COMPARING ACUTE HEART RATE VARIABILITY RESPONSE FOLLOWING DIFFERENT MAXIMAL GRADED EXERCISE TREADMILL PROTOCOLS

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Different GXT treadmill protocols do not cause differences in acute stress or recovery in the body's autonomic nervous system when assessed via HRV.

Introduction

- Heart rate variability (HRV) is a non-invasive marker of autonomic function and cardiovascular recovery following exercise.
- Many common HRV markers decrease acutely immediately following exercise due to increased sympathetic activity and overall HR.
- Graded exercise testing protocols (GXTs) are structured in different ways depending on the intended participant, with some increasing grade, speed, or both.
- The degree to which the type of protocol affects autonomic recovery via HRV has not been studied as of yet.
- The purpose of this investigation was to determine if acute HRV recovery differed between three GXT protocols.

Methods

- Eight male recreational runners (22.6±3.1yrs; 183.5±9.2cm; 83.8±10.8kg) completed three different GXTs on days separated by at least 72 hours and no more than 1 week.
- HRV was measured using ECG before and after exercise and three 5-minute recording periods were analyzed from 5-10min PRE, 5-10min POST1, and 25-30min POST2
- HRV metrics were calculated and a 3X3 RMANOVA was conducted to determine potential differences.

Results

- VO_2max for Astrand, Bruce, and vVO_2max were not significantly different (51.0±4.8, 49.9±4.8, 51.0±4.4 $mL \cdot kg^{-1} \cdot min^{-1}$; *p > 0.05*).
- RMANOVA found a significant effect of time for HRV, (*p<0.05)*, but no significant effect of protocol, *(p>0.05)*

Conclusion

- **No differences in VO2max were found between GXT protocols which supports previous research.**
- **HRV changed acutely as exercise state changed, (rested to exhausted to slightly recovered) which supports previous research.**
- **No differences were found in HRV between GXT protocols, which may indicate that GXT protocol does not affect autonomic stress state following maximal exercise**

Figure 1. RMSSD by Time Point and GXT Protocol

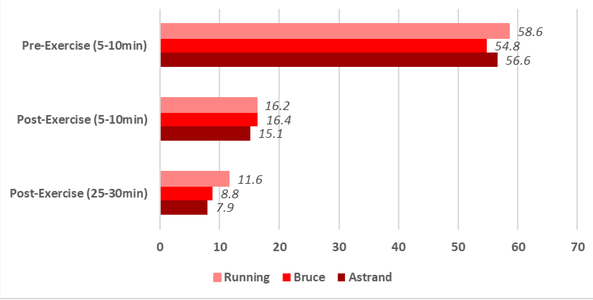


Figure 2. SDNN by Time Point and GXT Protocol

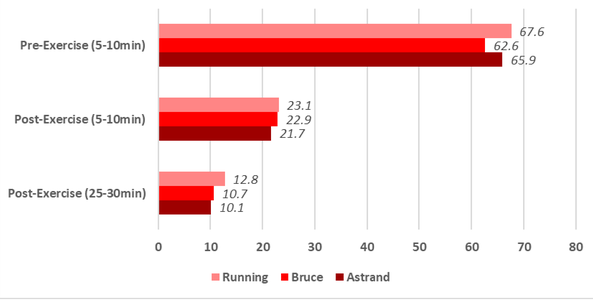


Figure 3. LogHF by Time Point and GXT Protocol

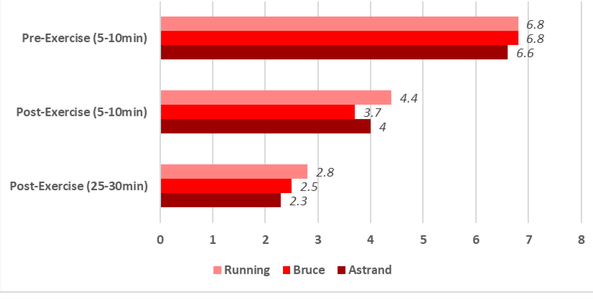
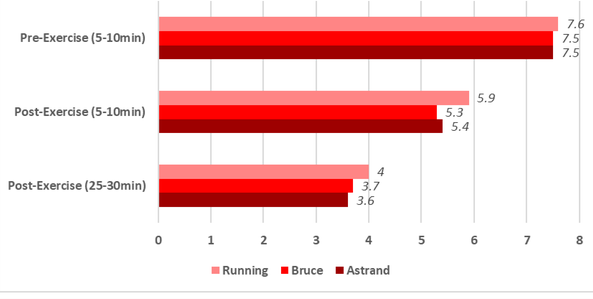


Figure 4. LogLF by Time Point and GXT Protocol



Supplemental Materials

Table 1. Participant results summary from maximal GXT by protocol

Protocol	VO_2max	TTE	RPEmax	HRmax	RERmax
Astrand	51.0 ± 4.9	14.2 ± 1.4†	19.8 ± 0.5	191.8 ± 7.5	1.2 ± 0.1
Bruce	50.0 ± 4.8	13.0 ± 0.6	19.4 ± 0.5	190.4 ± 10.0	1.2 ± 0.1
Running	51.0 ± 4.4	11.2 ± 1.3	19.8 ± 0.5	190.8 ± 7.5	1.2 ± 0.1

VO_2max = $mL \cdot kg^{-1} \cdot min^{-1}$, TTE = mins, HRmax = BPM.
*Significantly different from "Bruce" ($p < 0.017$)
†Significantly different from "Running" ($p < 0.017$)
Data reported as means ± standard deviation

Table 2. HRV metrics summary by protocol and time point

Protocol	Time	MeanHR	MeanRR	RMSSD	SDNN	logHF	logLF
Astrand	1	66.1 ± 9.5	926.7 ± 147.4	56.6 ± 38.7	65.9 ± 38.6	6.6 ± 1.1	7.5 ± 1.5
Astrand	2	91.2 ± 8.6	662.8 ± 60.5	15.1 ± 8.2	21.7 ± 7.8	4.0 ± 0.8	5.4 ± 1.0
Astrand	3	101.6 ± 10.3	596.0 ± 59.8	7.9 ± 6.0	10.1 ± 3.5	2.3 ± 1.2	3.6 ± 0.9
Bruce	1	66.7 ± 9.1	916.7 ± 143.1	54.8 ± 31.1	62.6 ± 27.6	6.8 ± 1.2	7.5 ± 1.1
Bruce	2	93.6 ± 6.5	643.5 ± 44.5	16.4 ± 16.6	22.9 ± 11.5	3.7 ± 1.0	5.3 ± 0.8
Bruce	3	102.4 ± 8.1	589.1 ± 46.5	8.6 ± 8.9	10.7 ± 4.6	2.5 ± 0.7	3.7 ± 1.0
Running	1	64.5 ± 9.5	952.0 ± 172.2	58.6 ± 32.4	67.6 ± 30.4	6.8 ± 0.9	7.6 ± 1.2
Running	2	94.3 ± 9.9	643.3 ± 69.8	16.2 ± 11.4	23.1 ± 7.2	4.4 ± 1.1	5.9 ± 1.0
Running	3	101.9 ± 10.3	594.2 ± 63.1	11.6 ± 13.2	12.8 ± 8.0	2.8 ± 1.9	4.0 ± 1.4

Time 1 = PRE, Time 2 = Post1, Time 3 = Post2, HR = BPM, RR = ms, RMSSD = ms, SDNN = ms.
*Significantly different from "Bruce" ($p < 0.017$)
†Significantly different from "Running ($p < 0.017$)
Data reported as means ± standard deviation

Practical Applications

- Post-exercise HRV recovery does not appear to be affected by the type of treadmill protocol.
- Practitioners can select GXT based on factors such as feasibility, participant familiarity, or sport specificity.
- This reinforces the utility of HRV as a recovery marker, regardless of the specific maximal treadmill protocol used.