SKILL ACQUISITION IN A MULTI-JOINT DANCE MOVEMENT
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INTRODUCTION
What constitutes “skilled” movement? What distinguishes the mastery of the expert from the student? The dance population was selected for study because expert dancers exhibit highly consistent spatial and temporal coordination patterns while performing domain-specific movements. The objective of this research was to understand the effect of skill acquisition on the organization of a sequential multi-joint dance movement (arabesque). The arabesque is a commonly performed dance movement which involves the coordination of postural control with upper and lower extremity multi-joint movement. This requires extreme changes in trunk orientation, temporal coordination of the endpoints of the gesture limbs, as well as balance control.

METHODS
Three-dimensional kinematic analysis of the arabesque in 30 adult subjects was conducted with a 5-camera Vicon system, at 120Hz, using a 29 marker set to create a 11 segment model (Fig. 1). Subjects represented three distinct levels of dance training: Expert (professionals with a mean of 15 years of dance training), Advanced (mean 11 years training), and advanced Beginner (mean 5 years training), based on their ballet placement by faculty at an international dance school. Subjects were excluded if there was any history of lower extremity injury during the previous six months which caused them to stop dancing. Subjects performed the arabesque to a metronome for 6 trials on the right limb. The movement was well known to each subject.

RESULTS
Results substantiate current motor learning theory of two concurrent and parallel processes: explicit and implicit learning (Gentile, 1998). Demonstrating explicit learning which is rapid early on, all subjects displayed similar movement shape and general organization measured by similar trunk-limb movement onset sequencing as well as peak resultant and angular displacements (Fig. 2).
Implicit learning, which is relatively prolonged, was demonstrated by group differences in posture and balance control as well as intra- and inter-limb coordination. Differences were found in magnitude and consistency of pelvic translation in the frontal plane, as measured by asis peak displacement and coefficient of variability (CV) (P<0.05). Experts translated their pelvis farther with greater consistency during both the passé and return phases. Balance control during the arabesque hold phase was also more consistent in Experts, as measured proximally by pelvic rotation CV in each of the three axes and distally by toe CV (P<0.05). Intra-limb segmental coordination was measured by calculating difference scores in peak velocity timing of the gesture hip, knee, and toe. Inter-limb coordination was measured by difference scores in peak velocity timing of the toe and finger. Group differences were found in peak velocity timing of the toe-hip, toe-knee, and toe-finger in the arabesque phase (P<0.05), with Experts demonstrating a different pattern in toe-hip and toe-finger coordination from that of Advanced or Beginners (Fig. 3).
DISCUSSION
Skilled performance of the arabesque appears to involve mastery of both postural control and segmental velocities to control the inertial forces generated by large limb and trunk movements. Students frequently focus their attention on maximizing vertical displacement of the gesture limb. However, successful mastery of trunk control as well as segmental timing appears to be a key area which differentiates expert from student dancers. The study of kinematics provides insight into the underlying control of movement dynamics and is a useful tool to analyze the effectiveness of our training techniques.

REFERENCES

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