Effect of Distraction and Alzheimer's Disease in Simulated Driving Based on Four Methods of Data Reduction

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Research Goals

- We will compare the driving positions of drivers with Alzheimer's Disease(AD) and without AD.
- We also want to compare the effects of having a distraction while driving.
- Learn new methods of data reduction.

SIREN Simulator

Simulated Driving Study

- Data Collected from University of Iowa Hospital and Clinics consists of:
    - 69 drivers with AD
    - 129 healthy drivers without AD
- Both group of drivers were exposed to two different types of segments:
    - One control segment freed the driver from any distractions
    - The other segment asked the driver to perform the Paced Auditory Serial Addition Task(PASAT)

Paced Auditory Serial Addition Test (PASAT)

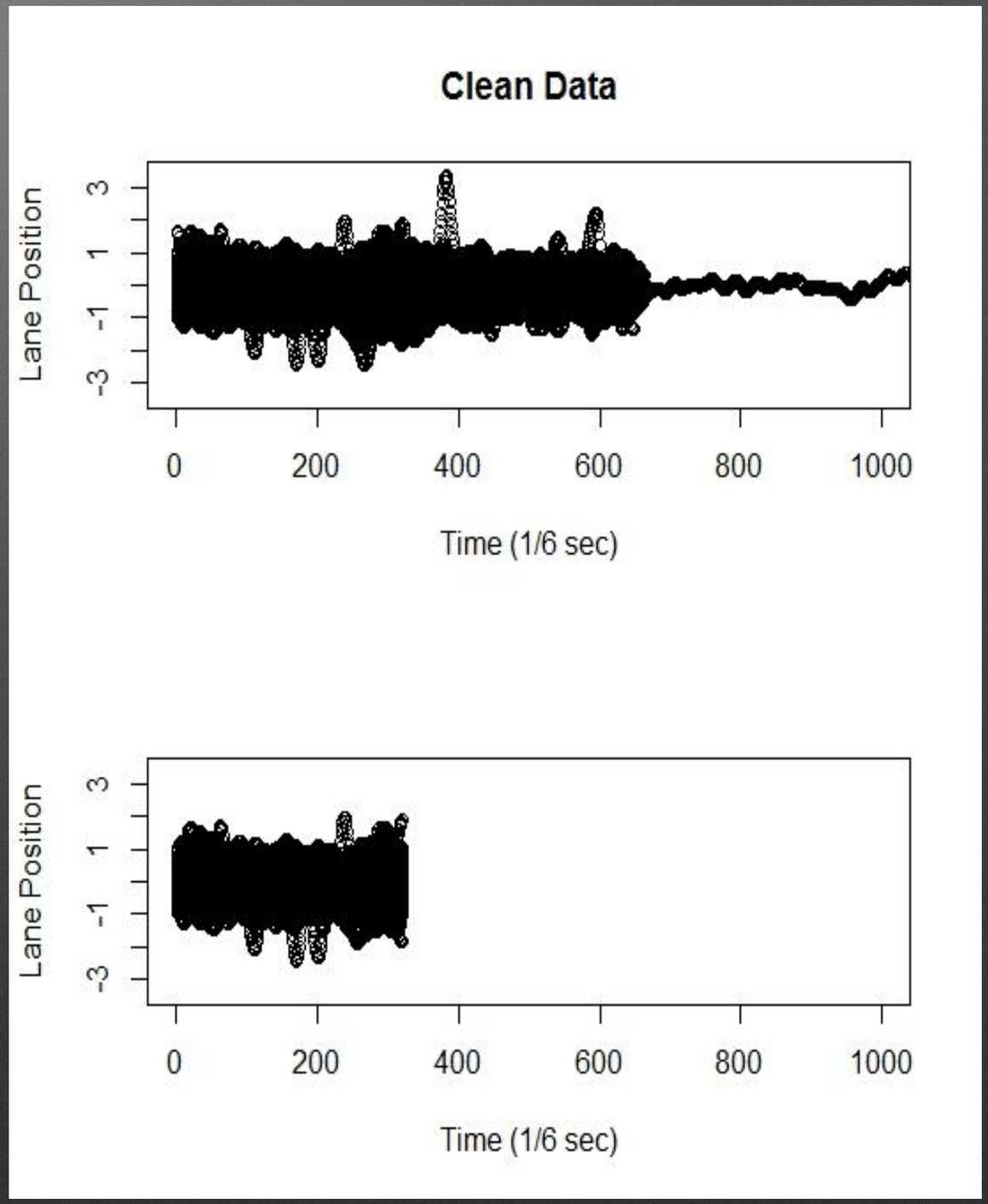
- The PASAT is the distraction test used in the simulated driving study.
- The test measures the capacity to maintain information and to process information.
- We did not use the measurements in our study. We only used the effects it had on the drivers.
- Example: The test begins with telling the driver two numbers and adding them. Then the driver is given another number to add with the previous number given. This process continues until the driving stops.
    - 2, 3=5
    - 7
    - 3,7=10
    - 6
    - 7,6=13

Description

- For the purpose of this research, we will name:
    - Subjects without AD, Group 0
    - Subjects with AD, Group 1
        - Segment without a distraction, Segment 0
        - Segment performing PASAT, Segment 1

Data Cleaning

- Removed subjects:
  - With lane position outliers
  - Who did not have both segments
  - Who did not have at least length of 320 frames
- Subjects remaining:
  - 60 drivers with AD
  - 114 drivers without AD
- Drivers are exposed to both segments are drive at the length of no more or less than 320 frames (53.33 sec)



Methods of Data Reduction

- There are 4 methods used to find a relationship between each group:

    1. Standard deviation of the lane position
    2. Counting the number of lane departures
    3. Integrating the area lane departures.
    4. The re-centering parameter based on the model proposed by Dawson et al (2010)

Null Hypotheses of Each Test

- H_0: $\mu_{G0,S0} = \mu_{G0,S1}$
- H_0: $\mu_{G1,S0} = \mu_{G1,S1}$
- $H_{0:}$ $\mu_{G0,S0} = \mu_{G1,S0}$
- $H_{0:}$ $\mu_{G0,S1} = \mu_{G1,S1}$
- All alternative hypotheses are 2-sided and $\alpha = .05$

Standard Deviation of the Lane Position

- We calculated the standard deviation (SD) of the lane position for each driver in each segment and group.

- We then calculated the mean of each segment and group to find if there is a interaction between having a distraction for both groups.

Standard Deviation of the Lane Position

For both segments, individuals without AD:

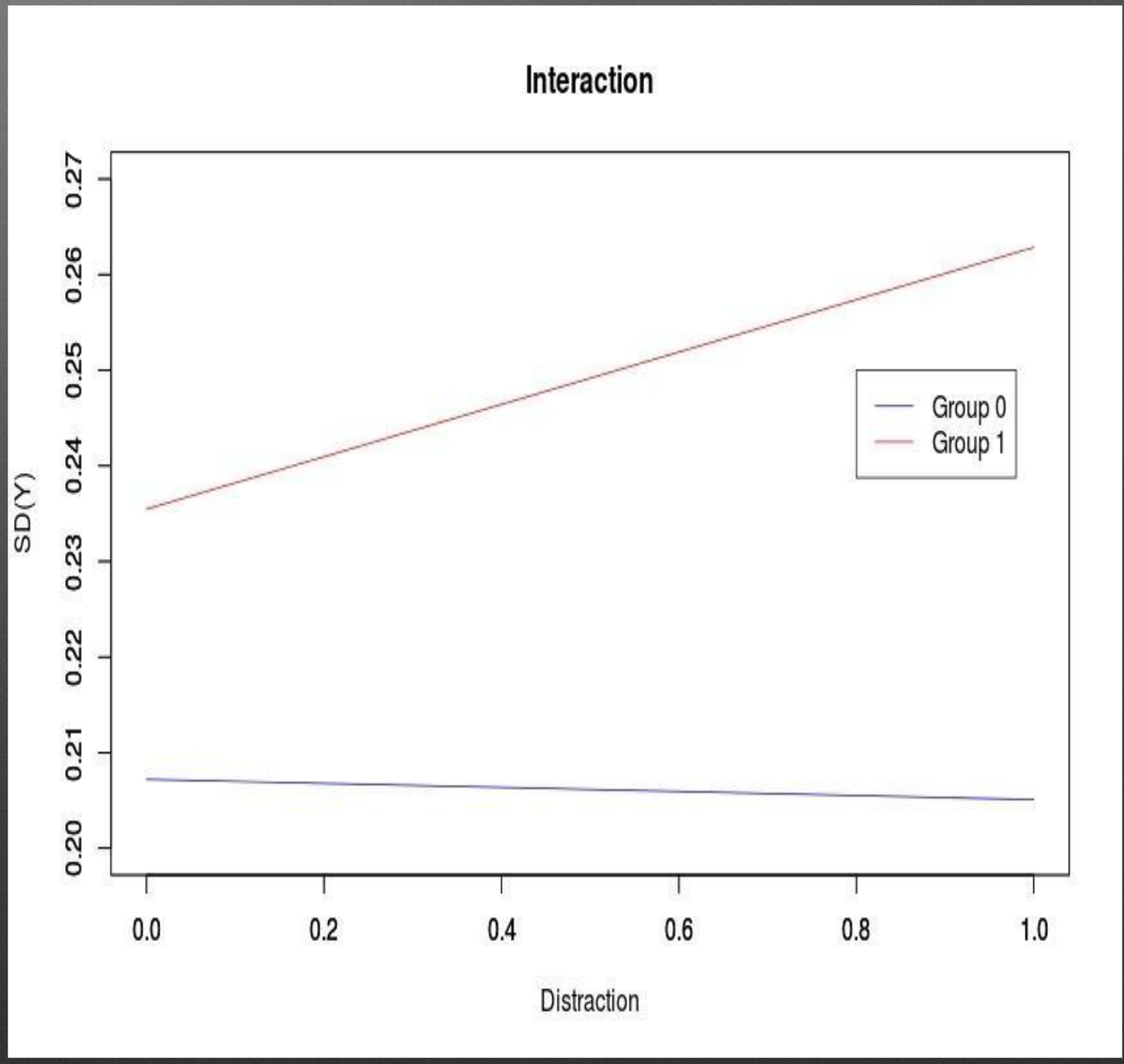
P-value = 0.789

There is no significant difference in the standard deviation between having a distraction or not.

For both segments, individuals with AD:

P-value = 0.1023

In both paired test, the results are not statistically significant.

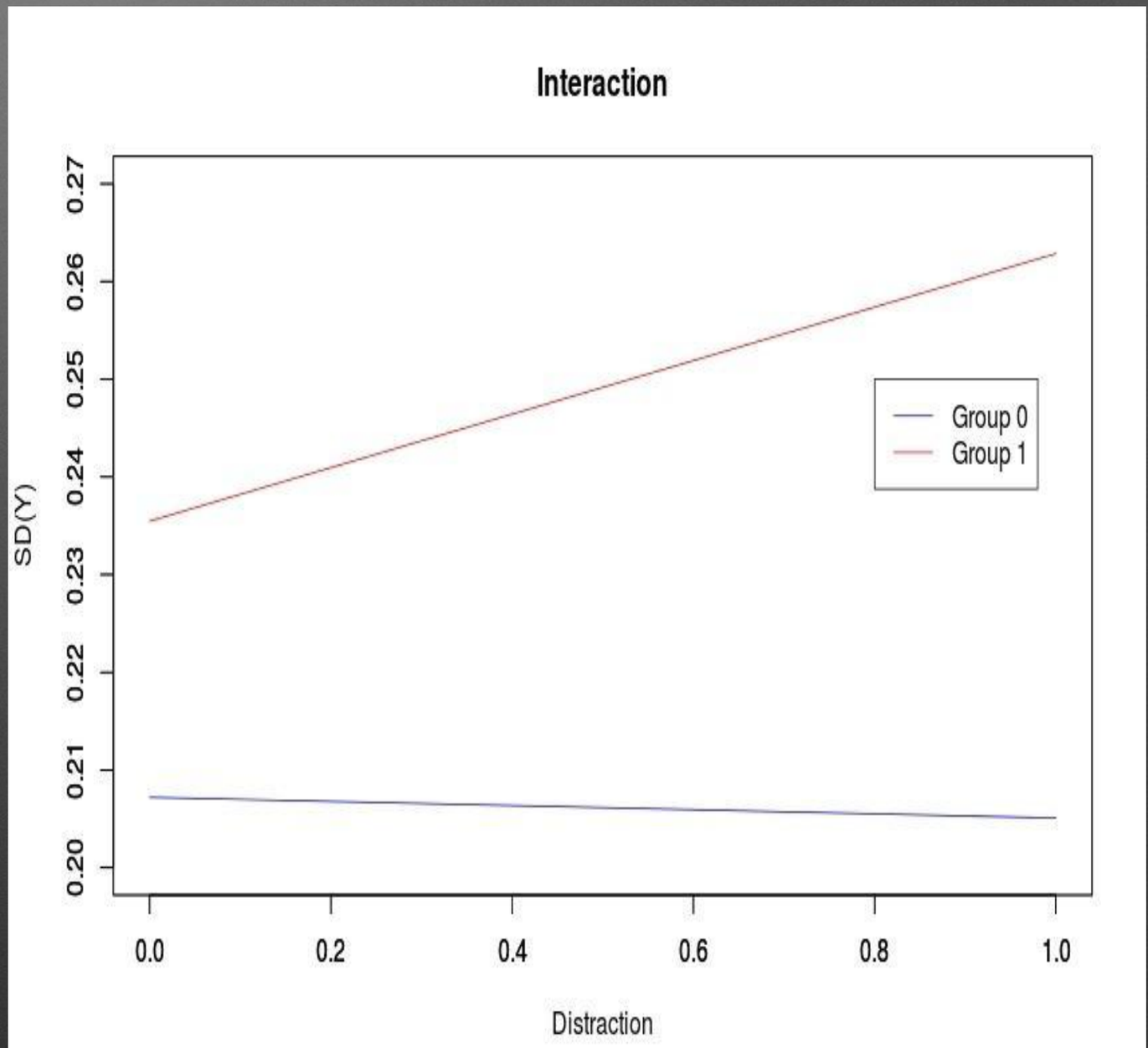


Standard Deviation of the Lane Position

For individuals without AD and with AD:

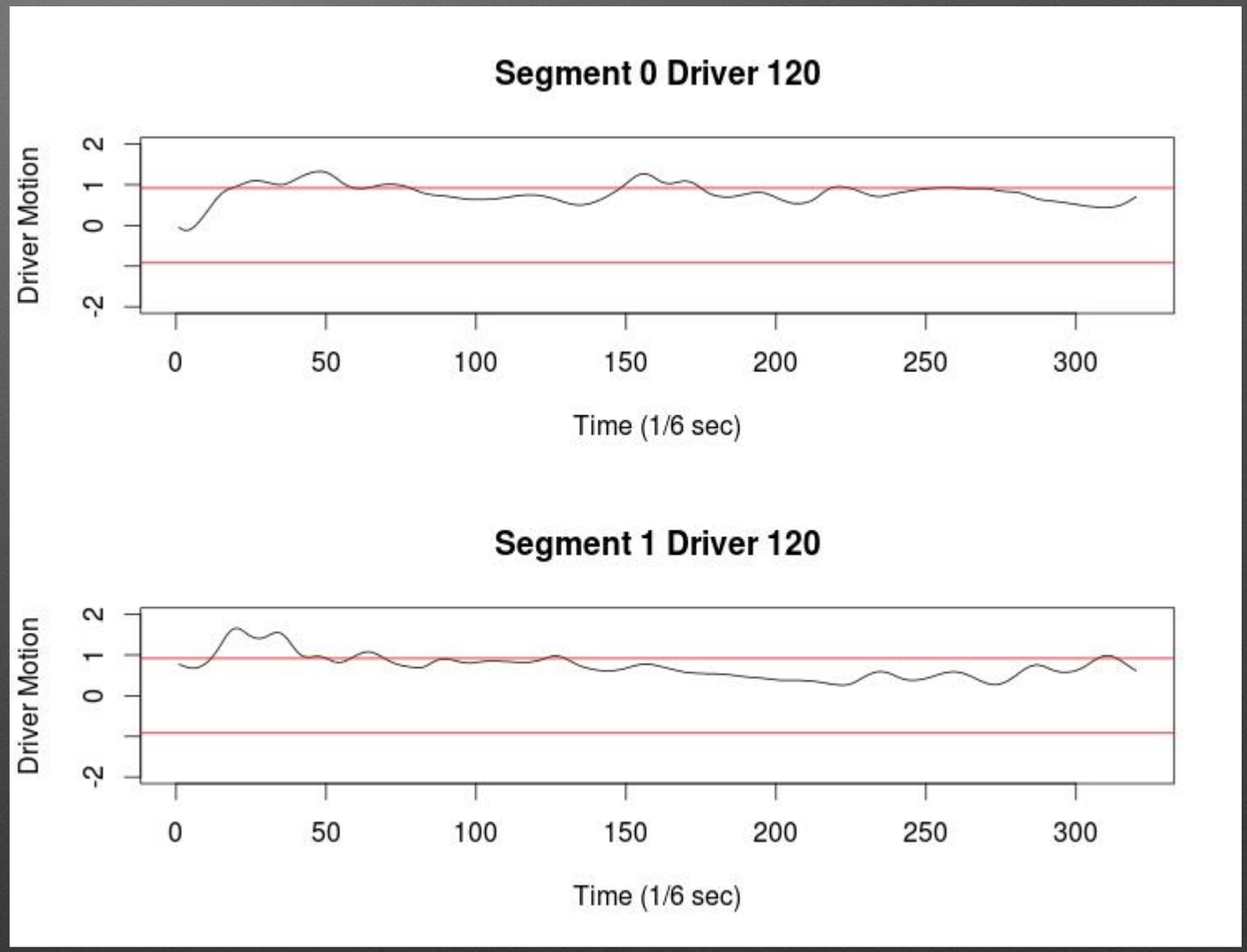
- Segment 0: P-value = 0.03206
- Segment 1: P-value = 0.001974

We can reject our H_0 hypotheses in both tests.



Number of Lane Departures

- We count the number of times that a driver crosses the sides of the lane.
- The total width of a lane equals 1.84
- From the center to each side is .92.
- +.92 means that the driver crossed the left side of the lane
- -.92 shows the driver crossed the right side of the lane



Number of Lane Departures

For both segments, individuals without AD:

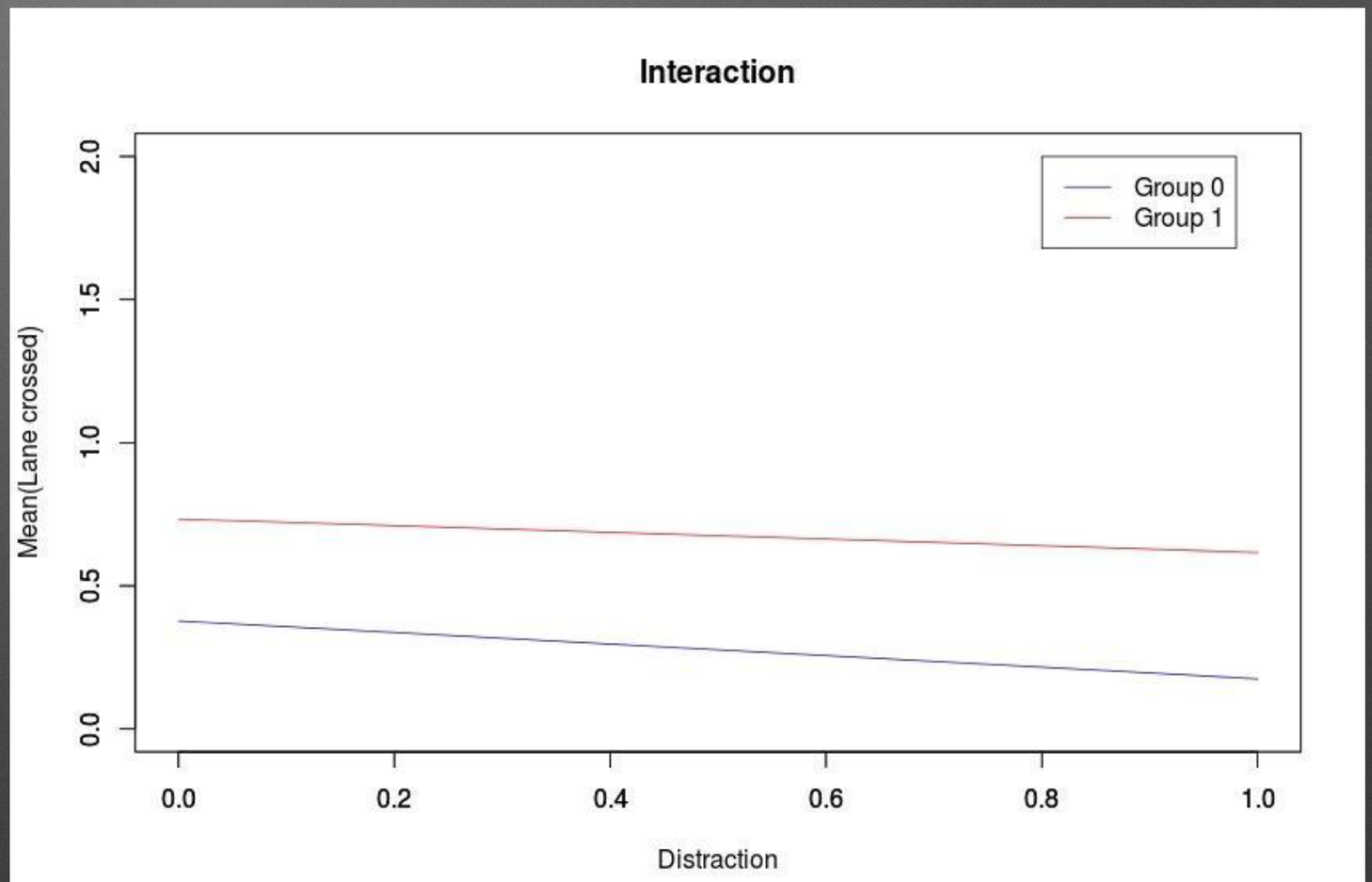
P-value = 0.02143

There is a difference in the mean of lane departures for drivers without AD.

For both segments, individuals with AD:

P-value = 0.539

Results are not statistically significant.

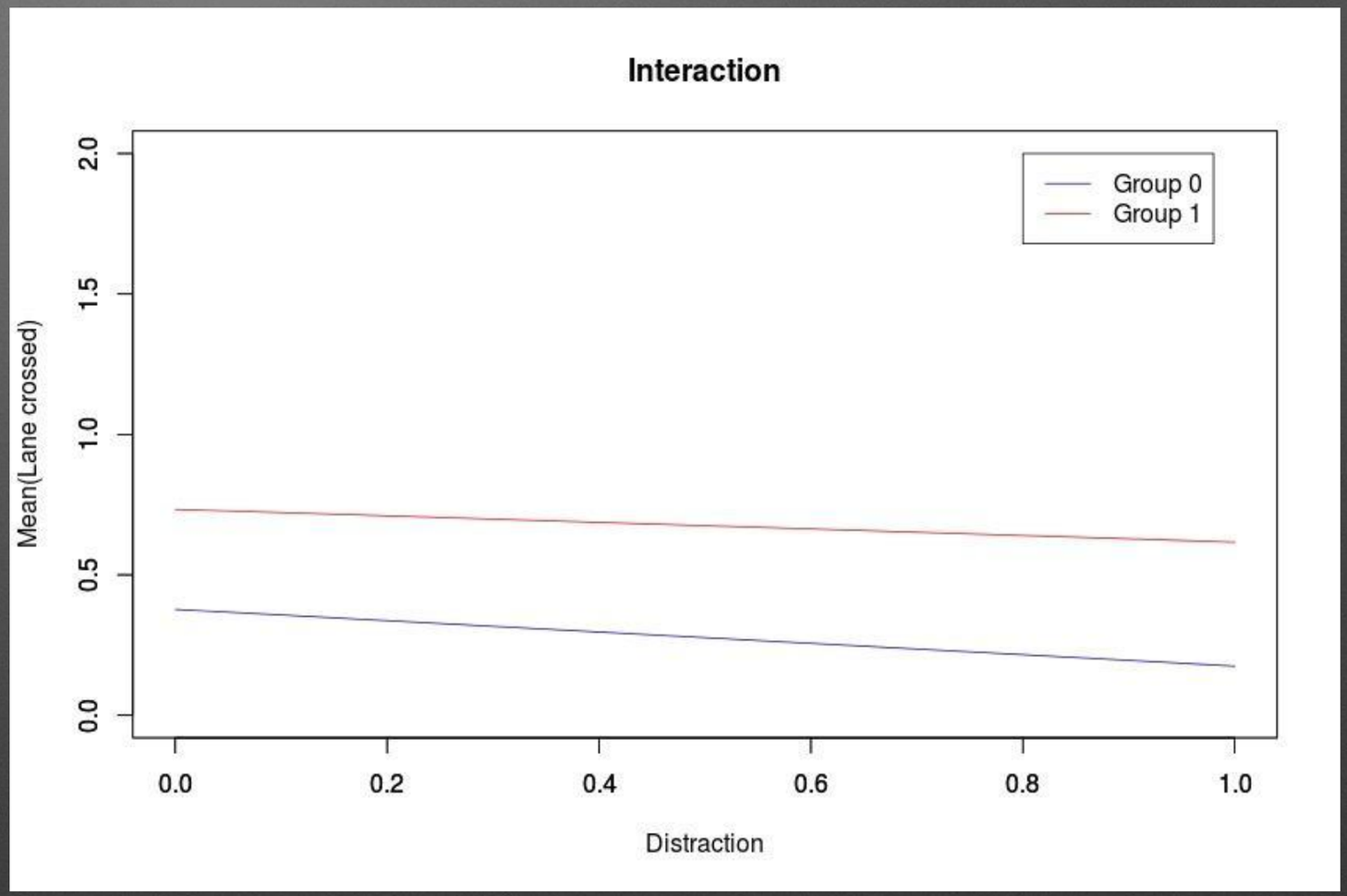


Number of Lane Departures

For individuals without AD and with AD:

- Segment 0: P-value = 0.0856
  - It is not statistically significant.
- Segment 1: P-value = 0.0126, so we reject our H_0 hypotheses.

  Drivers with AD and without AD have a difference of the mean of lane departures.



Area of Lane Departures

- We measure the area that the driver passes the sides of the lane (-0.92 or 0.92).

- Then, we calculate the area outside the lane for each of the drivers of the sample.

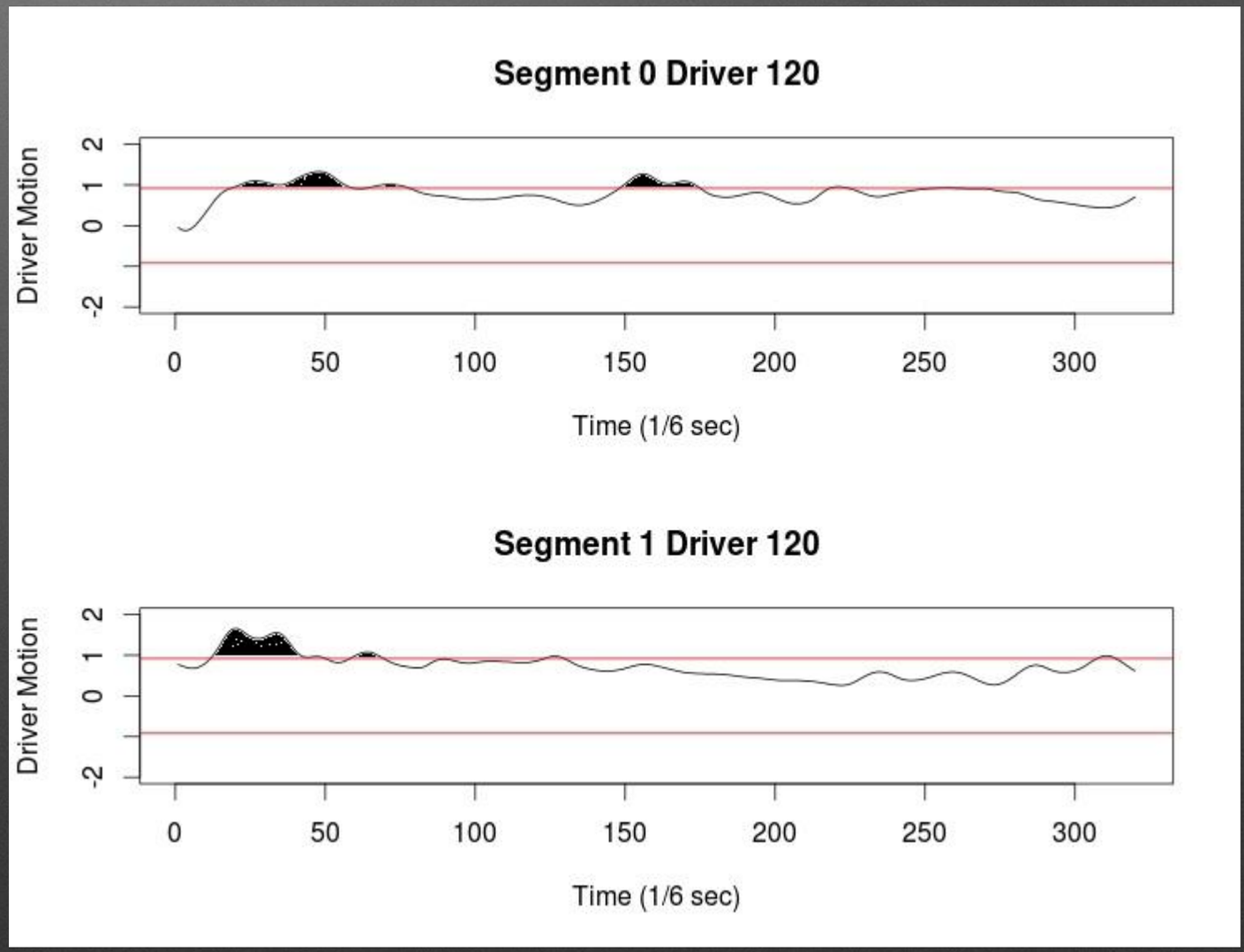
- Finally, we realize a paired t-test for the same group but different segment and an independent t-test for the different group but the same segment.

Area of Lane Departures

Example:

Segment 0 passes the lane 5 times and has an area of 13.84

Segment 1 passes the lane 4 times and has an area of 16.67



Area of Lane Departures

For both segments, individuals without AD:

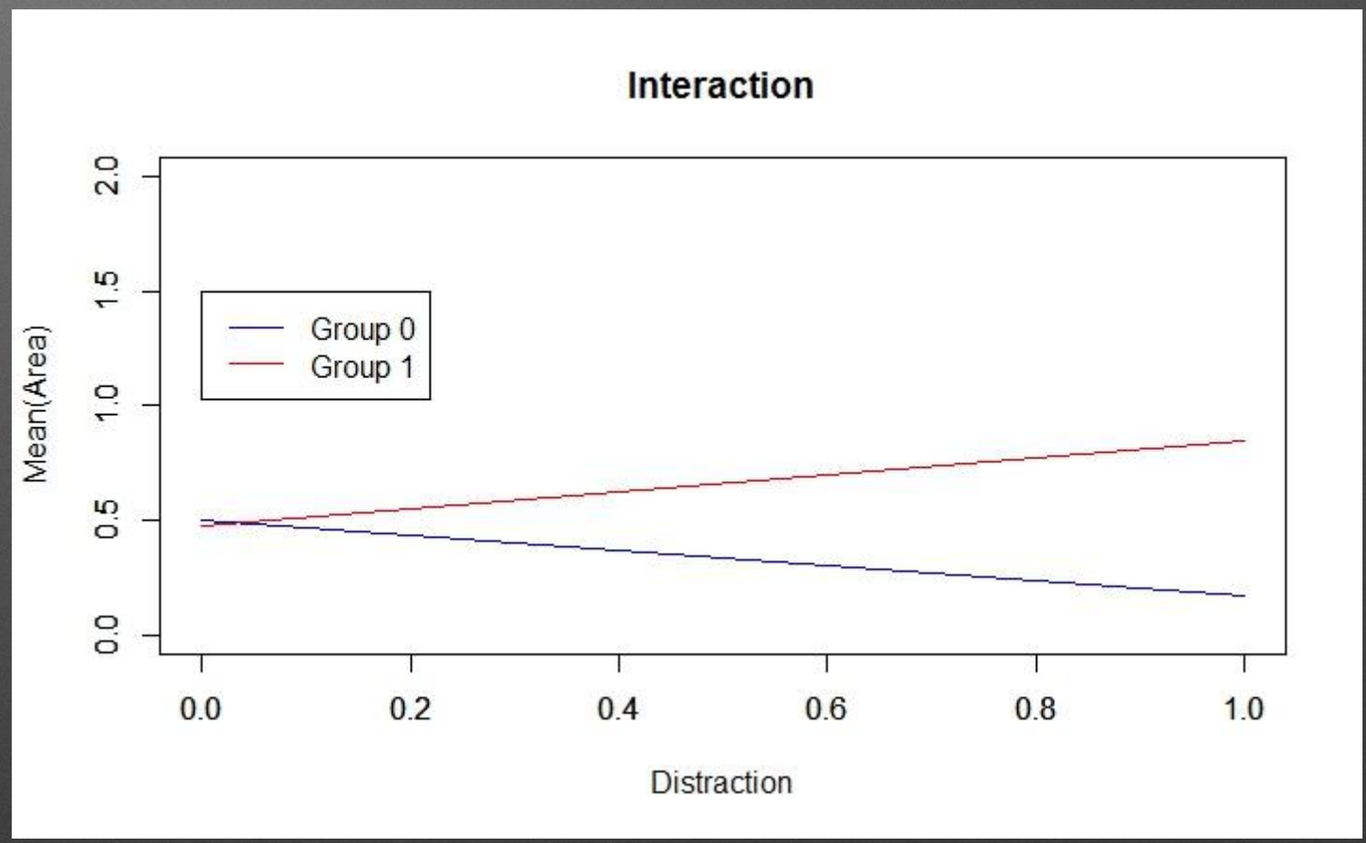
P-value = 0.03996

There is a difference in the mean of lane departures for drivers without AD.

For both segments, individuals with AD:

P-value = 0.3272

Results are not statistically significant.



Area of Lane Departures

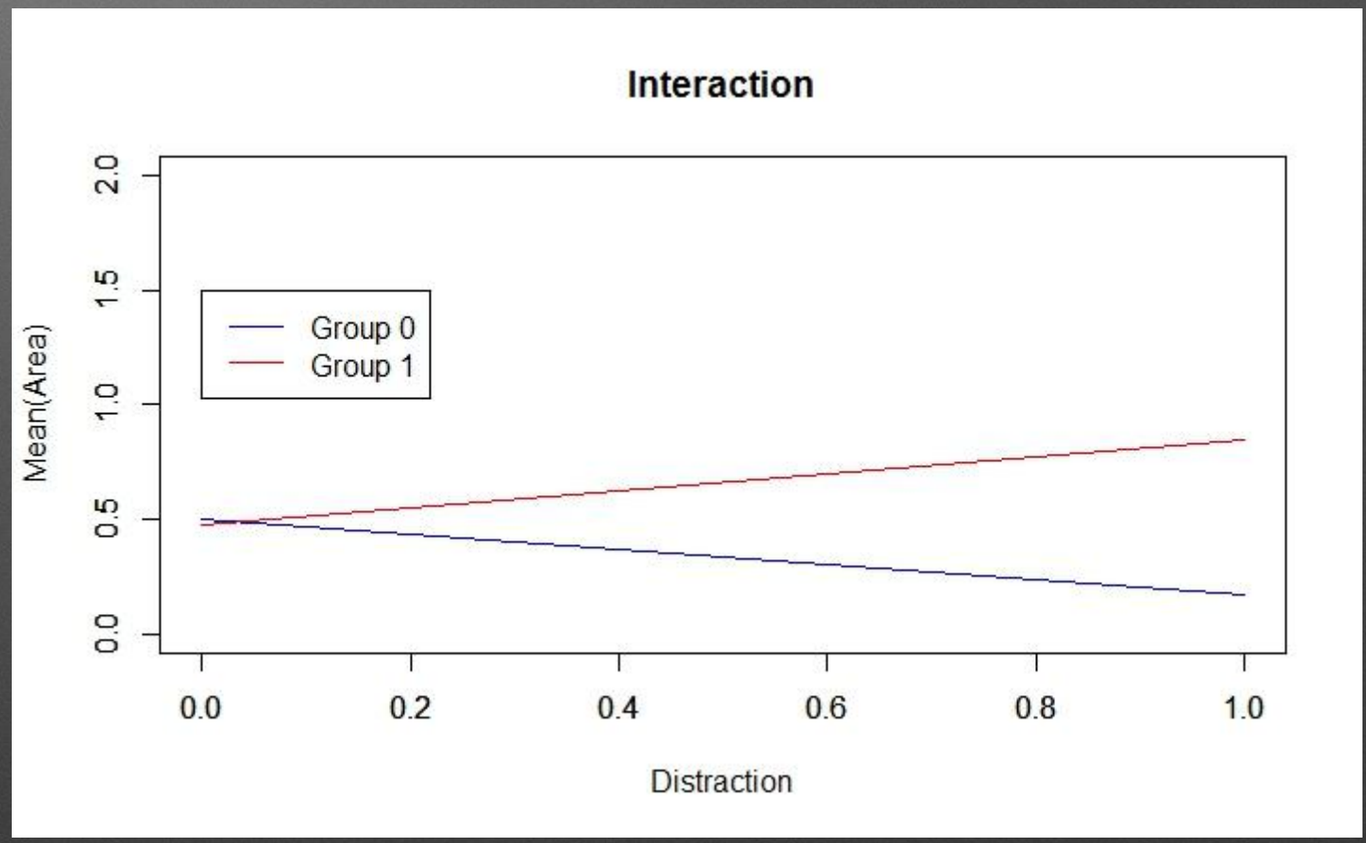
For individuals without AD and with AD:

- Segment 0: P-value = 0.9266

  It is not statistically significant.

- Segment 1: P-value = 0.07358

  It is not statistically significant.



Re-centering Parameter

- This method uses weighted polynomial projections to predict each data point from the previous three time points, and accommodates the attempts of the drivers to re-center the vehicle before crossing the borders of the traffic lane.
- The higher the value of the re-centering parameter, the better the driver attempts to re-center the car.

Re-centering Parameter

For both segments, individuals without AD:

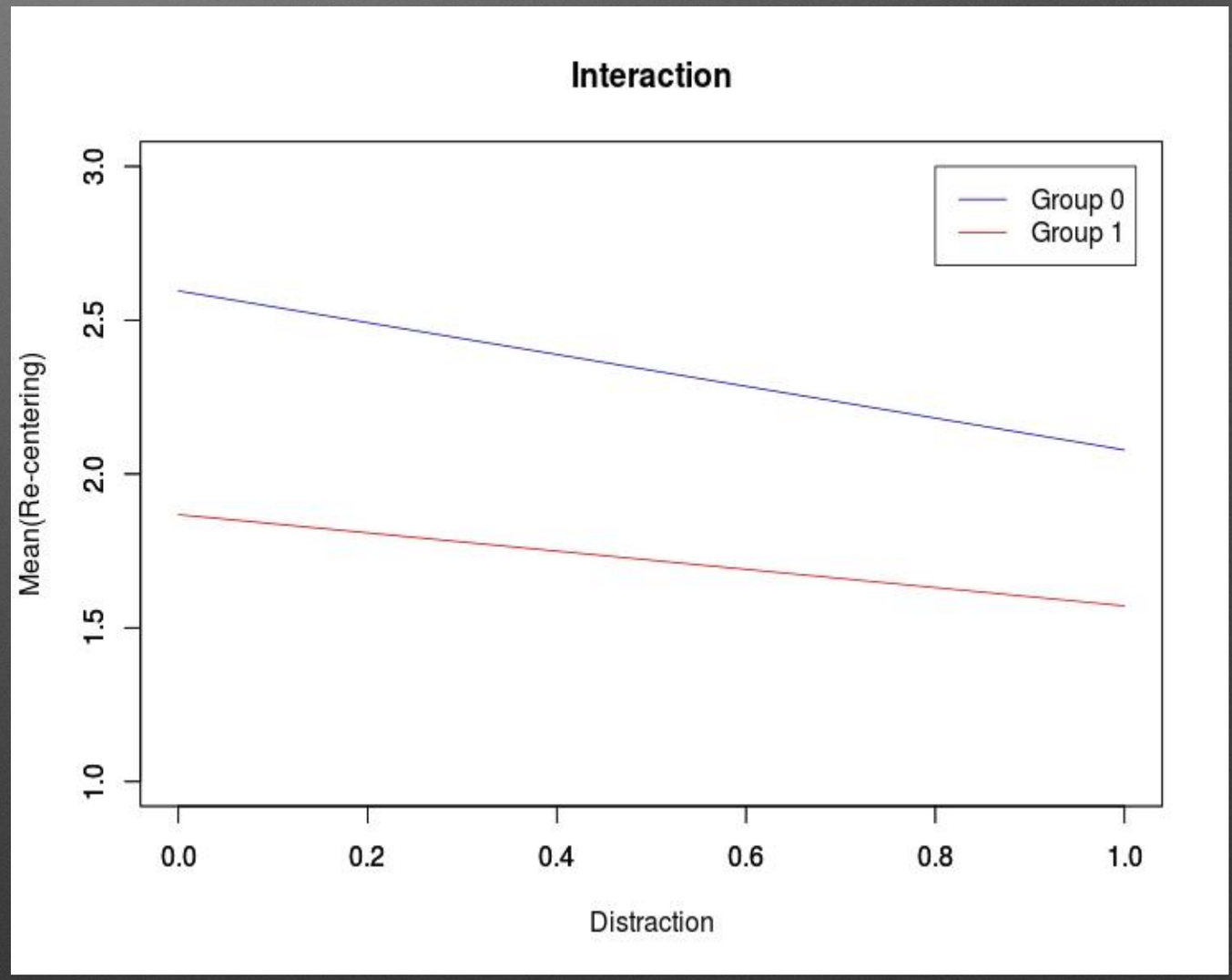
P-value =0.0209

There is a difference in the mean of re-centering parameters for drivers without AD.

For both segments, individuals with AD:

P-value = 0.1416

Results are not statistically significant.



Re-centering Parameter

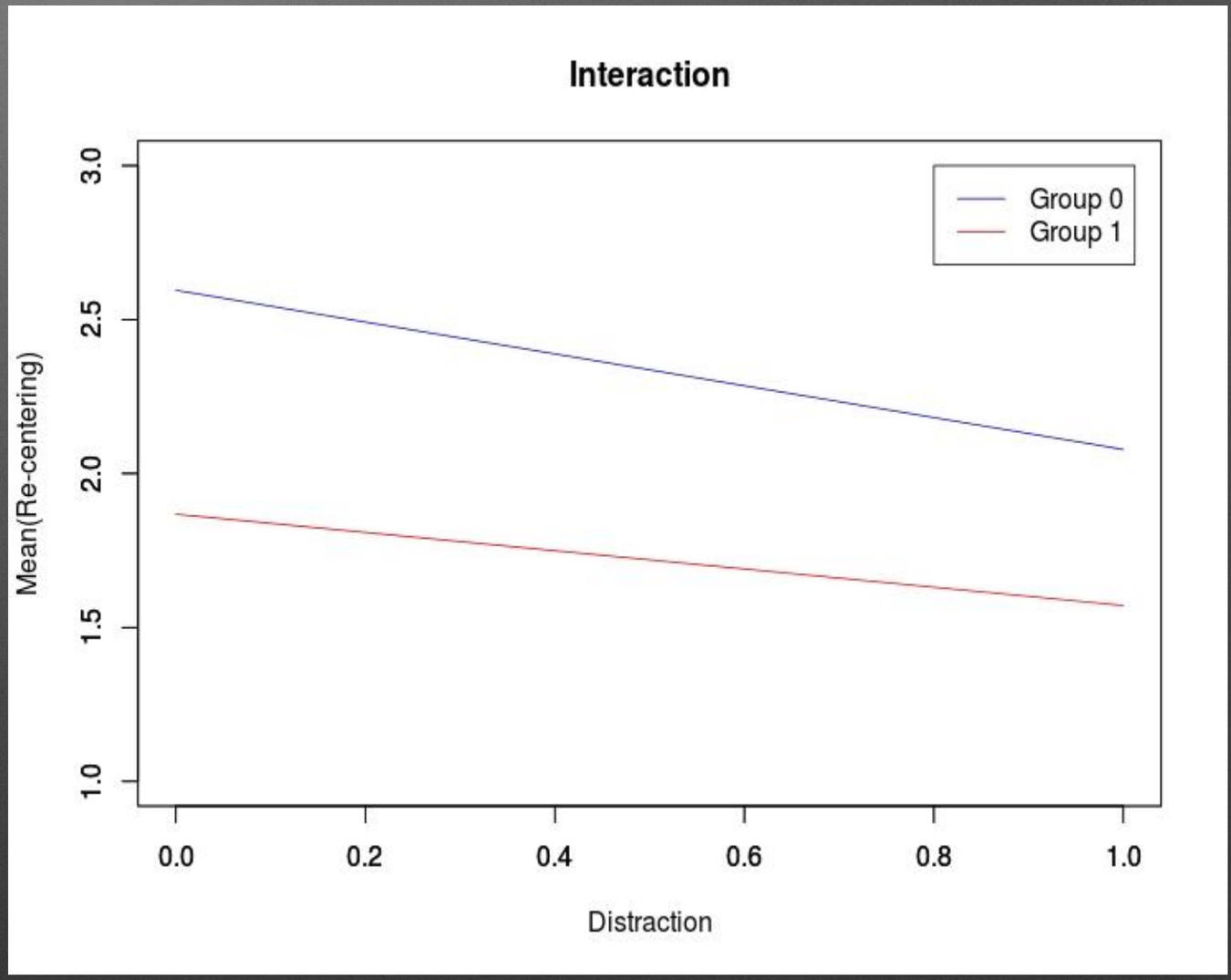
For individuals without AD and with AD:

- Segment 0: P-value = 0.00257

  We can reject our H_0 hypotheses. Furthermore there is a difference in re-centering mean of those with AD and without AD

- Segment 1: P-value = 0.05711

  It is not statistically significant.



Conclusion

For all methods of data reduction, Group 1 was not statistically significant for both segments.

There are factors that can contribute to the driver's lateral position, such as other distractions besides Segment 1. The researcher would sometimes ask questions about the comfort of the driver. We do not know the results of the PASAT for each driver.

- After seeing the result of the independent t-test for both segments, we can see that there is a difference in the variation of the lane position for both groups.
- Having AD with the distraction results in a significantly higher number of lane departures than not having AD.
- The area of lane departures in Group 0 is significantly lower in segment 1 than in segment 0.
- Group 1 without a distraction has a lower re-centering parameter than Group 0 without a distraction.

References

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