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Reply to “Perception of Lower Extremity Loading in Stroke”

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Reply to "Perception of Lower Extremity Loading in Stroke"

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As reflected by the comments of Kumar et al. (2015), there is an increasing interest in developing quantitative measurements of complex sensorimotor behaviors in people with neurologic injury or disease. In concept, our manuscript "Perception of lower extremity loads in stroke survivors" addresses one of these behaviors, which is likely to be important to gait function in stroke survivors (Chu et al., 2015). While we believe that impairment in load perception plays an important role in gait, Kumar et al. raise many important issues related to interpreting data from testing paradigms with higher complexity, and in extrapolating these laboratory results into a useful clinical tool. We appreciate the opportunity to share our views on these issues.

The diversity of stroke lesion location and size is an important consideration that is often overlooked by scientists and clinicians assessing sensorimotor behaviors. Traditionally, sensorimotor function has been measured only coarsely, making it feasible to group stroke survivors in research studies, with function primarily limited by 'hemiparesis'. The trend to individualize treatment, along with more complex testing of sensorimotor impairments, are compelling reasons to better understand stroke location and size. The traditional scientific question of structure–function relationships might now be feasible on an individual basis through modern imaging of brain structure and connectivity (e.g., Kalinosky et al., 2013). We concur that a better understanding of stroke location and size will eventually help inform clinicians on impairments and functional outcomes.

We acknowledge that a variety of types of stroke was used in the sample for our study. Unfortunately, these stroke presentations were not well defined and clinical descriptions of stroke lesions were nonspecific, making it difficult to clearly answer the question posed by Kumar and colleagues. We also recognize the importance of obtaining better descriptions of stroke location because of their impact on sensorimotor function. For example, basal ganglia stroke has been linked to persistent motor dysfunction and decreased recovery (Miyai et al., 1997). Sensory impairment has been linked to thalamic injury (Schmahmann, 2003). Additional research is needed to understand the structural changes that accompany specific impairments, such as load perception during gait. However, an adequate treatment of this topic would require state-of-the-art imaging, including structural and functional connectivity analyses.

Clinical testing of load perception during gait is an important question with a number of confounding issues, as suggested by Kumar and colleagues. Unfortunately, static load perception was not sensitive enough to identify deficits in load perception during gait in our study, and thus, static load testing is unlikely to provide a surrogate for testing of dynamic load perception. We postulate that static load testing allows for more processing time and the use of both limbs, which permits compensation for deficits in the paretic limb. Some deficits in load perception only became apparent in the dynamic test, emphasizing the need for load perception tests conducted during walking. This raises challenges in the development of a clinical test of dynamic load perception. We agree that dynamic perception of load is rife with problems, including body weight support, fear of falling and cognitive issues, as mentioned by Kumar and colleagues. In our study, we believe that the reduced fear of falling associated with body weight support (Hesse et al., 1995) actually aided subjects in focusing on load perception. Overall, our protocol was effective in identifying the ability to perceive load; however, the custom apparatus used in our study is not feasible for a clinical setting due to its complexity. Further research is needed to design clinical test equipment and protocols that capture the essence of dynamic load perception in a way that can be easily applied in the clinic.

Related to the development of a clinical test for dynamic load perception is the issue of when in the gait cycle load perception is best measured. Here we provide the additional correlational analyses requested by Kumar and colleagues, related to perception of load in mid-stance and push off. Before proceeding, we would like to clarify the conditions of the experiment. During the heel strike condition, participants were given the instruction to pay attention to when their foot struck the treadmill. During the mid-stance and push-off condition, the participants were asked to focus on when their legs are fully planted on the treadmill and when they pushed, to lift off from the treadmill, respectively. In our testing, the precise timing of the heel strike was not distinguished from toe or mid-foot contact; rather, it marked the end of swing and the transition to stance. The correlations with heel strike are shown in the manuscript. We performed the correlations with the other two conditions and the results are shown in Table 1 and Table 2. The mid stance condition reflected very similar correlation statistics as the heel strike condition. Conversely, the push off condition did not show significant correlation for either the static or dynamic load symmetry. As discussed in the original manuscript, we believe that load perception during push off was not accurate due to the convoluting factor of perception of a self-generated force.

Table 1. Regressions with static load asymmetry as the dependent measure.

	***F*-stats**	***P*-value**	**R^2**	**Coefficient**
Dynamic load response accuracy				
Mid stance condition	$F(1, 23) = 18.11$	0.0003	0.441	−0.57
Push off condition	$F(1, 23) = 3.81$	0.0633	0.142	−0.30
Dynamic load response error				
Mid stance condition	$F(1, 23) = 9.74$	0.0048	0.297	0.313
Push off condition	$F(1, 23) = 0.4$	0.533	0.17	0.082

Table 2. Regressions with dynamic load asymmetry as the dependent measure.

	***F*-stats**	***P*-value**	**R^2**	**Coefficient**
Dynamic load response accuracy				
Mid stance condition	$F(1, 23) = 12.32$	0.0019	0.349	−0.166
Push off condition	$F(1, 23) = 3.102$	0.096	0.116	−0.09
Dynamic load response error				
Mid stance condition	$F(1, 23) = 7.94$	0.0098	0.257	0.095
Push off condition	$F(1, 23) = 0.845$	0.37	0.035	0.039

We would like to thank Kumar and colleagues for a valuable discussion of this topic. We hope that this discussion will be continued in the scientific realm with new research in dynamic load perception and its impact on function in stroke survivors.

Conflict of interest

None of the authors have potential conflicts of interest to be disclosed.

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