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Effect of Sleep Deprivation and Sleep Recovery on Heart Rate and Heart Rate Variability in Males Versus Females

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Effect of Sleep Deprivation and Sleep Recovery on Heart Rate and Heart Rate Variability in Males Versus Females

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Background

- Heart rate variability (HRV) describes the variability in the length of time that elapses between sequential heart beats
- Heart rate (HR) and HRV are regulated by the autonomic nervous system² and follow an endogenous rhythm that parallels the circadian rhythm¹⁻³
- Elevated HR and lower HRV are indicators of increased sympathetic tone and cardiovascular risk^{1,4}

Purpose

- We used data from a sleep deprivation study to assess the effect of one night of sleep deprivation and a subsequent night of recovery sleep on HR and HRV in healthy males versus females

Methods

- Fifty-nine subjects (age 29±8.5, n=35 female) completed a 4-day/3-night laboratory study
- Subjects were healthy young adults, free from medical conditions, and caffeine-use was not permitted
- Subjects had a baseline sleep opportunity (22:00–08:00), followed by 38h of sleep deprivation, and a recovery sleep opportunity (22:00–08:00)
- HR and HRV were assessed via Holter ECG
- HRV measures, extracted from ECG, included the proportion of successive N-N intervals that differed by > 50ms (pNN50) and the root mean square of successive differences (rMSSD)
- Time points used for analyses included 09:00–09:20 during a seated task on each day: baseline, sleep deprivation, and recovery
- Mixed effects ANOVA was conducted with SAS version 9.4

Results

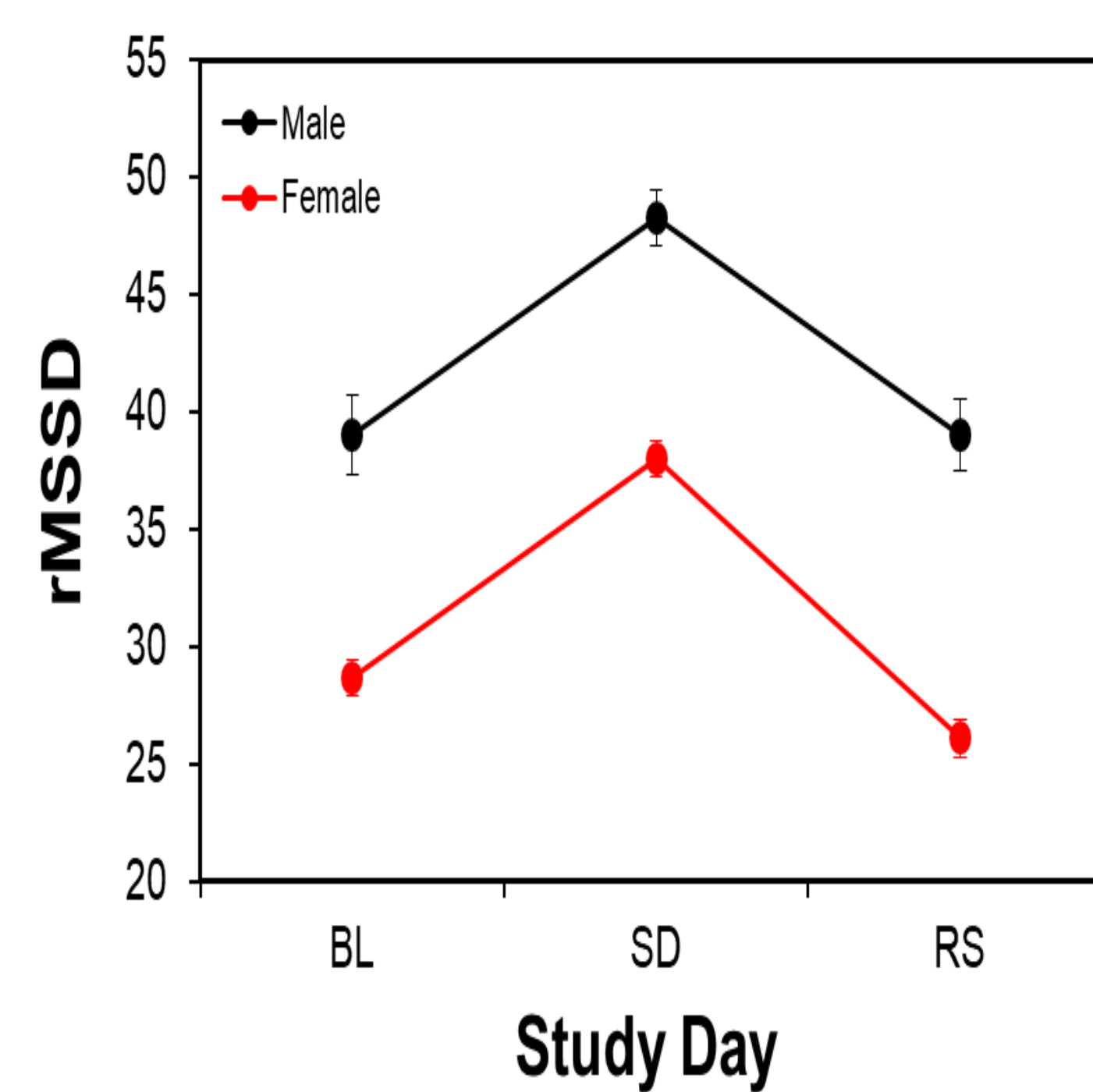
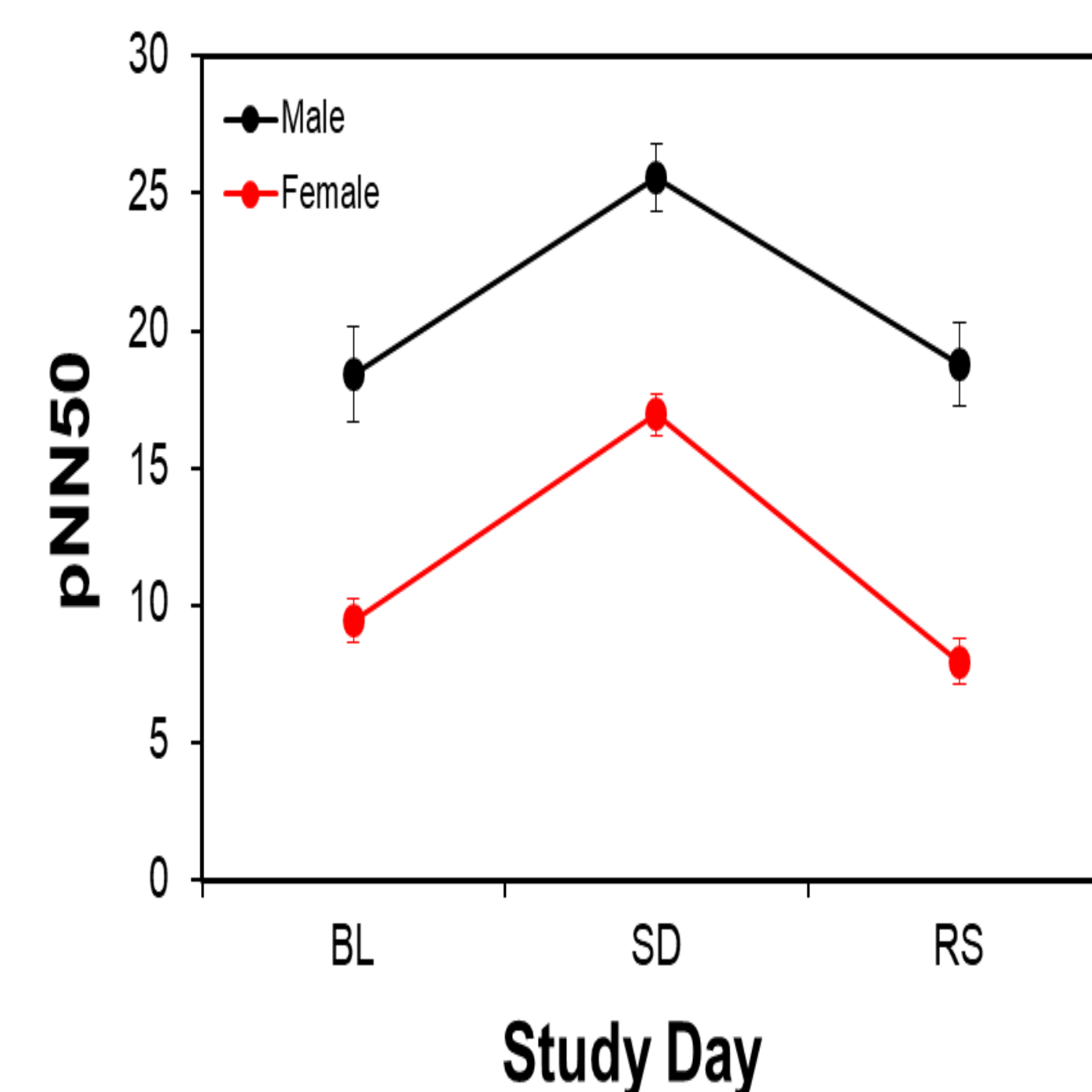
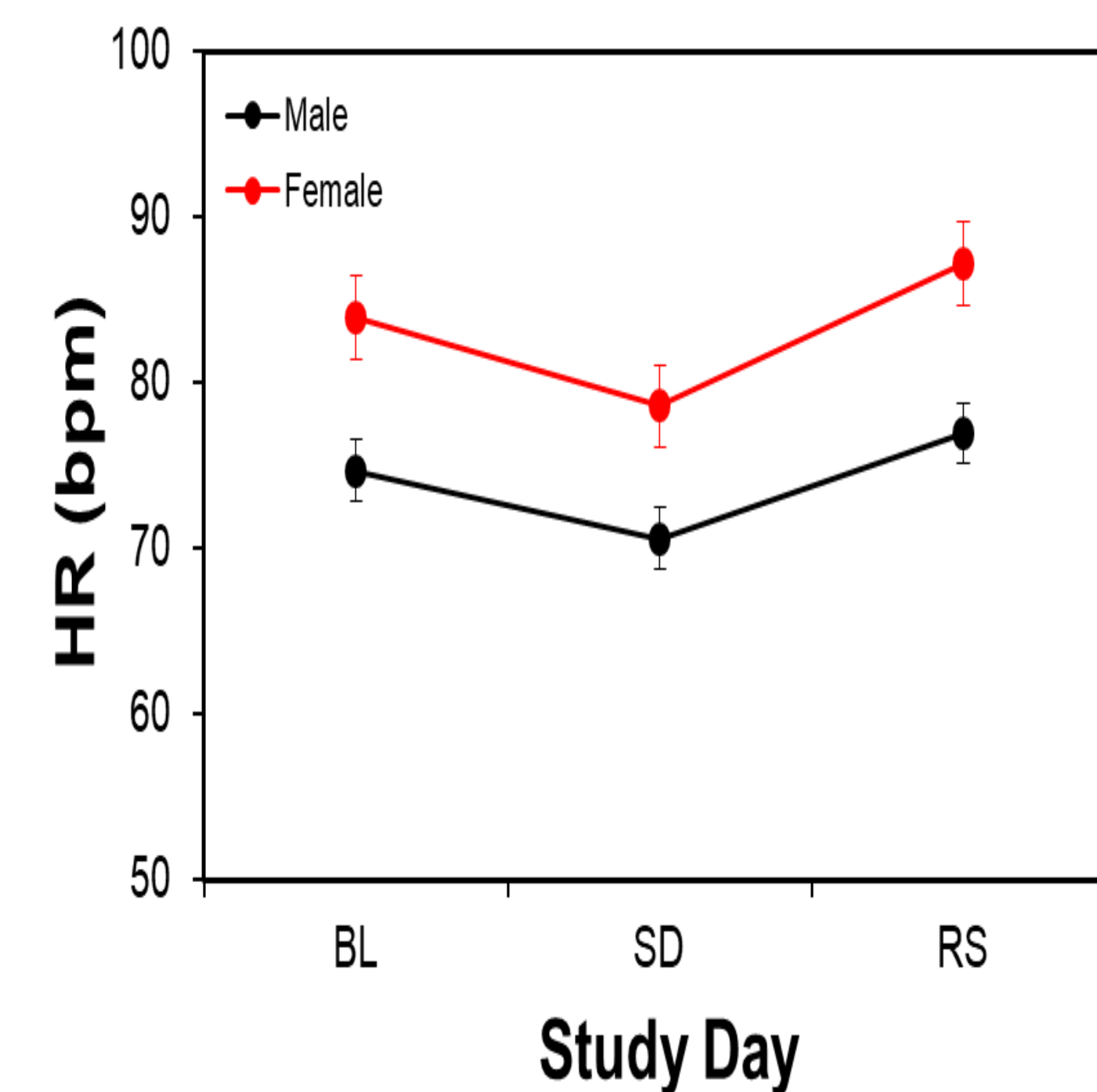


Figure. HR, rMSSD, and pNN50 at baseline (BL), sleep deprivation (SD) and post recovery sleep (RS).

- There was no significant interaction of study day by sex in HR, pNN50, or rMMSD ($p > 0.05$) as determined by mixed effects ANOVA with within-subjects fixed effects for study day, and with a random effect on the intercept over subjects to account for inter-individual differences (Figure)
- There was a significant main effect of day ($p < 0.01$) in which HR decreased and HRV measures increased during sleep deprivation for both male and female participants (Figure)
- There was also a significant effect of sex ($p < 0.01$): HR was lower and HRV measures were higher in males versus females at all three time points (Figure)
- HR and HRV returned to baseline levels following a night of recovery sleep for both sexes (Figure)

Conclusion

- The effect of sleep deprivation on HR and HRV indicates a decrease in sympathetic activity, in-line with previous research reporting inhibition of the brain's arousal centers as a consequence of increasing time awake^{1,2}
- While the majority of studies conclude that women have greater HRV at rest compared to their male counterparts^{5,6} the female subjects in this study had a significantly lower HRV at all three time points
- We did not address whether or how comorbidities, medications, or other stimulants modulate cardiac autonomic activity by sex
- Future studies should address the effect of chronic sleep deprivation by gender as chronic sleep loss may trigger allostatic mechanisms that modify HR and HRV to maintain homeostasis⁷

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