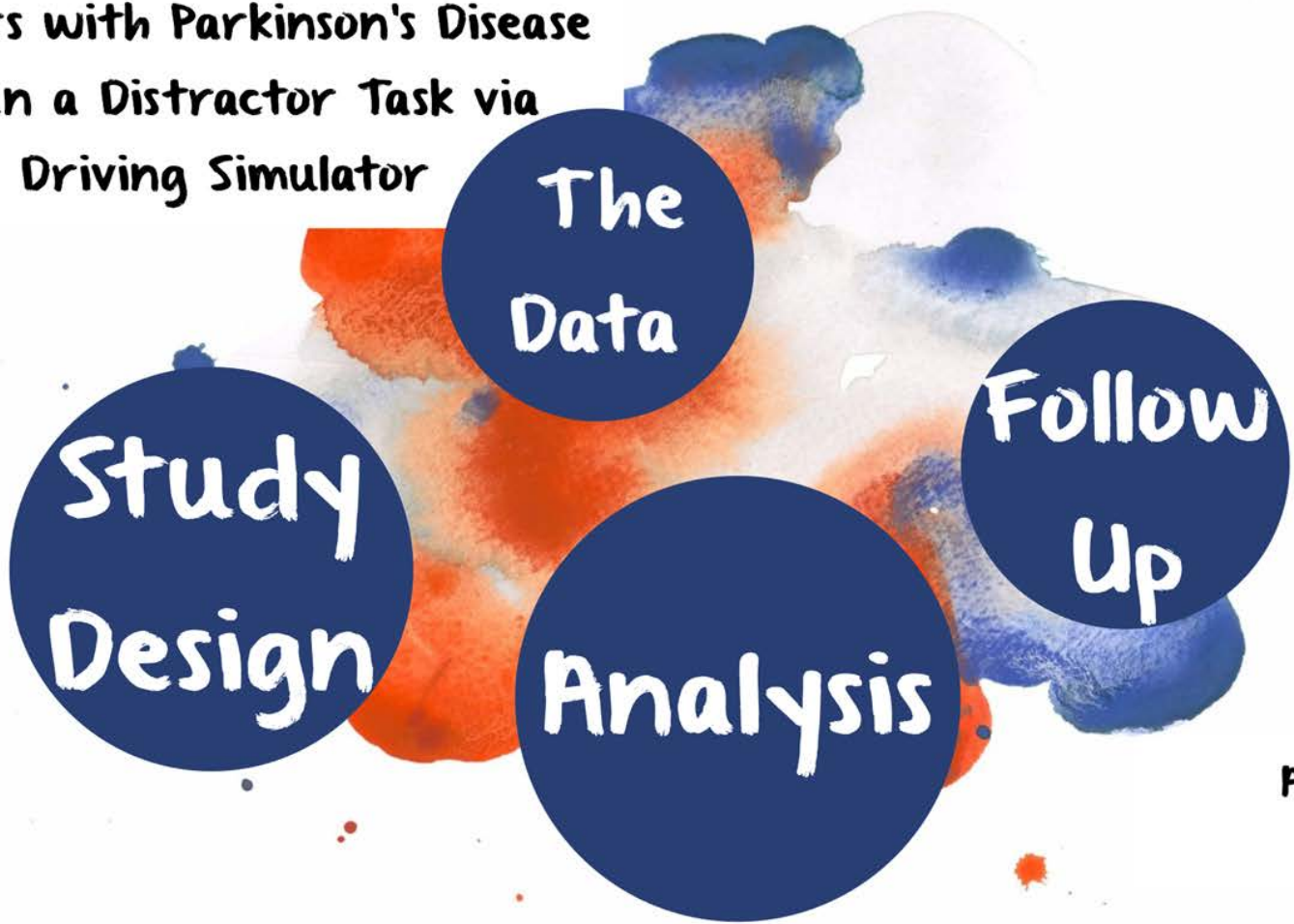
A Lane Position Analysis of Drivers with Parkinson's Disease Given a Distractor Task via Driving Simulator



Adalis, Eryn, Reyna

Our Project

About our Subjects

Parameters

Parkinson's Disease (PD)

- "a brain disorder that leads to shaking, stiffness, and difficulty with walking, balance, and coordination"
- Symptoms usually begin gradually and get worse over time
- affects about 50% more men than women
- No known cure

The Study

PICTURES

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Parkinson's Disease (PD)

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- affects about 50% more men than women
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*** "Control" in our study refers to those without PD**

The Study

PICTURES

Sample Size

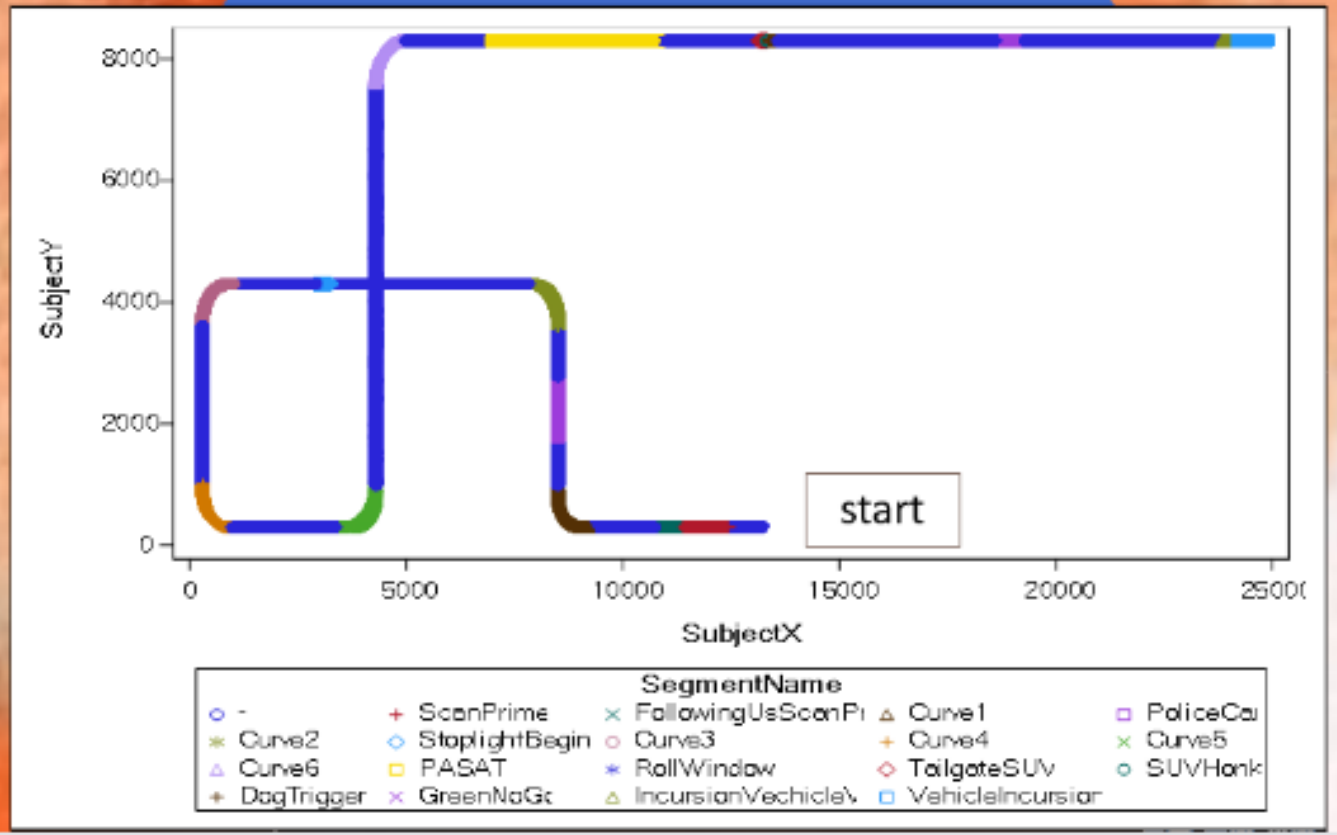
The study consisted of 136 participants (part_n):

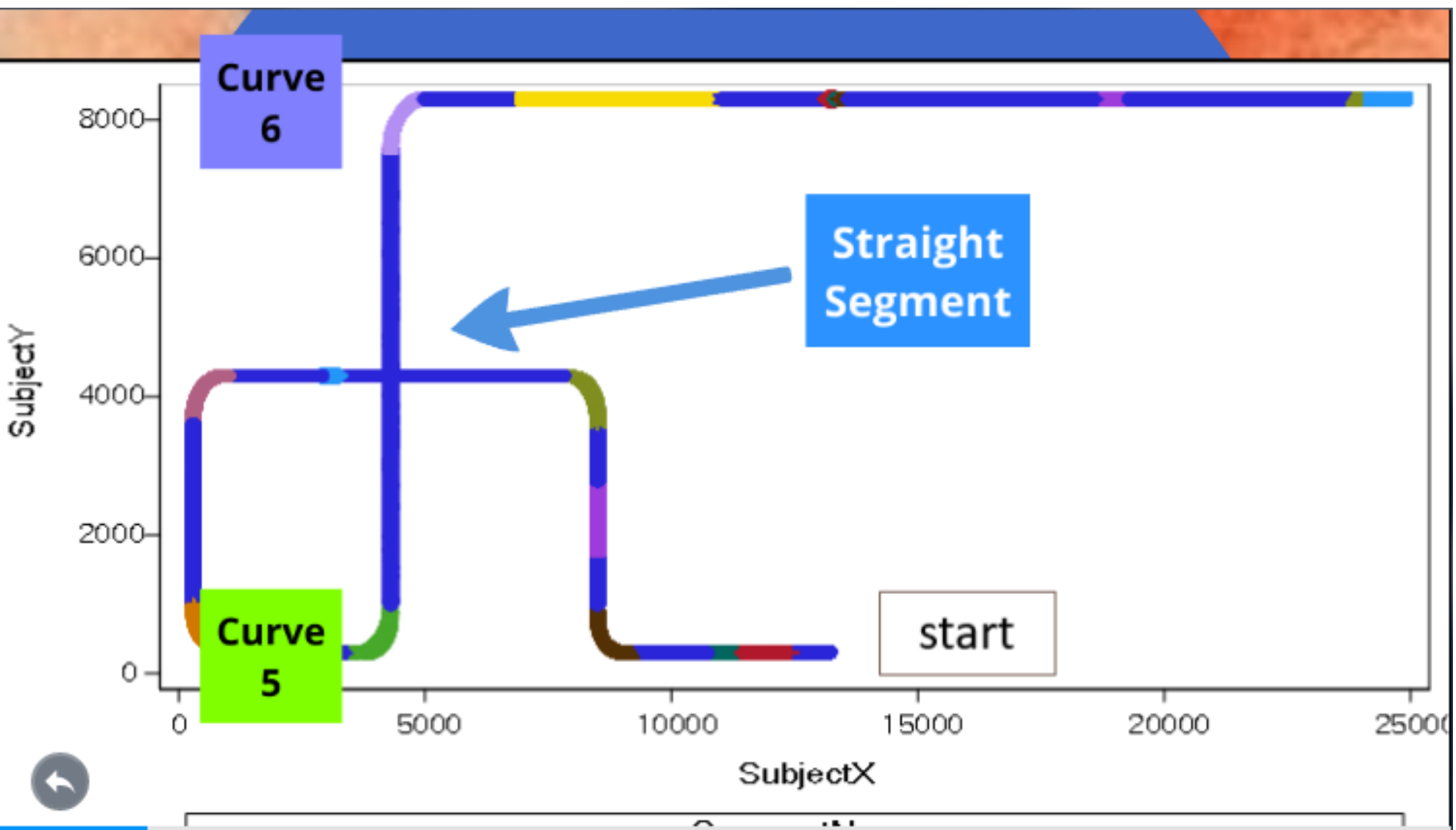
- 71 subjects with PD
- 65 subjects without PD (Control)

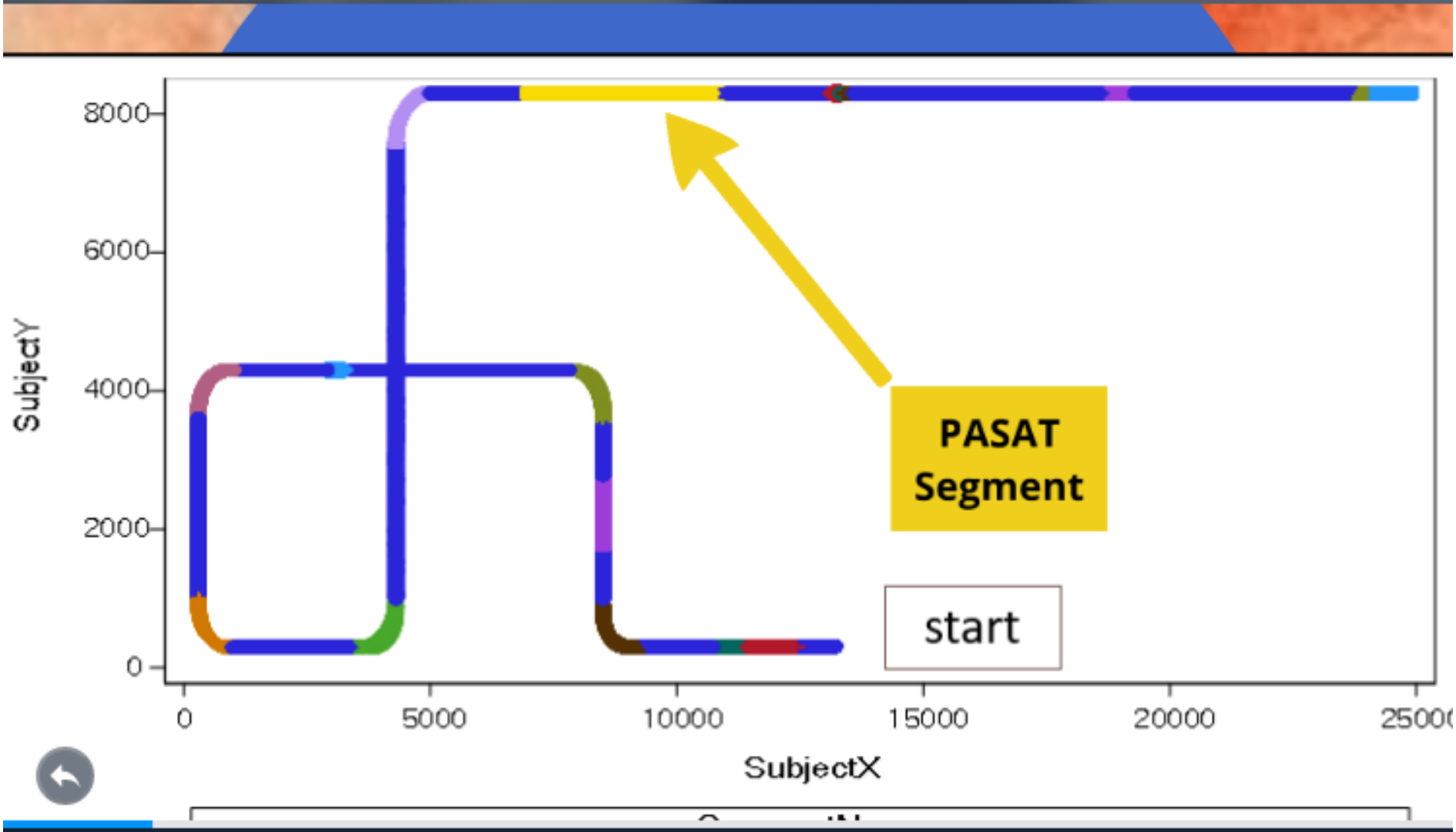
Each subject drove a fixed curved route via the Univ. of Iowa's driving simulator, SIREN*.

*Simulator for Interdisciplinary Research in Ergonomics and Neuroscience

Driving Route




Curve 6
Straight Segment
Curve 5
start
8000
6000
4000
2000
0
SubjectY
0
5000
10000
15000
20000
SubjectX


8000
6000
4000
2000
0
SubjectY
0
5000
10000
15000
20000
25000
SubjectX
PASAT
Segment
start

PASAT*

A neuropsychological test that assesses "auditory information processing speed and flexibility, as well as calculation ability."

- negatively affected by increasing age, decreasing IQ, and low math ability.
  - PD might accelerate impairment

*Paced Auditory Serial Addition Test

About the Test

Try it out!

The Process

Single digits are presented every 3 seconds where the patient must add each new digit to the one immediately prior to it.

Test it Out

https://www.miniwebtool.com/random-name-picker/

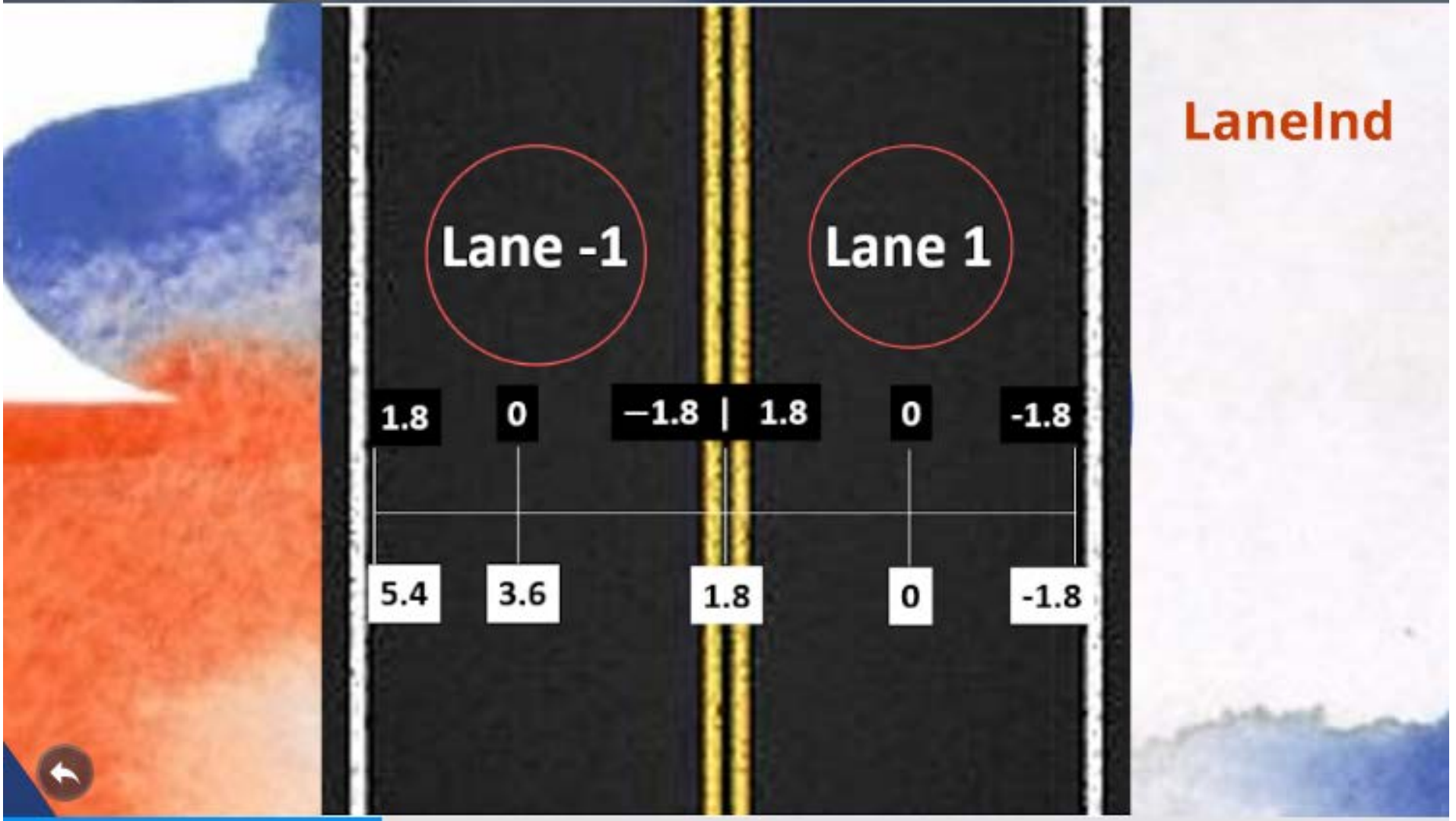
Lane Position

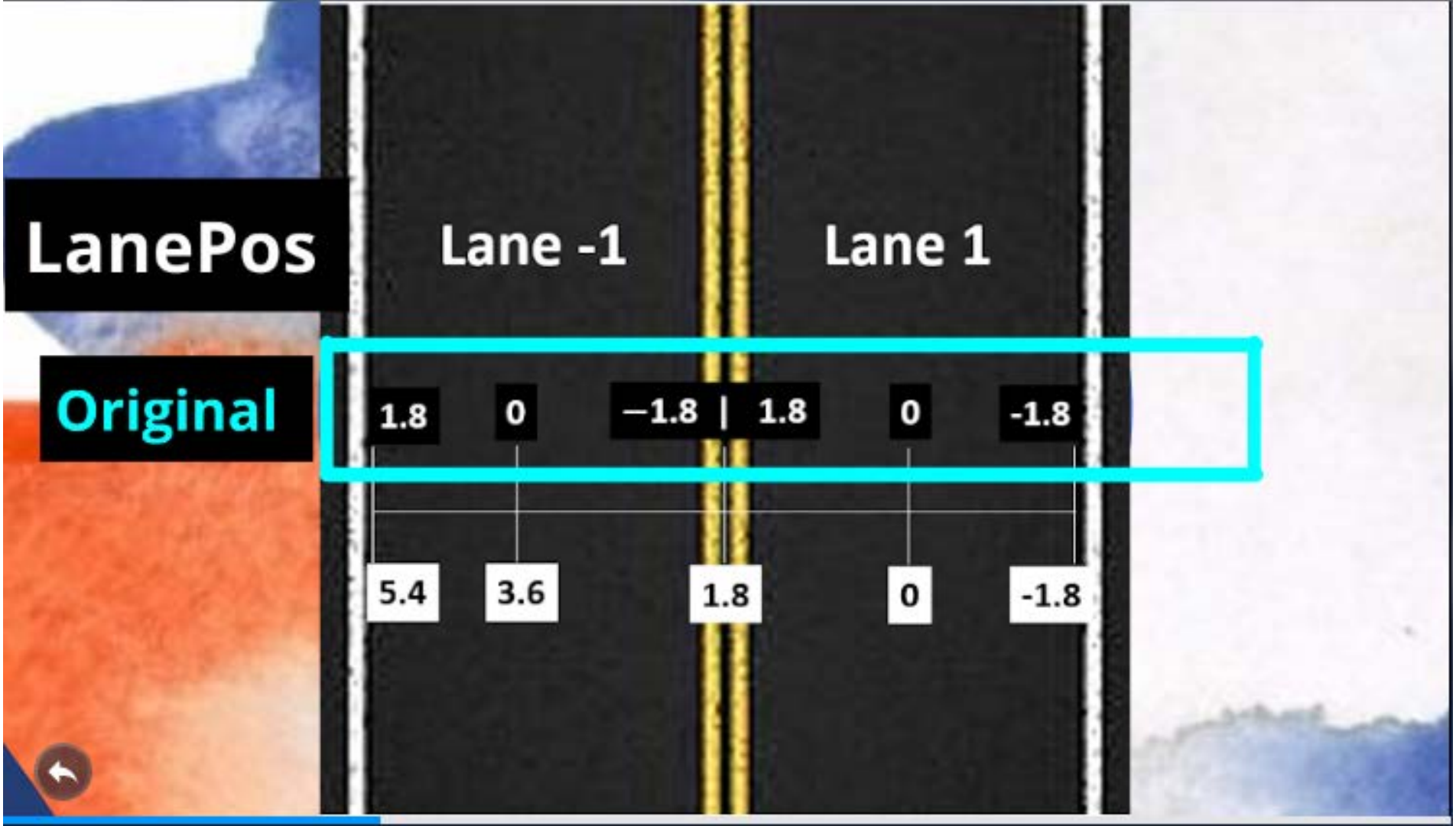
Lane Position (**LanePos**) is the position of the center of the vehicle within the lane.

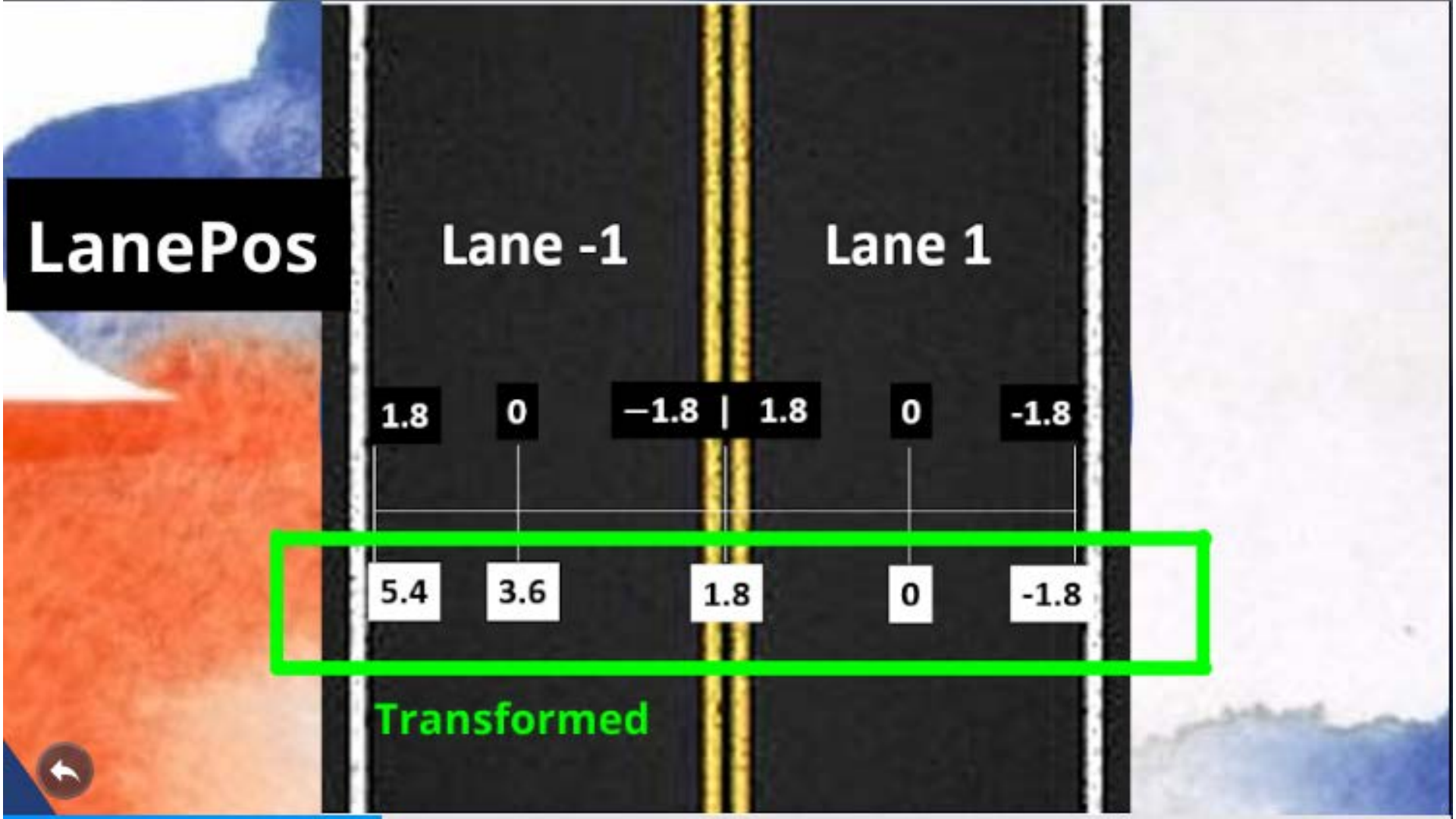
Lane Indicator (**LaneInd**) is the actual lane the subject is in while driving.

- **Lane 1 is the default lane**

LanePos Detail
Lane Crossing
Metrics
Original Data


LaneInd
Lane -1
Lane 1
1.8
0
−1.8 | 1.8
0
-1.8
5.4
3.6
1.8
0
-1.8


LanePos
Lane -1
Lane 1
Original
1.8
0
−1.8
1.8
0
-1.8
5.4
3.6
1.8
0
-1.8


LanePos
Lane -1
Lane 1
1.8
0
−1.8 | 1.8
0
-1.8
5.4
3.6
1.8
0
-1.8
Transformed

Lane Crossing

Lane crossing is when part of the car crosses the lane

- In our study, 1 lane crossing is defined when a person crosses into another lane for "multiple frames at a time consecutively."

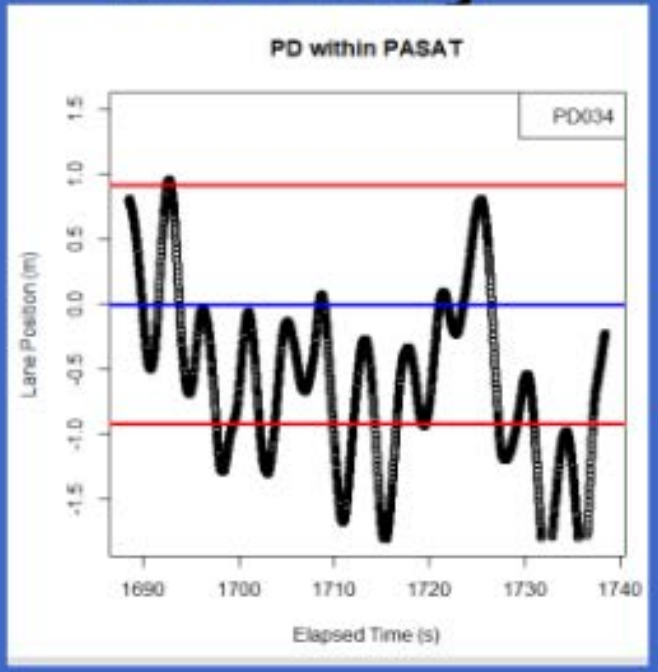
Coding: This is when the LanePos >.92 meters from the center.

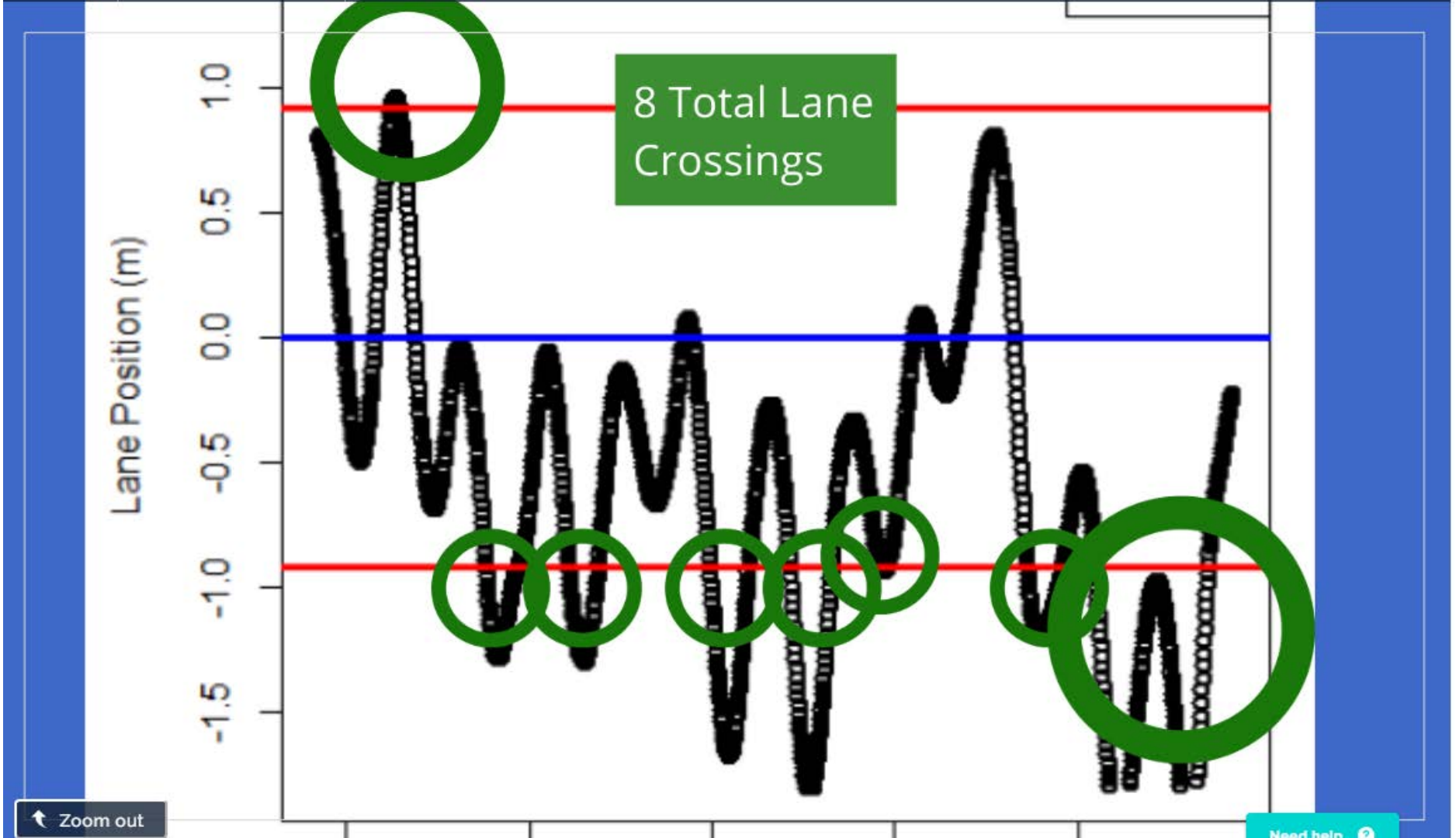
*.92m is based on car and width of the lane

In Detail

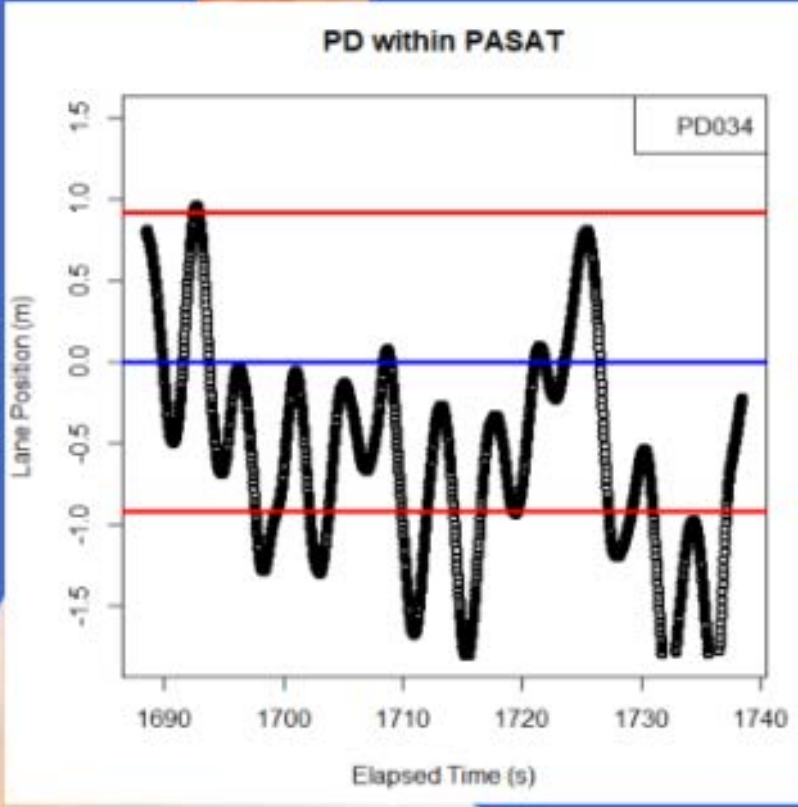
PD vs Control

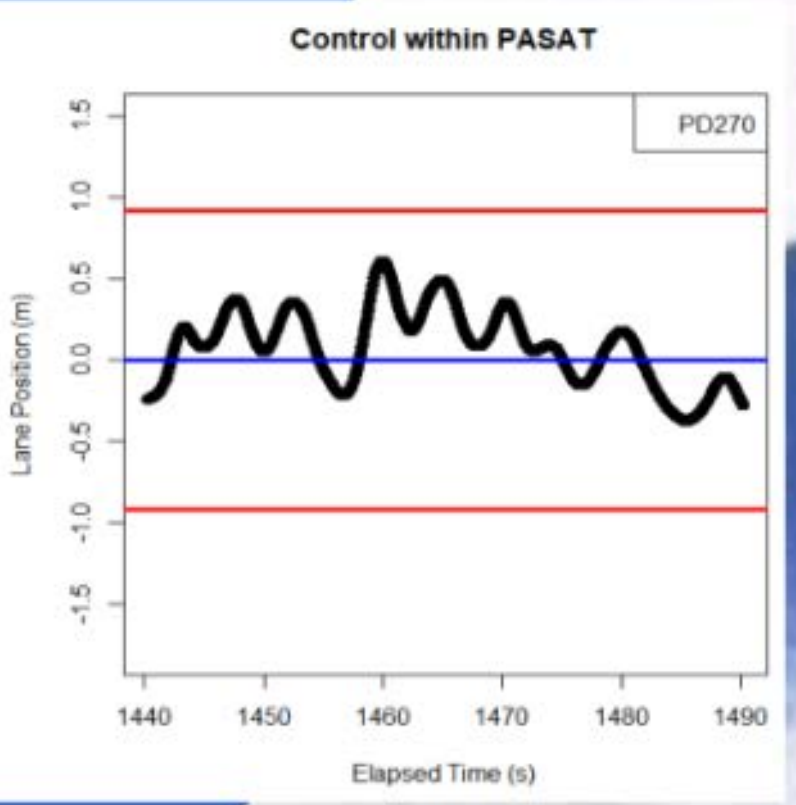
Guess the number of lane crossings:

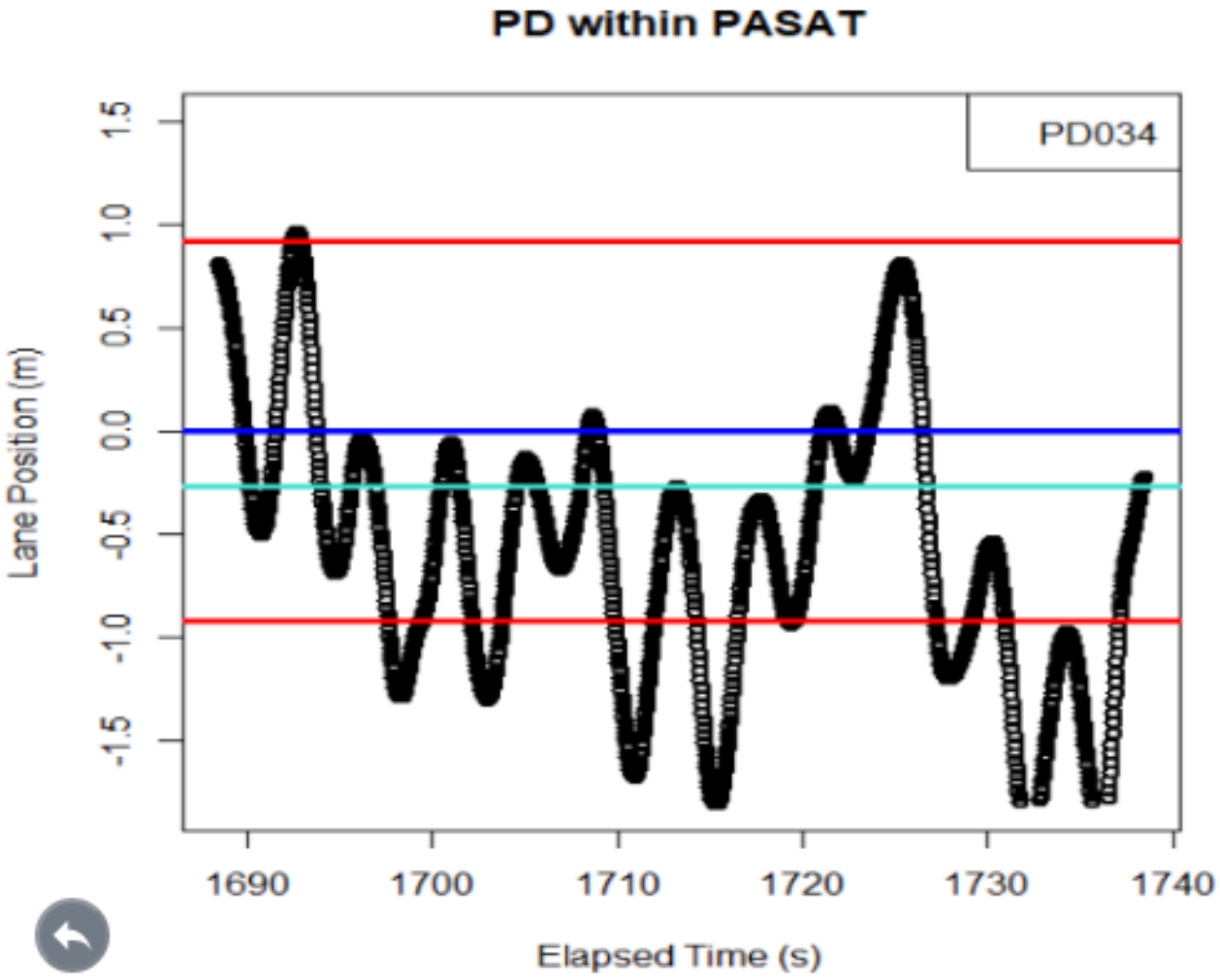



8 Total Lane Crossings
Lane Position (m)
1.0
0.5
0.0
-0.5
-1.0
-1.5
Zoom out
Need help

PD vs Control







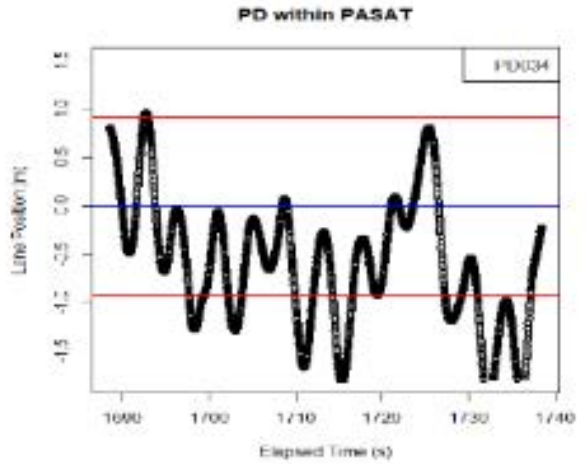
SDLP - standard deviation lane position

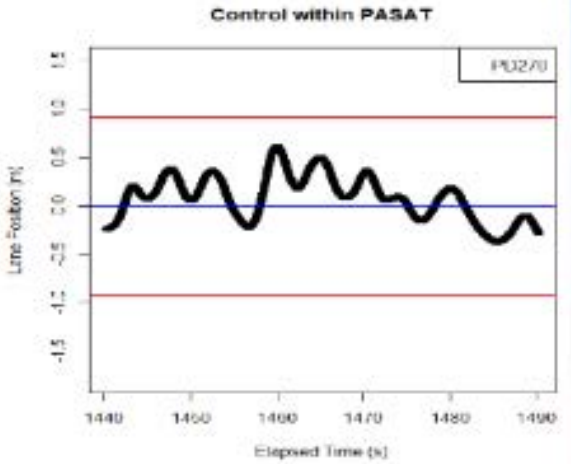
MAD_rel - mean absolute deviation (based on their LanePos mean)

MAD_0* - mean absolute deviation (based on 0)

LaneC* - number of lane crossings

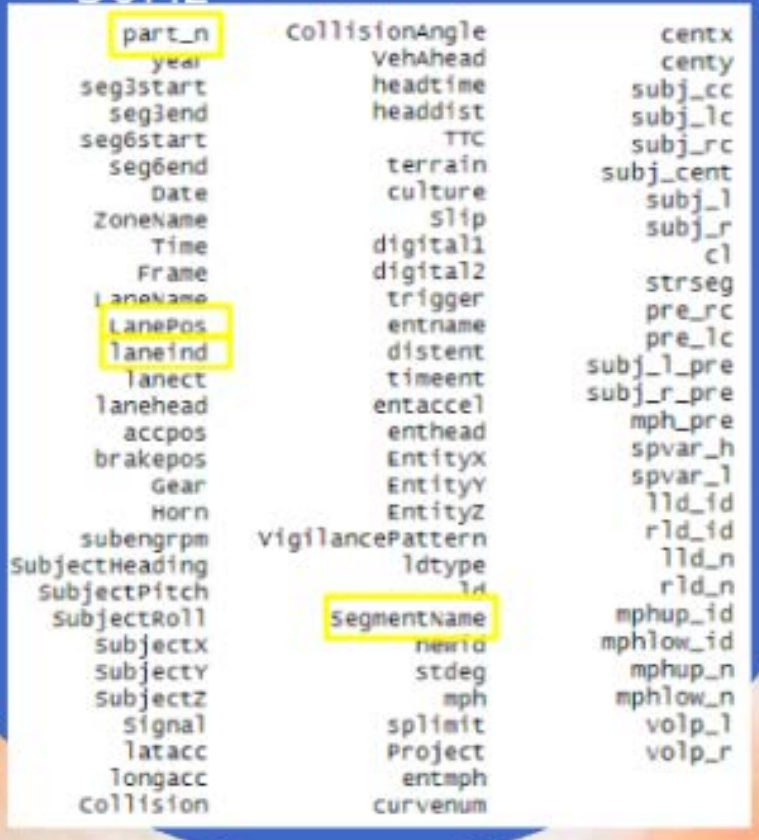
Recall the two previous subjects...



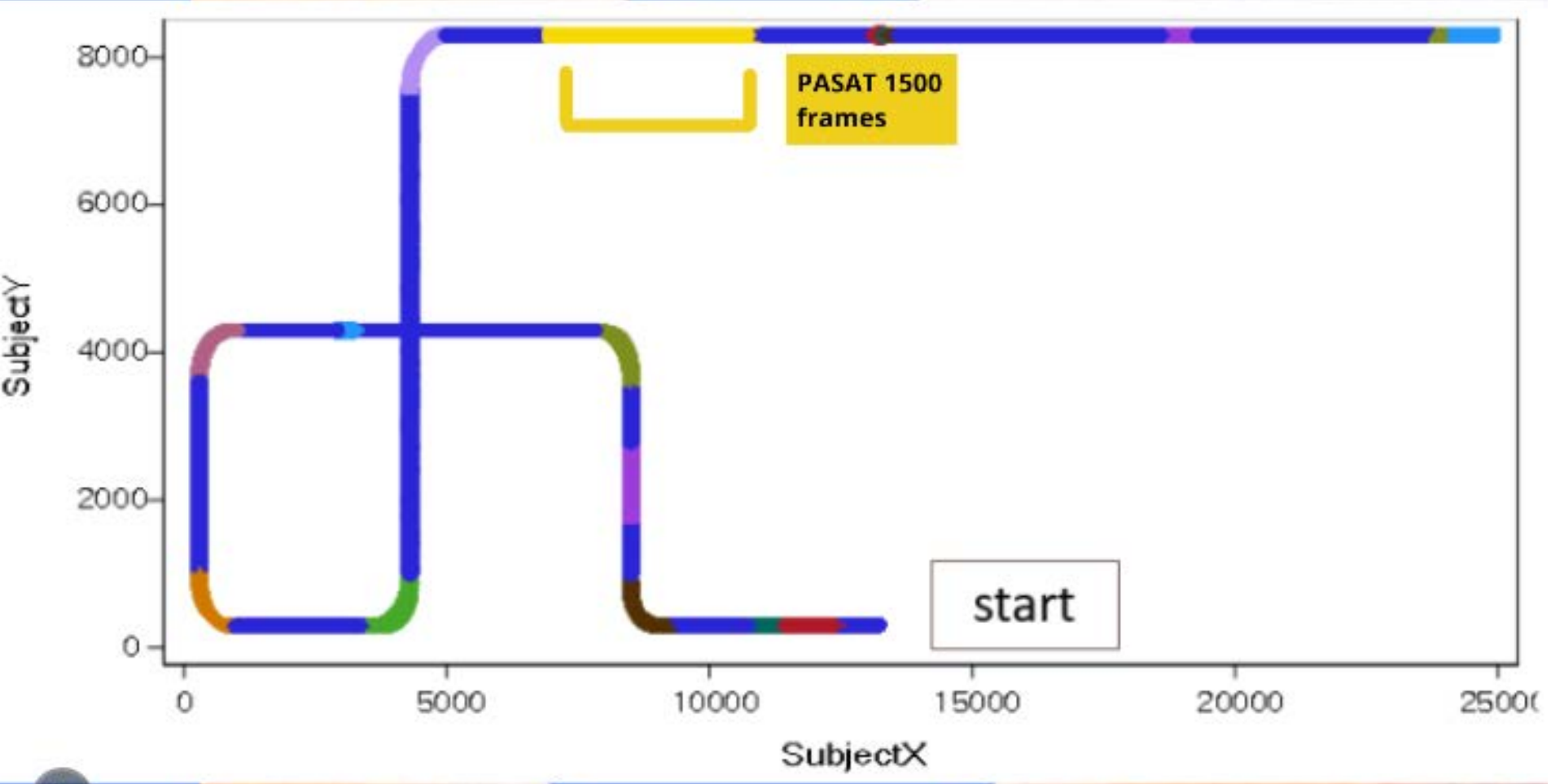


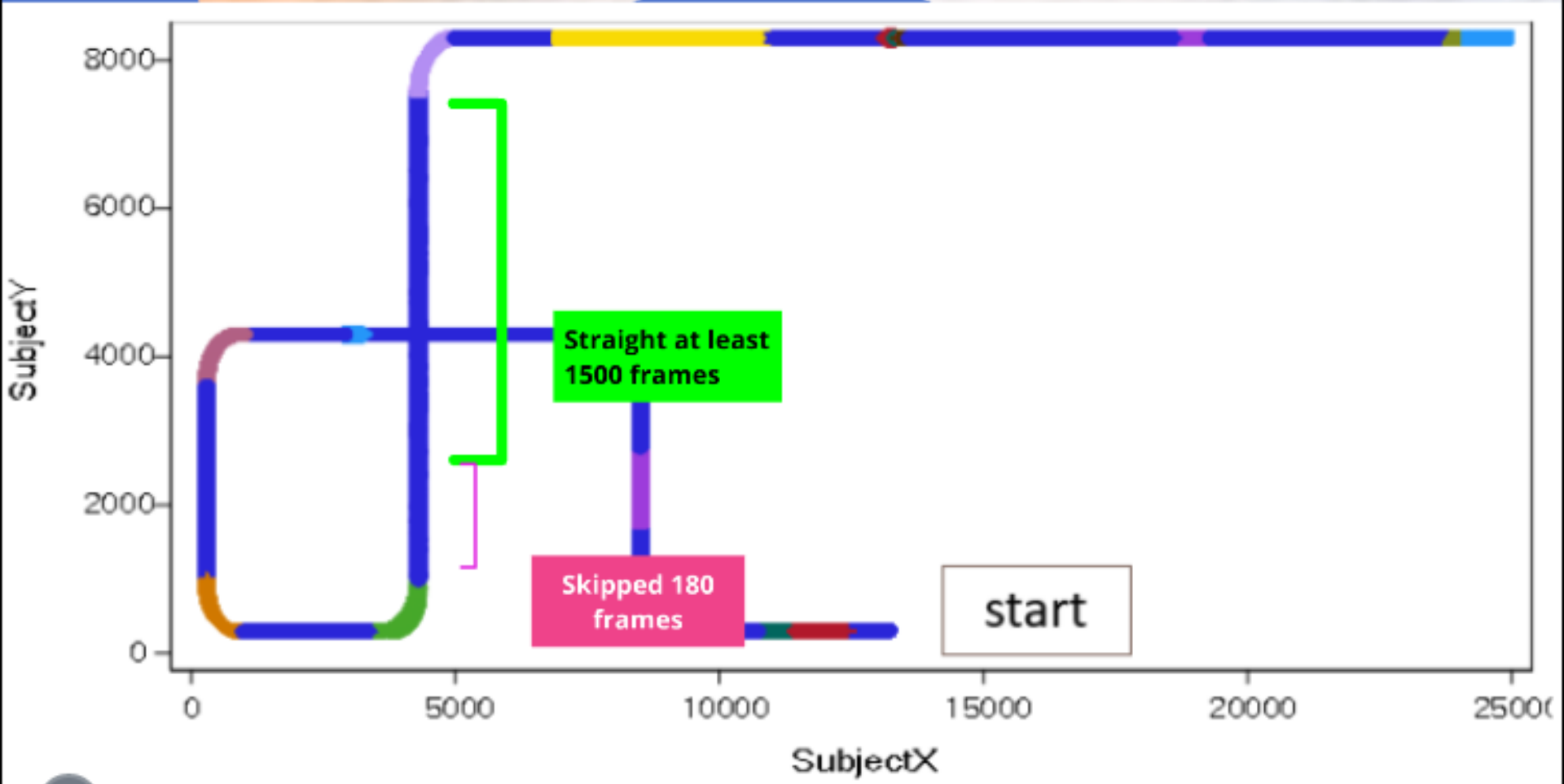
	PD034	PD270
MAD_0	0.739	0.209
MAD_rel	0.587	0.188
SDLP	0.792	0.233
Lane crossing	8	0

- Data was collected at 30Hz



Example


PASAT 1500
frames
start
8000
6000
4000
2000
0
SubjectY
0
5000
10000
15000
20000
SubjectX


8000
6000
4000
2000
0
SubjectY
0
5000
10000
15000
20000
SubjectX
Straight at least 1500 frames
Skipped 180 frames
start

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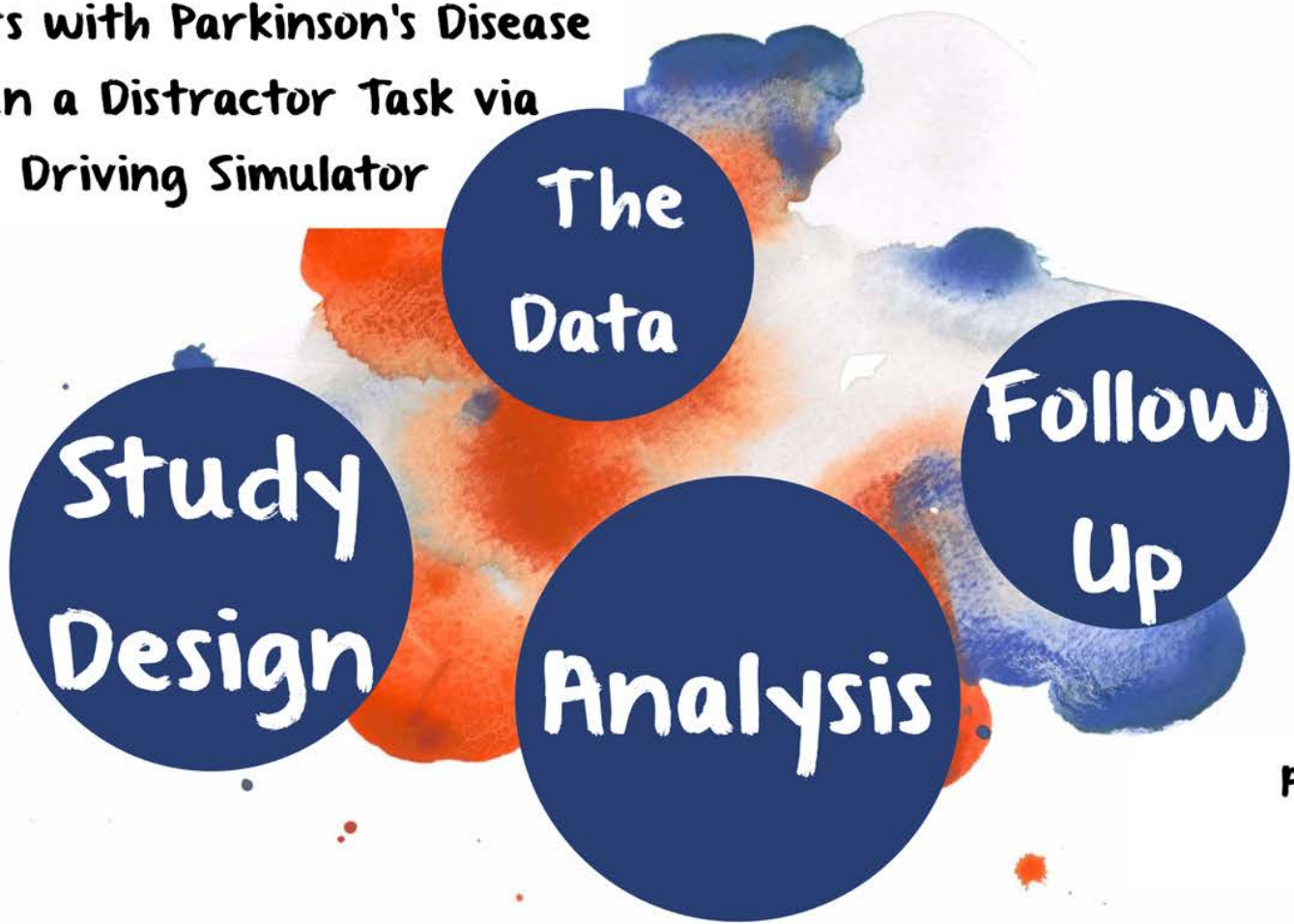

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Objective

- Former graduate student, Sean Devries, investigated the effect of PASAT among PD and Control subjects.

- Our objective was to replicate and extend his research given access to "year 3" data.

Questions

Data Cleaning

Our Questions to Consider

- Were PD and controls different during PASAT stretch? Straight stretch?
- Were PD subjects affected by PASAT task? How about controls?
- Were PD subjects affected by the PASAT task to a different degree than the Control subjects?

Cleaning up the Data

Extracted two subsets from each subject:

- From PASAT and Straight sections
- 1500 frames each

Excluded subjects if:

- Not long enough PASAT or Straight segment
- NAs in LanePos for the subsets

Data Table 1

Data Table 2

Table I. MAD_0 for 66 PD subjects and 59 control subjects in Year 1

	PASAT	Straight	Difference (P-value)	CI (95%)
PD	0.345	0.356	-0.011 (0.512)	(-0.045, 0.023)
Control	0.249	0.274	-0.025 (0.035)	(-0.049, -0.002)
Difference (P-value)	0.096 (< 0.001)	0.082 (< 0.001)		
CI (95%)	(-0.142, -0.051)	(-0.124, -0.040)		

Table II. Lane Crossing for 66 PD subjects and 59 control subjects in Year 1

	PASAT	Straight	Difference (P-value)
PD	51	59	-8 (0.380)
Control	12	13	-1 (0.894)
Difference (P-value)	39 (0.001)	46 (0.002)	

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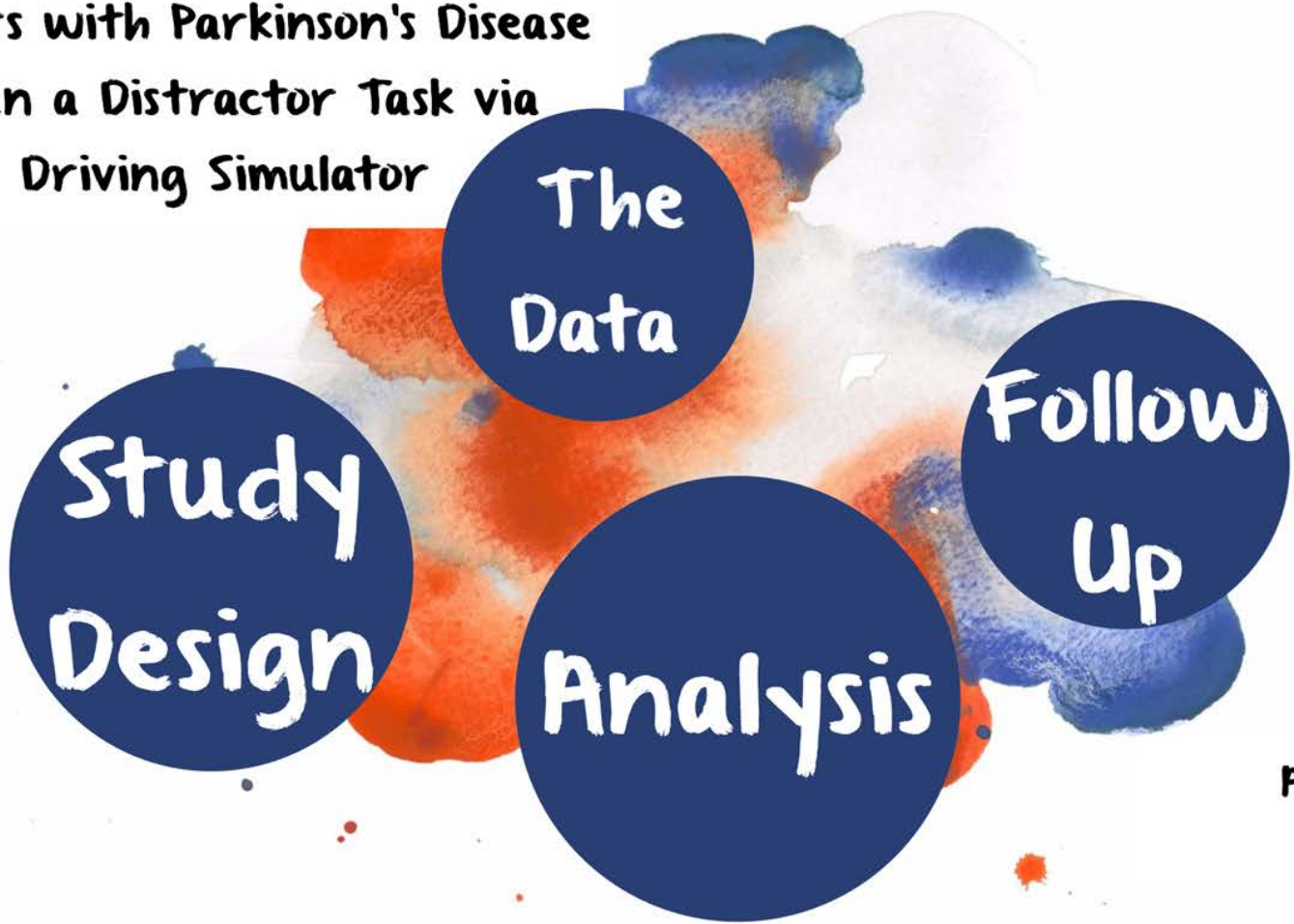

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Our Objective:

As an extension of Sean's research, we compared data from Year 1 to Year 3

- Year 3 is a subset of PD subjects from Year 1

Questions

Table 3

Table 4

Questions to Consider

- Was there a difference for PD subjects during Straight stretch between Year 1 and Year 3? How about for PASAT stretch?
- Were PD subjects affected by the PASAT in Year 3? Year 1?
- Was the amount of effect (due to PASAT) in PD subjects different in Years 1 and 3?
- Was the amount of effect (due to PASAT) in PD subjects during Year 1 associated/ correlated with the effect in Year 3?

Table III. MAD_0 for 20 PD subjects in Year 1 vs. Year 3

	PASAT	Straight	Difference (P-value)	CI (95%)
Year 1	0.354	0.316	0.038 (0.276)	(-0.033, 0.109)
Year 3	0.370	0.365	0.005 (0.878)	(-0.064, 0.075)
Difference (P-value)	0.017 (0.678)	0.050 (0.105)		
CI (95%)	(-0.101, 0.067)	(-0.111, 0.011)		

Table IV. Lane Crossing for 20 PD subjects in Year 1 vs. Year 3

	PASAT	Straight	Difference (P-value)
Year 1	8	8	0 (1.000)
Year 3	11	24	-13 (0.015)
Difference (P-value)	3 (0.345)	16 (0.003)	

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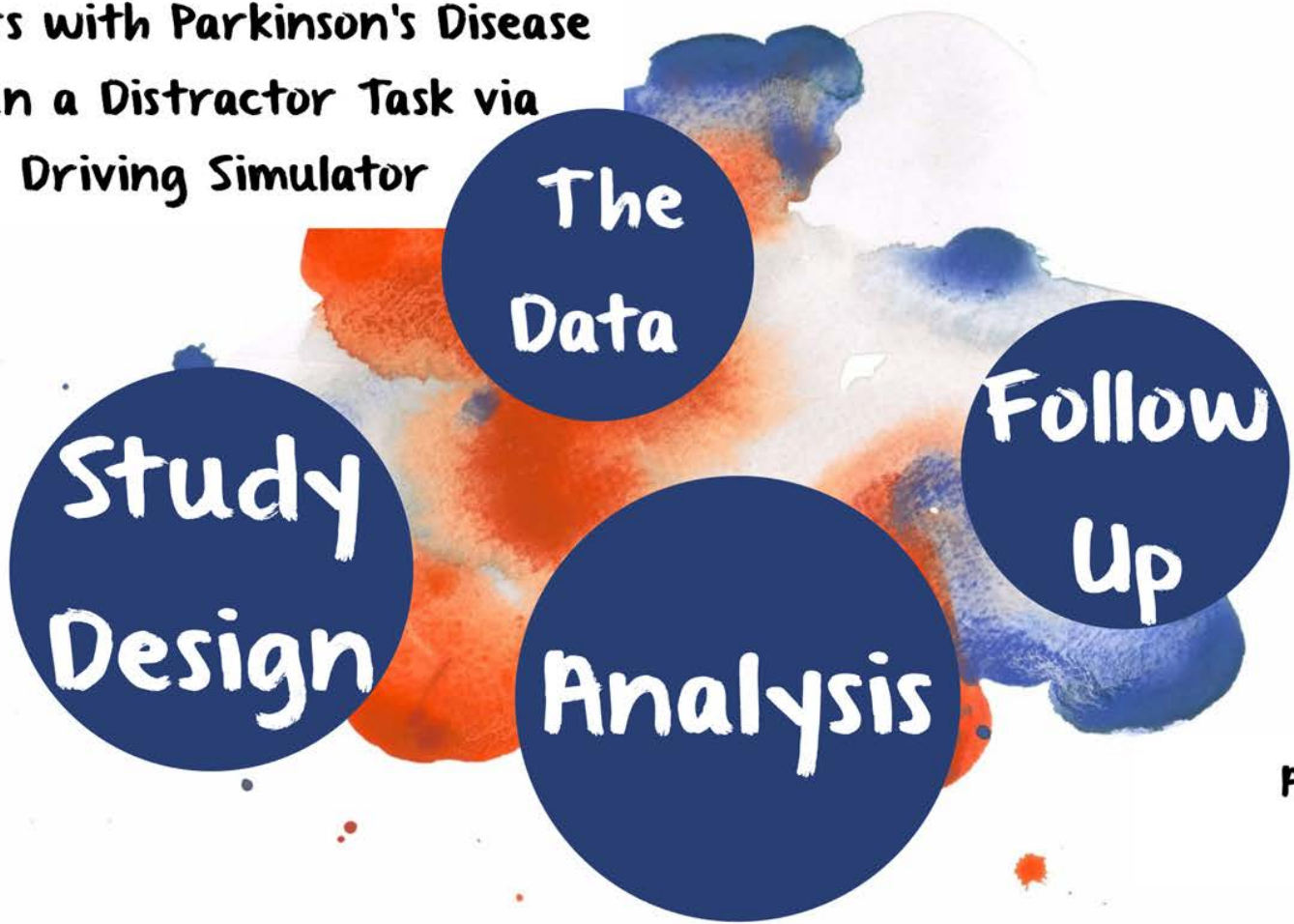

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To summarize...

- Appears to be no difference between PASAT and Straight for either PD or controls
- PD subjects have more variation in lane position than controls
- PD subjects in Year 3 make more lane crossings than in Year 1
- Year 3 PD subjects make more lane crossings in the Straight segment than the PASAT segment

Limitations

Acknowledgments

References

Questions

Limitations

- Perhaps some PD subjects did not return for Year 3 because their condition had worsened since Year 1
- Can't compare Year 3 PD subjects with Year 3 Controls
- Small sample size (n=20) in Year 3 which leads to poor power

Special Thank You to:

- Our Mentor, Professor Jeff Dawson
- Ergun Uc
- Sean Devries
  - Grant #RO1 NS 044930
- ISIB Program sponsored by the National Heart Lung and Blood Institute (NHLBI), grant # HL147231.

NIH National Heart, Lung, and Blood Institute

The University of Iowa | College of Public Health

Dream Team

ISIB Project 2019

Articles & More

Practical and statistical challenges in driving research
Jeffrey D. Dawson, Received: 21 March 2017 Revised: 5 June 2018 Accepted: 13 June 2018

Predictors of driving safety in early Alzheimer disease
J.D. Dawson, ScD S.W. Anderson, PhD E.Y. Uc, MD E. Dastrup, MS M. Rizzo, MD, Received August 4, 2008. Accepted in final form October 31, 2008

Questions?

Thank You!

Last Chance...

NOT SURE IF I DID A GREAT JOB
OR NO ONE PAID ATTENTION
VIA 9GAG.COM