

Effect of Temperature on Ephaptic Coupling

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Abstract

In this note, the authors consider ephaptic coupling in a tract of three axons. They vary the temperature of the tract and note the time interval before adjacent (unstimulated) axons begin firing.

In Figure 1 we demonstrate the impact of temperature on the sympathetic firing delay for both the adjacent axons, which are not stimulated. As temperature rises, the conduction velocity tends to rise as well, and this is shown in Figure 2. However, the coupling tends to weaken with temperature, as a result of which the effect or impact of the stimulated fiber spreads much slower at higher temperatures than at lower temperatures. The impact of geometry is also captured in these plots since the variation of sympathetic delay with temperature is different for the two unstimulated fibers, located at different distances.

Coupling is mediated by the return path extracellular current [1, 2, 3]. We can think of the ephaptic effect as being lateral (since there are lateral injections into the return extracellular path) and the regular conduction as being longitudinal (since it is primarily flow along the axon). These two flows mediate interaction and diffusion respectively. As temperature increases, since the longitudinal flow increases in velocity, we hypothesize a drag-like effect on the lateral flow, thereby possibly delaying the interaction.

This hypothesis will be examined mathematically in future work using the temperature dependence of the conduction velocity via the $Q_{10}(\cdot)$ factor in the Reutskiy system.

References

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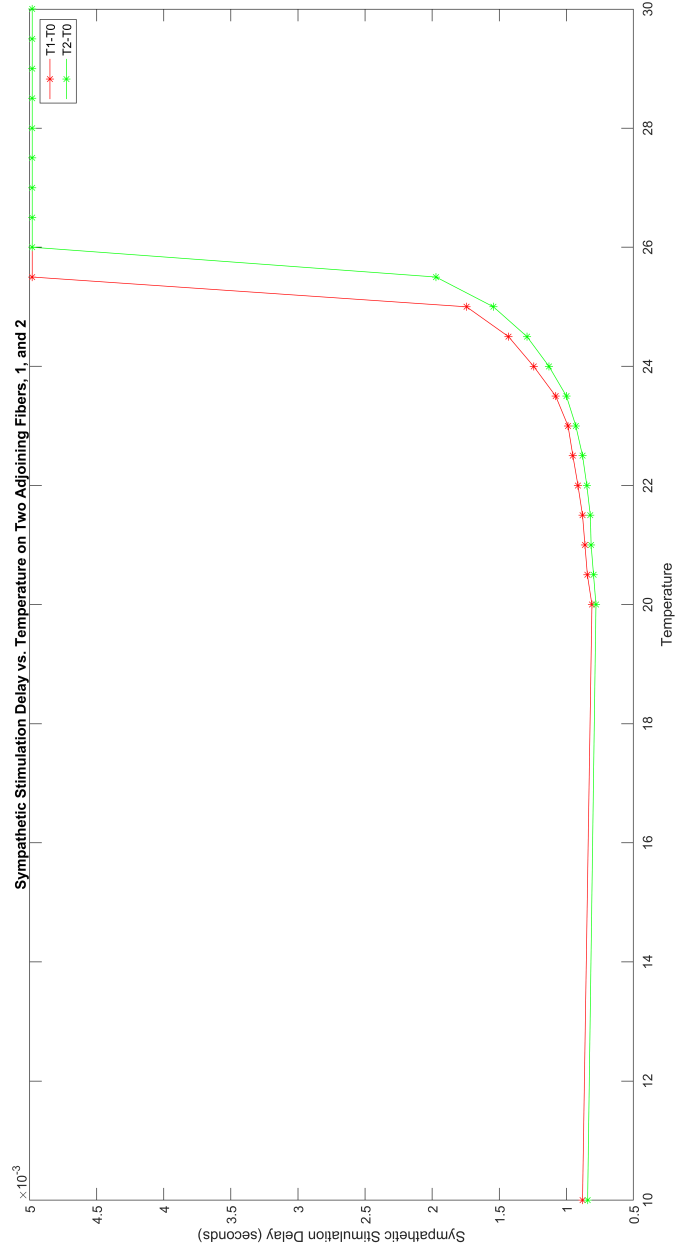


Figure 1: Ephaptic coupling delay on two coupled axons, vs. temperature.

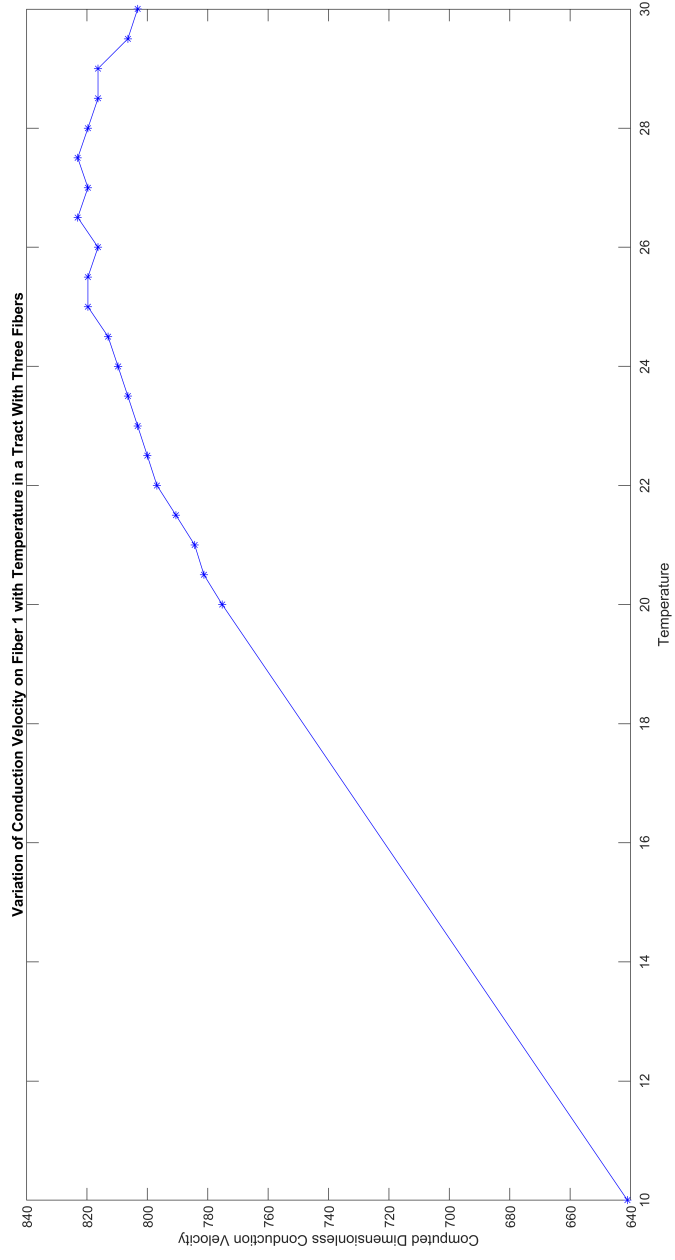


Figure 2: Variation of fiber 1 conduction velocity vs temperature.