Gait Analysis of Left and Right Stride Intervals in Neurodegenerative Diseases

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Gait Analysis and Neurodegenerative Diseases

- Neurodegenerative Diseases and Gait Cycle Duration Definitions
  ✓ Benefits of Research on Gait Deterioration Rates
- Definitions
  ✓ Hypothesis for test, Sample Populations, Statistic for the Degree of Variability, Tests applied
- Results of the Tests
- Conclusion
Neurodegenerative Diseases

Data Analysis and Modeling

- affect the ability to control muscle movements
- muscle tone, involuntary movements and smoothness of movement are significantly impacted while the range of motion and muscle mass remain the same
- unpredictable manifestation of degeneration
Gait Cycle Duration

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– In healthy adults the gait cycle duration (also known as stride time interval) fluctuates from one stride to another in a stable but complex pattern.

– Neurodegenerative diseases decrease the central processing capabilities of the brain and induce a degeneration of the stride interval correlation.
Benefits of Research

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• assist the development of dynamic ambulatory aids for people with neurodegenerative diseases
• provide information on the manifestation of the neurodegenerative disease in the right and left regions of control in the brain
Hypothesis

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• $H_1$: The left and right stride interval do not degenerate at the same rate
• $H_0$: The left and right stride interval do degenerate at the same rate
Sample Populations

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All data was retrieved from www.physiobank.org

• 4 sample populations
  ✓ Control
  ✓ Huntington’s disease
  ✓ Parkinson’s disease
  ✓ Amyotrophic Lateral Sclerosis (ALS)

  – 13 subjects were randomly chosen from each group
Data Acquisition Setup

Ultra thin force-sensitive switches were placed inside each subject’s shoe.
Switch outputs provided a measure of the force applied to the floor.
Signal was sampled at 300Hz.
Degree of stride variability statistic

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- Coefficient of Variation
  - common statistic for defining the degree of stride-to-stride variability and gait unsteadiness
  - defined for each subject by:
    → (100*SD/mean)
  - used in this study for comparison of variability between the right and left stride interval
## Coefficient of Variability

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<table>
<thead>
<tr>
<th></th>
<th>Left Mean Coefficient Of Variance</th>
<th>Right Mean Coefficient of Variance</th>
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<tbody>
<tr>
<td>Control</td>
<td>3.5385</td>
<td>3.5385</td>
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<tr>
<td>ALS</td>
<td>25.5385</td>
<td>27</td>
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<td>Huntington</td>
<td>8.2308</td>
<td>8.1538</td>
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<tr>
<td>Parkinson</td>
<td>17.8462</td>
<td>14</td>
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Testing

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- Visual inspection of the stride interval time series
- The F test, comparison of coefficient of variance
- The sign test, comparison without any underlying assumptions
Results

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- Visual inspection and the F test were poor tests to apply
  - visual inspection is unreliable
  - the F test is sensitive to outliers and makes an assumption of normality about the data
- The sign test worked well
  - makes no assumptions about the data
Sign Test Results

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Sign Test Statistic = number of times the left and right stride coefficient of variance are not equal

0.05 Level of Significance

<table>
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<tr>
<th></th>
<th>Test Statistic</th>
<th>PValue</th>
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<tbody>
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<td>Control</td>
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<tr>
<td>ALS</td>
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<tr>
<td>Parkinson</td>
<td>Num of nonties</td>
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Conclusions

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• The left and right stride intervals do degenerate at the same rate for subjects with ALS and Huntington’s disease

• Subjects with Parkinson’s disease did not display an equal degeneration rate between the right and left stride intervals
Notes for further study

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- ALS
  - a high coefficient of variance in both the right and left stride intervals (25.5 and 27 respectively), however not a statistically significant differentiable variance in the right and left stride intervals

- Parkinson’s
  - a lower coefficient of variance (17.8 for the left and 14 for the right) than ALS but a statistically significant differentiable variance in the right and left stride intervals
Summary

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✓ Neurodegenerative diseases affect motor control
✓ Study of the degeneration rate improves aid development and disease analysis
✓ Degeneration rate between the left and right stride intervals is largely unknown, hypothesize that they do not degenerate at the same rate
✓ Testing with a nonparametric test proved that they do degenerate at the same rate in ALS and Huntington’s disease but not in Parkinson’s disease