Supplementary Material

Experiment S1: Switching perturbation and movement class – speed control

It is possible that the improvement in performance observed for the main switching movement class Experiment 5 may have resulted from differences in the kinematics between the rhythmic and discrete movements, rather than differences in the underlying control mechanisms. To demonstrate that this was not the case, control Experiment S1 was performed. A total of 6 subjects (n=6) participated.

Experiment S1 was similar to Experiment 5, except that a modified pacing cursor was employed to achieve a closer match in speeds between the two movement conditions. In addition, the discrete movements consisted of $1\,5/16$ revolutions (a slight increase over the $1\,1/4$ revolutions used previously). Consequently, over the course of each block, a more uniform coverage of starting locations around the circumference of the target circle was achieved. In addition, a single visual indicator (pacing cursor) was used to cue the desired rotational frequency, which started moving only when the subject started moving. The subjects were specifically instructed to track the rotation of the pacing cursor whilst performing the rotation task. To this end, a single pacing cursor was used to make it easier for subjects to follow. Histograms of hand velocity and position, as well as the mean and standard error of the speed profiles across subjects, were computed separately for the rhythmic and discrete movements.

Figure S1A and B show the two-dimensional velocity and position distributions for the original switching Experiment 5, respectively. As can be seen, there are differences in the distributions between the two movement classes in both cases. Figure S1C and D show the two-dimensional velocity and position distributions for the speed control Experiment S1. In the original Experiment 5, there are differences between the rhythmic and discrete classes, especially in terms of the velocity which has a wider spread in the discrete case. However, in the speed control Experiment S1, the differences between the velocity and position distributions are smaller, with a large overlap between the regions of highest densities. A smaller difference can also be seen in the mean speed profiles, which are shown in Figure S2 (original Experiment 5: red=rhythmic, grey=discrete; speed control Experiment S1: green=rhythmic, blue=discrete).

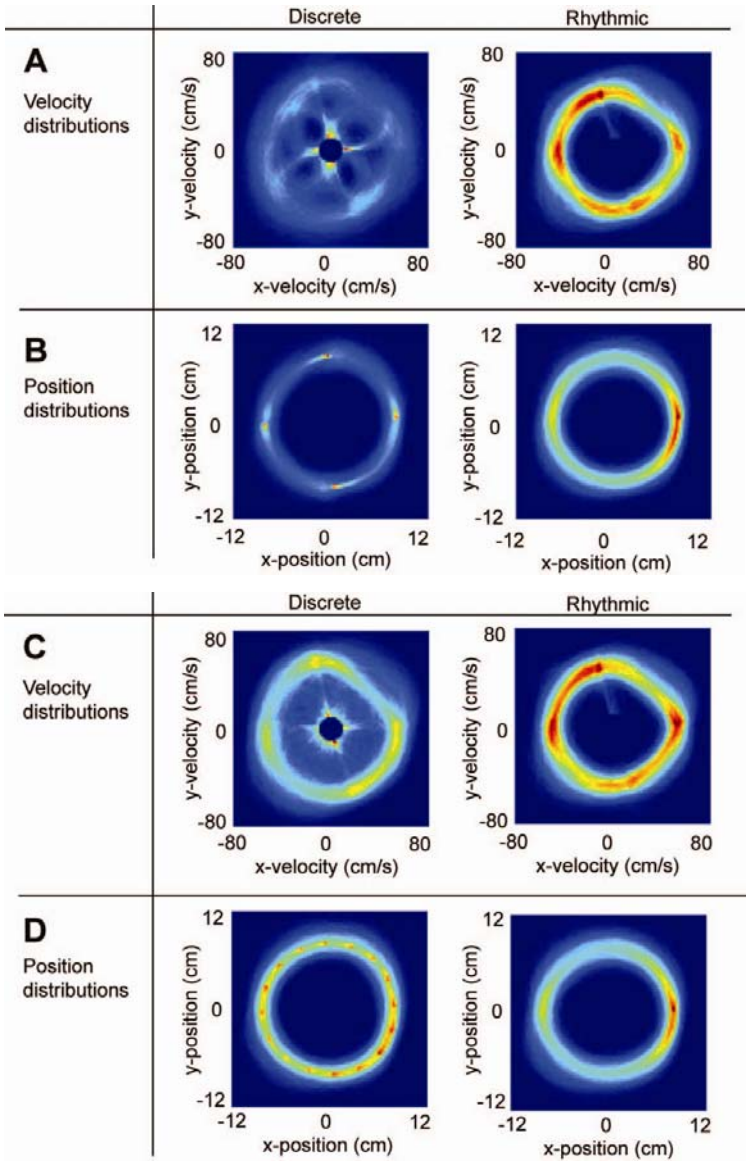

Figure S1 Distributions of velocity and position for Experiments 5 and S1. **A** Distributions of end-point velocity for the discrete (first column) and rhythmic (second column) movement conditions across all trials and all subjects for the switching Experiment 5. **B** Distributions of end-point position for the discrete (first column) and rhythmic (second column) movement conditions across all trials and all subjects for the switching Experiment 5. **C** Distributions of end-point velocity for the discrete (first column) and rhythmic (second column) movement conditions across all trials and all subjects for the speed control Experiment S1. **D** Distributions of end-point position for the discrete (first column) and rhythmic (second column) movement conditions across all trials and all subjects for the speed control Experiment S1.

The form of the speed profiles is similar between the two experiments for both rhythmic and discrete movements. The discrete movements show a slow increase to maximum speed, followed by a plateau. The rhythmic movements show a similar increase (note different time scales), but with an overshoot before the subsequent plateau. In the speed control Experiment S1, the difference between the plateau speeds for the two movement classes was smaller. To confirm this, we compared the average speed during the plateau regions between the rhythmic and discrete movement cases across subjects. In Experiment 5 the difference in speed between the two movement classes was significant (8.3±3.1 cm/sec, p=0.04) whereas in the control Experiment S1 it was not (5.7±2.7 cm/sec, p=0.09). Note that although the changes in absolute speed may appear small, the two-dimensional velocity distributions are more closely matched (compare the left and right panels of Figure S1A and S1C). That is, the rhythmic and discrete cases are now more similar.

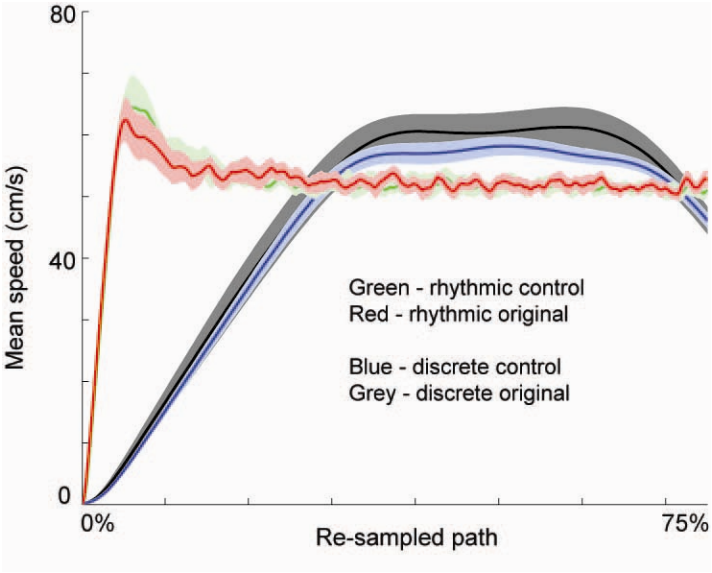

Figure S2 Speed profiles for Experiments 5 and S1: Mean speed and standard error for the duration of the trial, normalized for trial length, across all trials and all subjects. The original switching Experiment 5 is plotted in red (rhythmic) and grey (discrete). The speed control switching Experiment S1 is plotted in green (rhythmic) and blue (discrete).

Figure S3 shows the signed error for Experiment 5 (red=rhythmic, grey=discrete) and the speed control Experiment S1 (green=rhythmic, blue=discrete). There were no significant differences for the final error during the exposure phase between the two experiments (rhythmic: -0.0005±0.023, p=0.84; discrete: -0.0047±0.04, p=0.90). That is, more closely matching the speeds for the rhythmic and discrete movement classes did not affect adaptation to the switching perturbations. Importantly, as in the original switching Experiment 5, the signed error during the post-exposure blocks for the control Experiment S1 were significantly different from zero for both movement classes (rhythmic: -0.16±0.03, p=0.002; discrete: -0.11±0.024, p=0.006). This suggests that the improvement in performance was due to an underlying difference in the control mechanisms between the two movement classes rather than differences in speed.

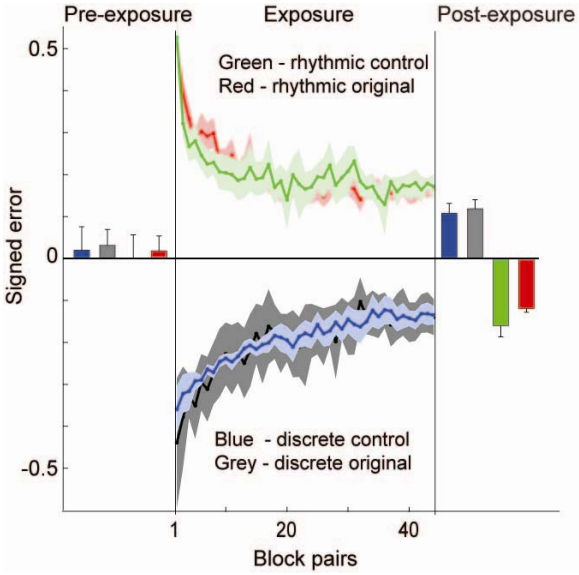

Figure S3 Comparing Experiments 5 and S1: Signed mean error (solid line) and standard error (shading) across subjects (n=6) for the original switching Experiment 5 and speed control Experiment S1. Experiment 5 is plotted in red (rhythmic) and grey (discrete). Experiment S1 is plotted in green (rhythmic) and blue (discrete).