Angular momentum regulation during a ballet turn as a balance control indicator

Coren Walters-Stewart, Gholamreza Rouhi, D. Gordon E. Robertson

In contrast to walking, during which angular momentum is ultimately used for locomotion[1], in ballet, when performing a turn, angular momentum is used to accomplish a rotation. This study characterizes the mechanisms used by a dancer to generate and control angular momentum and quantifies the transfer of angular momentum throughout. Our results demonstrate that the period during which the heel makes contact with the ground is an important domain of analysis in considering the dancer's ability to develop angular momentum about the main axis of the turn. In addition, significant transfers of angular momentum occur between the extended leg and the trunk as a result of the technique in which the extended leg leads the turn. While the principal motion of the turn occurs about the z-axis, considerable changes in momentum (thus, an external moment) occur in the axes parallel to the ground, as well. Yet, the balance of the dancer is maintained by continuously transferring momentum between the mediolateral and anterioposterior axes. If angular momentum is not transferred between these axes, external moments create torque about the ankle joint and can cause the dancer to lose his or her balance. When deviations from vertical result in a torque about the ankle joint, the body is further accelerated from a stable upright position similar to a tripping situation[2]. A counteracting torque is required to arrest and reverse the torque created by a gravitational force component.

[1] Herr, H and M. Popovic. (2008) Angular momentum in human walking. *J Exp Biology* 211:467-481
[2] Pijnappels, M et al. (2004) Contribution of the support limb in control of angular momentum after tripping. *J Biomech* 37:1811-8