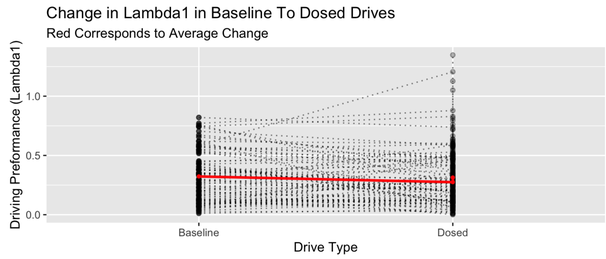
where λ_0 is the intercept term and λ_1 is the re-centering parameter, the key parameter for statistical analysis (O'Shea and Dawson 2019).



Results

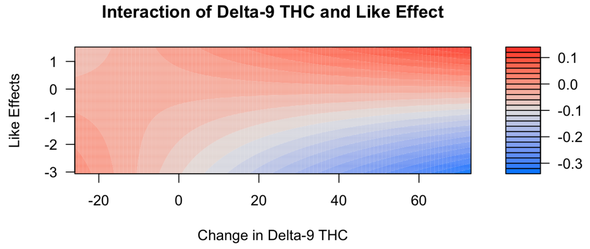
Used Mixed Effects Linear Regression to model change in λ_1 after dosage.

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



Model 1 Estimates: $\hat{\alpha} = -.05$ with CI $= (-0.09, -0.011)$, $\hat{\beta}_1 = .04$ with CI $= (-0.01, 0.10)$.

Model 2: $\triangle\lambda_1 = \alpha + \alpha_{\text{Subject}} + \beta_1 \triangle\text{THC} + \beta_2 \text{Like} + \beta_3 \triangle\text{THC} \cdot \text{Like} + \varepsilon$, for $i \in \{1, \ldots, 30\}$.



Model 2 Estimates: $\hat{\beta}_3 = 1.319 \cdot 10^{-3}$ with CI $= (-.00005, 0.00279)$.

Discussion

In model 1, the estimates of β_1 and α indicate that intoxicated drivers preformed worse when not ready to drive, but once they were ready to drive, preformed slightly below baseline (sober). However, since β_1 has a confidence interval that includes 0 as well as an insignificant F-test, comparing model 1 to the null model (p-value = .12), we are limited in the conclusions we can draw from this analysis. Model 2 tried to account for the objective and subjective effects of cannabis. However, due to the confidence interval of β_3 including 0 and an insignificant F-test (p-value = .34), we do not have the evidence to make conclusions regarding relationship between the interaction of $\triangle$-THC and the enjoyment of the high. A possible explanation for both insignificant models is that either, there is no relationship between the explanatory variables and λ_1, or λ_1 may not be capable of picking up impairment that is represented by self assessment or blood measures.

Although this investigation was inconclusive, we must contextualize the study: the drivers were moderate users of cannabis, many of whom were comfortable driving while intoxicated. Moreover, the sample size of this study was quite small, 30 participants. The same study is being conducted with a larger sample size, up to 500 participants, which may add crucial information to our investigation.

Acknowledgments

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References

Driving Saftey Reserch Institute. March, 2022. "NADS Mini Sim." https://www.nads-sc.uiowa.edu/minisim/wiki/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.