Rebuttal from Raymond Reynolds, Callum Osler, Linda Tersteeg and Ian Loram

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We believe the data presented by Carpenter *et al.* (2015) neither contra- dict our argument nor support their own. Although their recent findings show that fear influences high-frequency muscle/ force responses to stochastic vestibular stimulation (Horslen *et al.* 2014; Lim, 2014), they themselves concede that these changes may not influence centre-of-mass position. They state: '...high frequency threat-related changes observed in ground reaction forces and muscle activity would be less evident in trunk kinematics because of natural low-pass filtering in conversion from muscle activity or force to sway.' Not only do we agree, but we believe this supports our original view, i.e. to investigate balance it is necessary: (i) to use a stimulus relevant for balance; and (ii) to measure body movement. Their use of stochastic stimuli and focus on the muscle/force responses renders the relevance of their argument to neural control of balance uncertain. In contrast, our square-wave stimuli caused significant body sway. We interpret the absence of effect of fear upon this response to mean that, judged to a functional standard, vestibular control of balance is unaffected.

While accepting the accuracy of the findings cited by Carpenter *et al.* (2015), we question whether their CrossTalk proposal fully considers the amplitude and/or functional significance of the vestibular responses that are modulated by fear. Firstly, the sway response in our study illustrates an important point; fear clearly affects the integration of multiple balance-relevant sensory inputs, and this modulation is far stronger than the purported effect on the initial response to pure vestibular input. Secondly, Carpenter *et al.* (2015) cite the effect of fear of falling upon Vestibular-evoked myogenic potential (VEMP) amplitude in support of their argument. However, to our knowledge the function of the VEMP reflex is uncertain. While it may contribute to head orientation to sound or head stabilization, it has not been linked to whole-body control, i.e. balance. Thus, as for the original findings of Horslen *et al.* (2014) and the effects of fear on the Vestibular-ocular reflex (VOR), we query their relevance for balance.

Furthermore, we did not study tandem stance as stated by Carpenter *et al.* (2015), although we appreciate the possible ambiguity. Regarding the presence of fall threat on both sides in the study by Osler *et al.* (2013), this would only serve to increase any effect of height, but no statistically significant effect of fear was observed in vestibular-evoked sway.

In summary, we believe that there is currently no experimental evidence to support a change in vestibular control of balance caused by fear of falling.

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Additional information

Competing interests

None declared.

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