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Functional Connectivity in Gait Under Dual-Task Paradigm in Healthy Adolescents

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Abstract

PURPOSE: Functional connectivity can be viewed as the mechanism used to coordinate different neural networks in order to perform a complex task. Dual-task walking requires an individual to walk, while simultaneously performing a secondary task. The purpose of this study was to determine the level of functional connectivity and neuro-efficiency in adolescents under the dual-task walking. We hypothesized that we would see an increase in local and global efficiency within adolescents when transitioning from a single task gait test to a dual task gait test.

METHODS: 15 healthy adolescents (12 male, age: 16.33±0.94 years, height: 1.69±0.10 m, mass: 64.08±9.81 kg) were recruited. The brain activity of the left and right prefrontal cortex (dorsal lateral, and dorsal media) were measured by fNIRS, the sampling rate of 20.3 Hz. Vicon motion capture system was used to record kinematic data, the sampling rate of 100 Hz. The first test was a single task gait test in which the subject walked at a self-selected speed between two cones 15 meters apart for 2 minutes with 10 seconds of standing as the baseline for fNIRS measures. Subjects were then tested under a dual-task paradigm (serially subtracting 7's from randomly presented 2 or 3-digit numbers). The primary outcome measures include normalized local and global efficiency, gait speed, and stride length. Two two-way MANOVA with repeated measures were used to examine the task difference (alpha level = 0.05).

RESULTS: There was a significant task effect on gait performance ($F_{3,12} = 6.430$, $p = 0.008$). Post hoc pairwise tests indicated that single-task presented greater average walking velocity ($p < 0.001$, ST vs. DT: 1.33 ± 0.18 vs. 1.23 ± 0.20 m/s) and shorter stride time ($p = 0.002$, ST vs. DT: 1.11 ± 0.10 vs. 1.14 ± 0.12 s) than dual-task. There was no significant task effect on brain activity and neural efficiency ($p > 0.05$).

CONCLUSION: There was a significant difference in gait speed between adolescents and young adults. This is due to the task complexity affecting adolescents significantly more than adults. Young adults don't see a change in speed but do see an increase in PFC activation. Adolescents having lower levels of functional connectivity compared to young adults could be due to the number/size of functionally connected regions measured within adolescence. Children are still developing day by day, indicating that the strength of functional connectivity seemingly develops as they age. With this information we can conclude that functional connectivity continuously changes while going through your adolescent years.

Functional connectivity in gait under dual-task paradigm in healthy adolescents

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Introduction

- Functional connectivity is used to reveal the coordination of neural networks when performing a complex task [citations].
- Dual-task walking requires an individual to walk, while simultaneously performing a secondary cognitive task.
- Why examining dual-task walking is important to adolescents?
- The purpose of this study was to determine the level of functional connectivity and neuro-efficiency in adolescents under the dual-task walking

Methods

Participants

- Fifteen healthy adolescents. Demographics in Table 1.

Table 1. Participant Demographics

Demographics	Values
Age (Years)	16.33 ± 0.94
Height (m)	1.69 ± 0.10
Mass (kg)	64.08 ± 9.81
Sex	80% Male; 20% Female

Equipment

- A portable fNIRS device (NIRSport2, NIRx Medical Technologies, Berlin, Germany) was used to record the activity of the right/left prefrontal cortexes. Optode Model in Figure 1.
  - Prefrontal Cortex:
    - Dorsal Lateral, and Dorsal Medial

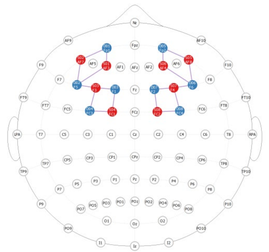

Figure 1. Optode Model

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Methods Continued

Procedures

- The first test was a single-task gait test in which the subject walked at a self-selected speed between two cones 15 meters apart for 2 minutes with 10 seconds of standing as the baseline for fNIRS measures
- Subjects were then tested under a dual-task paradigm (serially subtracting 7's from randomly presented 2 or 3-digit numbers).
- The primary outcome measures include brain activity, normalized local and global efficiency, gait speed, and stride length.
- Three two-way MANOVA with repeated measures were used to examine the task difference (alpha level = 0.05).

Results

- There was a significant task effect on gait performance ($F_{3,12} = 6.430$, $p = 0.008$). Post hoc pairwise tests indicated that single-task presented greater average walking velocity ($p <$ 0.001, ST vs. DT: 1.33 ± 0.18 vs. 1.23 ± 0.20 m/s) and shorter stride time ($p = 0.002$, ST

Conclusions

- There was a significant difference in gait speed between adolescents and young adults.
- Young adults don't see a change in speed but do see an increase in PFC activation
- Adolescents having lower levels of functional connectivity compared to young adults could be due to the number/size of functionally connected regions measured within adolescence

References

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Dietsje D. Jolles, Mark A. van Buchem, Eveline A. Crone, Serge A.R.B. Rombouts, A Comprehensive Study of Whole-Brain Functional Connectivity in Children and Young Adults, *Cerebral Cortex*, Volume 21, Issue 2, February 2011, Pages 385–391, https://doi.org/10.1093/cercor/bhq104

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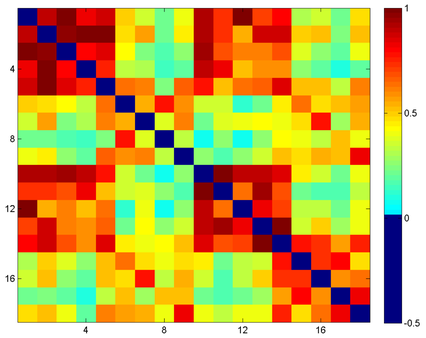
Results

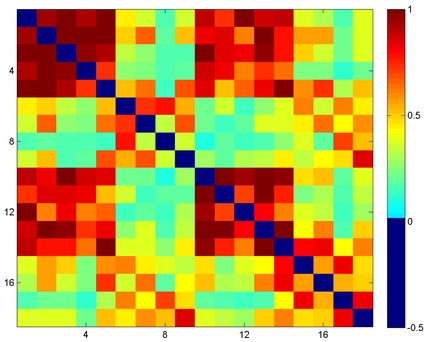
PFC Activation

- Adolescents did not see a significant increase in in local and global efficiency

Functional Connectivity in single task gait vs dual task gait.



Dual-task Functional Connectivity chart



Single-task Functional Connectivity chart

functional connectivity continuously changes while going through your adolescent years.

Figure 2. DT vs ST Functional Connectivity