Effects of active-assisted cycling on upper extremity motor and executive function in Parkinson's disease

Angela L. Ridgel, Corey Peacock, Emily J. Fickes, Chul-Ho Kim

Exercise Physiology , Kent State University, Kent OH 44107

ABSTRACT

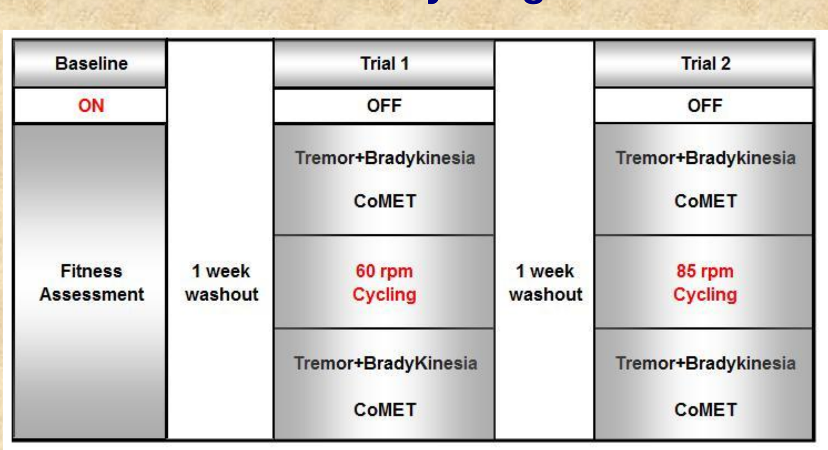
Previous studies have shown that single bouts of high-rate active cycling on a stationary tandem bicycle (> 80 revolutions per minute, rpm) result in significant motor improvement in Parkinson's disease (PD). Interestingly, this lower extremity exercise reduced tremor and bradykinesia in the upper extremity. It is unknown if active-assisted leg cycling at fast rates on a motorized bike will produce similar improvements. Furthermore, the effects of exercise mode and intensity on cognitive function in PD have not been investigated. The goal of this study was to examine if acute bouts of leg cycling at 60 and 85 rpm have differential effects on upper extremity motor function and executive function in individuals with mild-moderate PD. Subjects completed three sessions, each separated by one week. In the 1st session, baseline fitness was measured using the YMCA submaximal cycling protocol. In the 2nd-3rd sessions, a motorized bicycle was set to assist the subjects to pedal at 60 or 85 rpm for 30 minutes. Upper extremity motor and executive function assessments were completed before and after each cycling session. A motor task which assesses bradykinesia during a sequential goal-directed movement was used the collect quantitative data regarding the function of the upper extremity. Executive function was measured using the Trail Making Test A/B. Both upper extremity motor function and executive function showed greater improvement after a single bout of leg cycling at 85 rpm when compared to 60 rpm. This suggests that high-rate active cycling could affect central motor and cognitive processing. Future studies will examine the effects of additional modes and intensities of exercise on motor and cognitive function in this population.

PURPOSE

- To evaluate heart rate, exertion and power during the active-assisted cycling intervention at slow and fast pedaling rates in individuals with Parkinson's disease
- To examine changes in motor and cognitive function after acute bouts of active-assisted cycling at slow and fast pedaling rates in individuals with Parkinson's disease

METHODS

Active-Assisted Cycling Intervention



Data Collection

- Control and Intervention groups: Age 45-74, Idiopathic Parkinson's disease, no cardiovascular or musculoskeletal contraindications for exercise
- During active-assisted cycling (Fig. 1), the motor was set to 50 and 75 rpm and subjects were asked to pedal at 60 and 85 rpm, respectively (30 min main set).
- The Control group watched a video about the Motomed Viva 2 (off meds)
- Tremor assessment (Kinesia™, Fig. 2) and Cognitive Motor Evaluation and Testing software (CoMET, Fig. 3) used to assess motor and cognitive function before and immediately after cycling or video.
- Repeated measures ANOVA was used to analyze differences in tremor score and time to completion ($\alpha \leq 0.05$).

Photo: Jeff Glidden

Figure 1: The Motomed Viva 2 was used for active-assisted cycling.

Photo: Jeff Glidden

Figure 2: Kinesia™ was used to assess tremor.

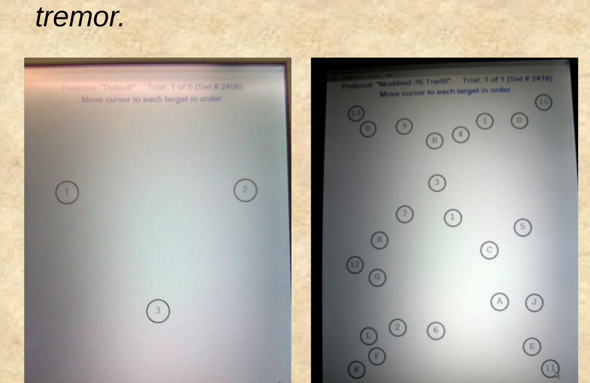


Figure 3: Motor and cognitive tests (Trail-making test, TMT) in CoMET software.

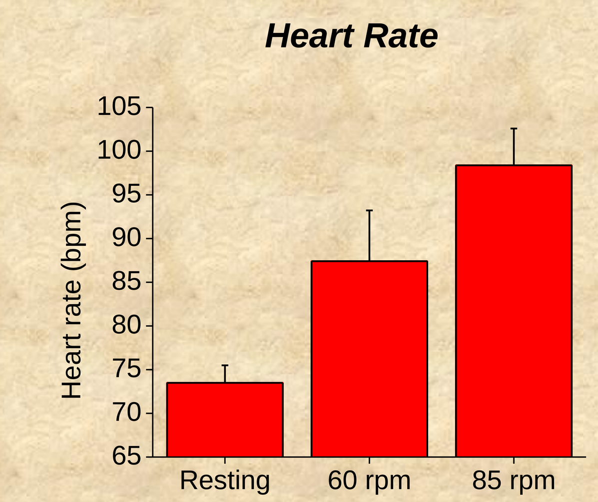
Intervention Group

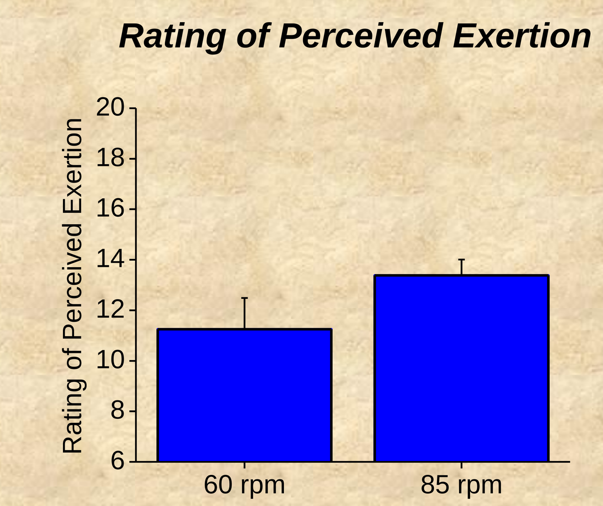
Gender	Age (Years)	H & Y stage	Disease Duration (Years)	Estimated VO_{2max} (ml/kg/min)
Male	54	2	15	33.8
Female	67	1	0.5	30.9
Female	56	1	5	25.0
Male	70	3	9	22.4
Male	65	3	12	47.3
Female	60	1	3	37.9
Female	71	2	3.5	41.7
Male	66	1	1.5	41.6
Female	75	3	16	28.0
Female	61	1	0.25	28.1
Average (SEM)	64.5 (2.1)	1.8 (0.3)	6.5 (1.9)	22.4 (2.6)

Control Group

Gender	Age (Years)	H & Y stage	Disease Duration (Years)	Estimated VO_{2max} (ml/kg/min)
Male	57	2	6	44.8
Male	66	1	6	45.4
Male	62	1	2	42.8
Male	68	1	2	39.0
Male	58	2	2	36.9
Male	59	1	3	47.5
Female	71	2	19	19.6
Male	72	2	16	45.6
Female	73	2	6	26.7
Male	61	2	9	33.3
Average (SEM)	64.7 (1.9)	1.6 (0.2)	7.1 (1.9)	38.1 (2.9)

ACTIVE-ASSISTED CYCLING INTERVENTION





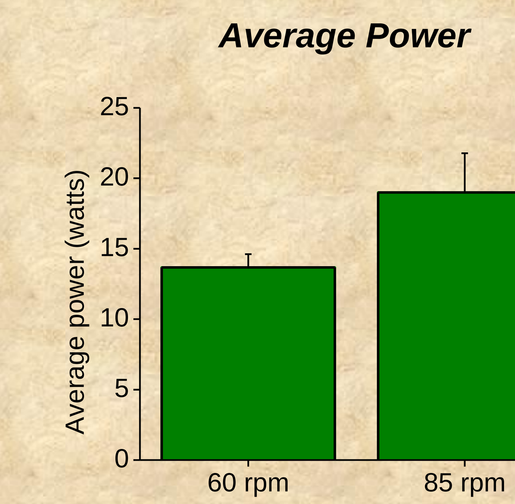
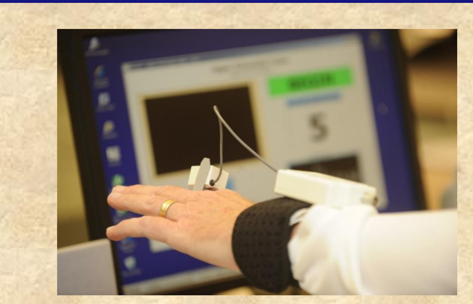


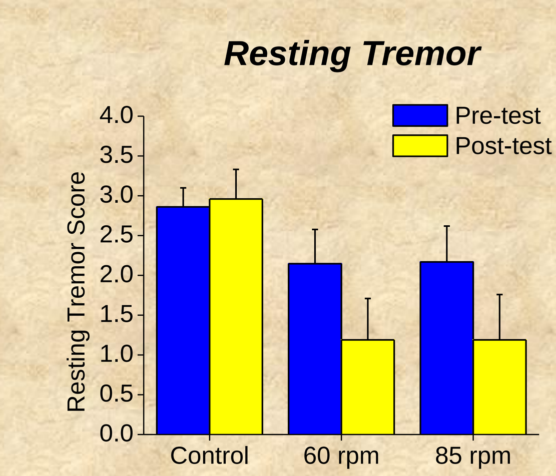
Figure 4: Subject heart rate (bpm) increased by 27% from resting to 60 rpm. High-rate active-assisted cycling increased heart rate by 13% above the slower cycling rate (p = 0.059). Rating of perceived exertion showed an increase of 19% between 60 and 85 rpm (p = 0.057). Average power during the cycling sessions showed an increase by 38% from 60 to 85 rpm (p = 0.09). High-rate active-assisted cycling promoted an increase in heart rate, perceived exertion, and average power outputs above slow-rate active-assisted cycling. This intervention could be used to assist individuals with Parkinson's disease to cycle at high cadence without excessive fatigue.

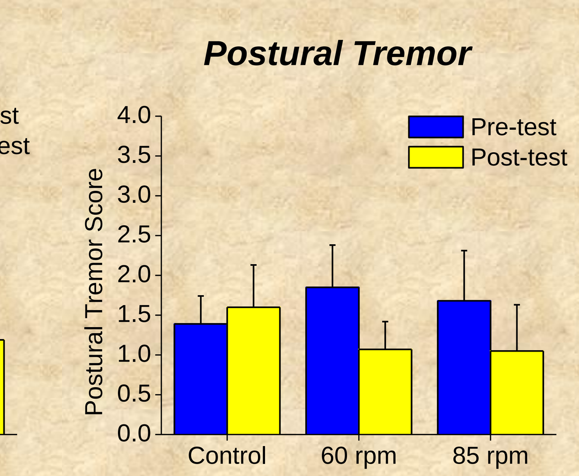
TREMOR ASSESSMENT



Postural Tremor: hands outstretched

Kinetic Tremor: finger to nose





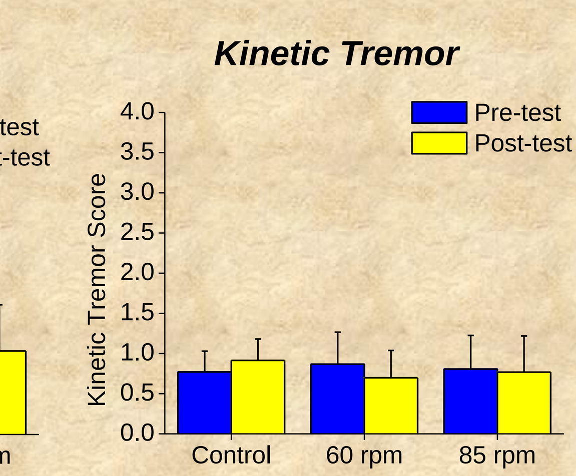


Figure 5: Individuals with baseline 'off' medication resting tremor score >1 (N= 5 controls, N=5 intervention). Resting tremor score decreased by 44% (0.95, p=0.24) after active-assisted cycling at 60 rpm and 45% (0.98, p=0.08) at 85 rpm. Postural tremor score decreased by 41% (0.77, p=0.12) after active-assisted cycling at 60 rpm and 37% (0.77, p=0.31) at 85 rpm. Kinetic tremor score decreased by 19% (0.17, p=0.17) after active-assisted cycling at 60 rpm and 5% (0.04, p=0.78) at 85 rpm.

COGNITIVE AND MOTOR EVALUATION TESTING

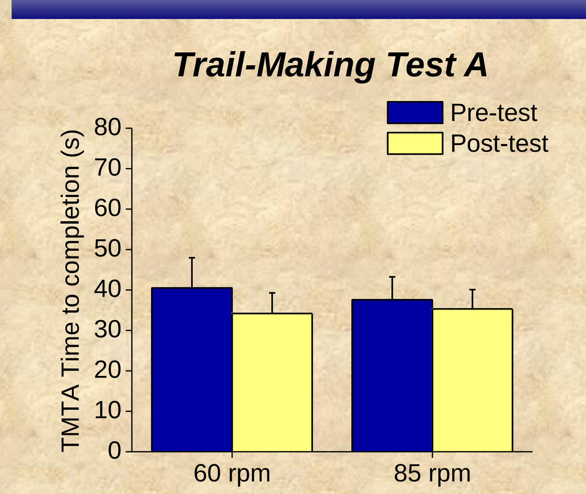


Figure 6: TMT-A showed a 15% (6 s, N.S.) improvement at 60rpm and a 6% (2 s) improvement at 85rpm. (normative data- 31 s, Tombaugh, 2004).

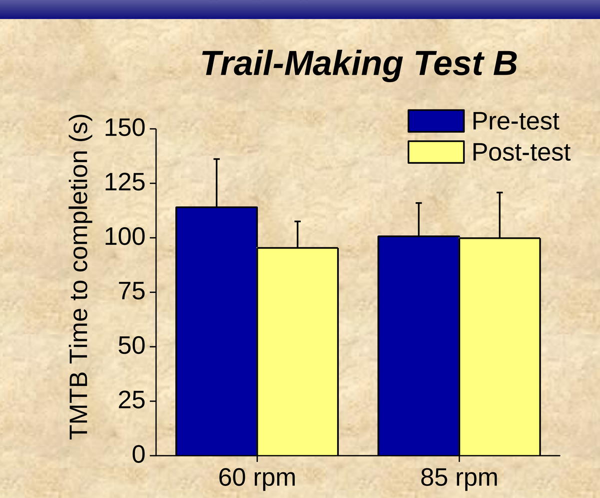


Figure 7: TMT-B showed a 16% (19 s, N.S.) improvement at 60rpm and a 0.8% (0.8 s) change at 85rpm. (normative data- 64 s, Tombaugh, 2004).

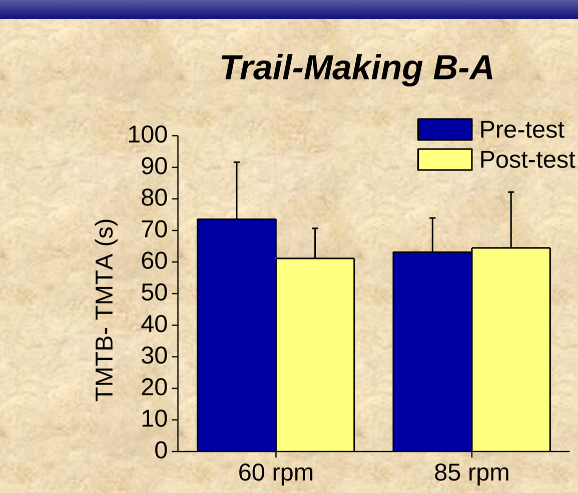


Figure 8: The difference between TMT-B and TMT-A is highly correlated with severity of impairment (Corrigan & Hinkleydey, 1987). TMTB-TMTA showed a 17% (12 s, N.S.) improvement at 60rpm but no changes at 85rpm.

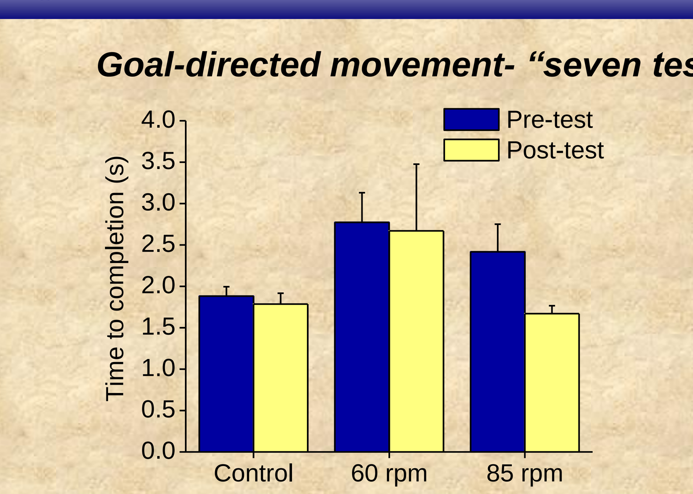


Figure 9: Time to complete the "seven" test showed no change in the control or at 60rpm but a 31% (0.7s, p= 0.030) improvement at 85rpm. This task assesses bradykinesia during the production of sequential goal-directed movements.

CONCLUSIONS

- Active-assisted cycling at 85 rpm promoted an increase in heart rate and perceived exertion although power outputs were similar.
- Executive function (as measured by the TMT) showed slight improvements after 60rpm active-assisted cycling. Lack of improvement at 85rpm could be due to fatigue.
- Subjects showed improvement in bradykinesia, during a goal-directed movement task, after a single bout of cycling at 85 rpm but no change after cycling at the slower rate.
- Future studies will examine a wider range of pedaling rate as well as motor and cognitive changes with repeated bouts of active-assisted cycling.

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