INTRODUCTION

Twist may be initiated during the aerial phase of a somersault by using asymmetrical arm movements to tilt the body away from the vertical plane of the somersault (Yeadon, 1993). A reversal of the asymmetrical arm movement can also remove the tilt and stop the twist. Since there will be some variation in the movement initiating the twist, it will be necessary to make in-flight adjustments in order to complete the required amount of twist. Adjustments in arm asymmetry have been shown to be capable of controlling twist in unstable non-twisting somersaults (Yeadon and Mikulcik, 1996). This study investigates whether the same type of control can control the twist in the final phase of a twisting somersault.

METHODS

An 11-segment computer simulation model of aerial movement (Yeadon et al., 1990) was used to produce a backward somersault with one twist. The arms each moved from an initial symmetrical position through 90° until one was by the side of the body and the other was overhead (Figure 1). The arm movements were later reversed so that the tilt was removed and the twist ceased after one revolution had been completed. The arm movement initiating the twist was perturbed by reducing the amplitude of the movement by 5°. This resulted in less tilt and a slower twist. The timing of the arm reversal in this perturbed movement was the same as that in the original simulation and lead to insufficient twist.

A control system was introduced into the model whereby arm asymmetry was adjusted with arm abduction acceleration being a function of twist angular velocity and acceleration (Yeadon and Mikulcik, 1996). With zero feedback time delay in the control system, the perturbation was accommodated with the required amount of twist being completed. With a time delay of 0.2 somersaults problems were encountered arising from the high rate of twist with the arms in the asymmetrical position. To overcome this difficulty the arms were abducted through 50° from the asymmetrical position before the control system was activated.

The procedure was repeated for a perturbation in which the simulation overtwisted.

RESULTS

The original simulation produced 1.00 twists with a final tilt angle of 0.2° after one somersault (Figure 1a). The perturbation resulted in a final twist angle of 0.86 revolutions and a final tilt angle of 7.0° (Figure 1b). With zero time delay the control system was able to compensate automatically for the perturbation, producing final amounts of 1.01 revolutions of twist and 0.4° of tilt (Figure 1c). With a time delay of 0.2 somersaults and a spreading of the arms in mid-flight, the control system was at its limit in coping with the disturbance producing final amounts of 1.00 revolutions of twist and 2.3° of tilt (Figure 1d). Similar results were obtained when a perturbation was used to produce too much twist.

DISCUSSION

There are few reports of difficulty in controlling the twist when gymnasts or trampolinists first attempt double somersaults in the straight position. This suggests that the method of control has been learnt prior to the attempt at the unstable movement. It may be speculated that gymnasts learn this method of twist control in single somersaults with twist.
SUMMARY

A feedback control system for making in-flight adjustments to the twist in twisting somersaults has been shown to be capable of effecting control for time delays of up to 0.2 somersaults.

REFERENCES