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Title: Segment specificity of load signal processing depends on walking direction in the stick insect leg muscle control system

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In terrestrial locomotion sensory feedback from load sensors is important for adapting the ongoing motor output on a step-by-step basis. Here we investigated in the walking system of the stick insect how load signals from the leg exert their influence onto motoneuron pools of the thorax-coxa (TC-) joint. We stimulated load sensors during rhythmic, alternating activity in protractor coxae (ProCx-) and retractor coxae (RetCx-) motoneuron pools. Alternating activity in the segment of inspection was induced by mechanical stimulation of the animal or by pharmacological activation of the isolated thoracic segment. Load signals from the leg affected the timing of TC-motoneuron activity by affecting the central rhythm generating network of this joint: Load signals were able to reset and to entrain TC-motoneuron activity. In front and middle legs load signals induced or promoted RetCx-activity and decreased or terminated ProCx-activity. In the hind leg, reverse transitions were elicited with increasing load terminating RetCx and initiating ProCx activity. Studying the influence of load signals in intact walking animals showed that the execution of the load influence on the TC-joint motoneurons depended on walking direction, with increased load promoting the functional stance phase motoneuron pool. In forward walking this is RetCx activity, in backward walking ProCx activity. Thus, we show for the first time that modifications of sensory feedback in a locomotor system are related to walking direction. In a final set of ablation experiments we showed that the load influence is mediated by the three groups of trochanteral campaniform sensilla.

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