SPATIAL-TEMPORAL DISTRIBUTIONAL PATTERNS FOR VIRTUALLY CONTACTING THE STABILITY BOUNDARY IN HUMAN STANCE

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Introduction

Virtual time-to-contact (VTC) is introduced as a model for the neural basis underlying behavioural postural responses in human stance. Here the motion of the center-of-pressure (COP) is related to the functional stability boundary in that a temporal safety margin (VTC) is derived (= time remaining to adaptively compensate postural motion before stability may be compromised) [Slobounov, 1997]. The emphasis of this study was to investigate the spatial-temporal distributional patterns for virtually contacting the stability boundary as a function of skill (healthy young adult female ballet dancers and non-dancers) and the availability of visual information (vision and no vision). ***Methods:*** The experimentally derived functional stability boundary is defined as the maximum/ limiting 2D spatial coordinates for the COP in upright stance. The functional stability boundary is smaller than the limits of the base of support (feet). The stability boundary is modelled as 20 linear segments, each covering a sector of 0.314 radians. The temporal safety margin is then derived from an extrapolated (virtual) COP trajectory in 2D space that departs from the current COP location and contacts the modelled functional stability boundary at a certain segment relative to the COP motion (see Figure 1). The shape and velocity of the virtual COP trajectory are based on the COP dynamics at each time instant.

Results and Discussion

The area of the functional stability boundary was significantly greater with vision than under no vision. The withdrawal of vision decreased VTC and increased the probability of virtual contacts with the front and especially back segments of the stability boundary. Moreover, the complexity of the turnaround of the virtual COP trajectory during the quiet stance was studied through computing the Lempel Ziv complexity (LZC) of the finite sequence of boundary segments that were contacted by the virtual COP. LZC was decreased for non-dancers and without vision which may indicate a functional decline of the postural control system in that a modest level of exploratory movements is reduced.

Conclusion

The findings provide further evidence that VTC holds a basis for modelling boundary relevant postural instability and assessing the probabilistic properties of losing postural stability.

Figures

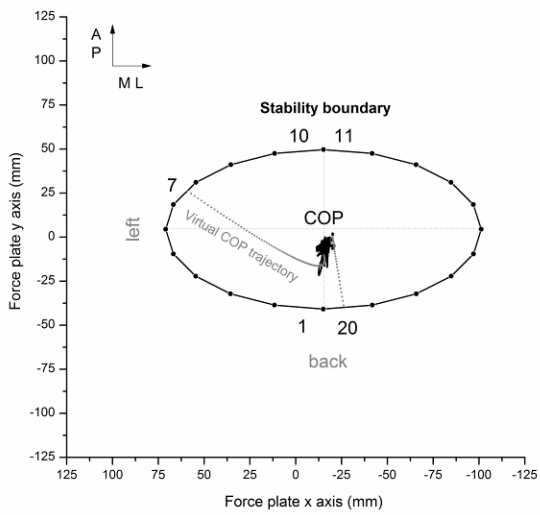

Figure 1: Data from one typical trial under the no vision condition. The polygon representation of the functional stability boundary, the center-of-pressure (COP) path of one single trial and two virtual COP trajectories at arbitrary time instants are illustrated in original aspect ratio, resolved in the force platform coordinate system. Numbers ranging from 1 to 20 were assigned to the different boundary segments, each representing one specific direction in relation to the COP (e.g. front or back segments).

References

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