Supplementary Material

Experiment 1: Dynamic switching Δ180º/Δ0º

As described in the main text, for the first experiment, subjects were exposed to alternating dynamic perturbations (CW and CCW curl fields). The perturbation always switched at the end of each batch of 16 trials. Subjects performed three sets of 24 batches with the order of the sets counterbalanced across subjects. Two sets were static context sets and the third set was a switching context set. In one of the static sets, the two arms moved in the opposite directions in Cartesian space (Context A, Δ180º). In the other static set, the two arms moved in the same directions (Context B, Δ0º). In the switching context set, the movements alternated between context A and B at the end of each batch (Δ180º/Δ0).

To quantify learning, we calculated the maximum perpendicular error (MPE) from a straight line to the target, for each arm during the outward part of the movement. Values reported in the main text are the mean *absolute* MPE over pairs of consecutive batches (see Figure 2). In addition, Figure S1 shows the mean *signed* MPE for each batch, averaged across subjects for the right arm (for the three sets: Δ180º, Δ180º/Δ0º and Δ0º). For each set, the upper curves (crosses) correspond to performance in one direction of the perturbation and the lower curves (circles) correspond to performance in other. Signed MPE is initially low in the Null pre-exposure phase but increases sharply upon introduction of the perturbation, in the direction of the perturbation. The first set (Figure S1 A) was a static context set in which the two arms moved in opposite directions (Δ180º). MPE remained high (either positive or negative, depending on the perturbation direction) over the course of this set, suggesting that

28   subjects could not co-represent the switching perturbations. The second set (Figure S1

29   B) was a switching context set (Δ180º/Δ0º). MPE for both perturbations decreased

30   over the course of this set, suggesting that in this case subjects were able to co-

31   represent the perturbations. The final set (Figure S1 C) was a static context set, in

32   which the arms moved in the same direction (Δ0º). As for the first static set, MPE

33   remained high, again suggesting that subjects were unable to co-represent the

34   perturbations.

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37   *Control Experiment S1: Dynamic switching Δ90º/Δ0º*

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39   Control experiments were also run with perpendicular movement directions (Δ90º) to

40   examine other bimanual contexts. Control experiment S1 was identical to Experiment

41   1 in the main text, except for the bimanual contexts, which were Δ90º (Context A)

42   and Δ0º (Context B). Context A required the left hand to move in a direction 90º

43   counter-clockwise relative to movement of the right hand. Context B consisted of Δ0º

44   movements as in Experiment 1. Figure S2 A shows the absolute MPE for the right

45   arm and Table S1 contains detailed data for both arms. For both arms MPE was low

46   during exposure to the Null condition and increased upon introduction of the

47   perturbation. As in the first experiment, over the course of exposure there was no

48   significant decrease in MPE in either of the static context sets (Δ90º p=0.29; Δ0º

49   p=0.92). However, in the switching context set (Δ90º/Δ0º) there was a significant

50   decrease in MPE (p=0.002). Analysis of catch-trial forces for the right arm showed

51   that significant compensatory forces where produced only in the switching set (Δ90º,

52   0.27±1.64 N, p=0.71; Δ0º, 0.06±3.21 N, p=0.96; Δ90º/Δ0º 3.40±1.14 N, p=0.0007).

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Control Experiment S2: Dynamic switching Δ180º/Δ90º

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57 Control experiment S2 was identical to Experiment S1, except that bimanual context

58 A consisted of Δ180º movements and context B consisted of Δ90º movements. Figure

59 S2 B shows the absolute MPE for the right arm and Table S1 contains detailed data

60 for both arms. Results were very similar to Experiment S1. Specifically, over the

61 course of the exposure there was no significant decrease in MPE in either of the static

62 context sets (Δ180º p=0.91; Δ90º p=0.53), whereas in the switching context set

63 (Δ180º/Δ90º) there was a significant decrease in MPE (p<0.001). Similarly, analysis

64 of catch-trial forces for the right arm showed that significant compensatory forces

65 where produced only in the switching set (Δ180º -0.42±1.69 N, p=0.57; Δ90º

66 1.56±5.22 N, p=0.50; Δ180º/Δ90º 3.88±2.33 N, p=0.01).

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68 Results from Experiment S1 and S2 show that other movement relations, such as ones

69 made in orthogonal directions (Δ90º), also involve partially separate representations.

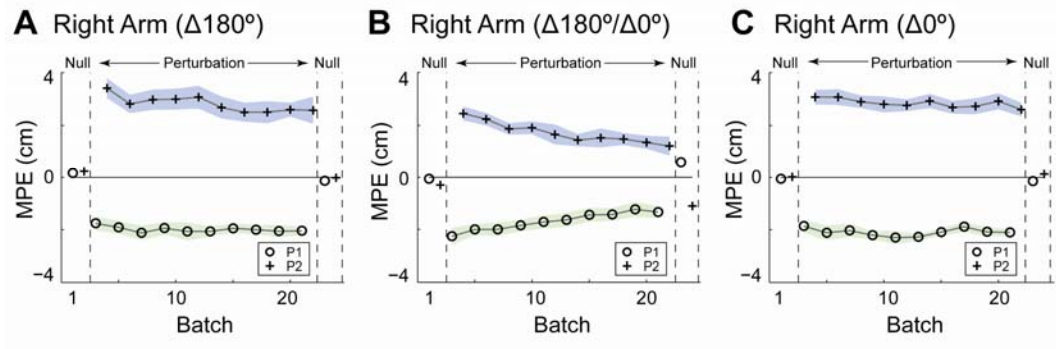70 It should be noted that Δ90º refers to a relative difference in movement direction

71 between the arms of 90º and does not relate to a temporal phase difference of 90º.

72 Temporal phase, which is often studied in the context of symmetry bias, was not

73 examined in the current study.

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A Right Arm (Δ180º) **B** Right Arm (Δ180º/Δ0º) **C** Right Arm (Δ0º)

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78 **Figure S1** Dynamic perturbation experiment 1 with both arms experiencing switching

79 curl fields and bimanual movement contexts of Δ180º and Δ0º. **A, B, C** Mean signed

80 MPE for the right arm for each batch across all subjects for all three sets. Positive and

81 negative MPE are for deviations to the right and left of the straight line to the target,

82 respectively.

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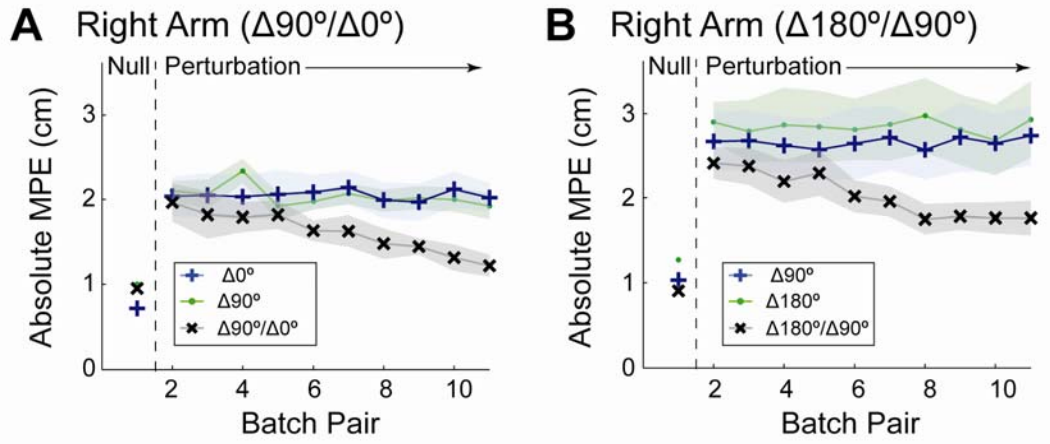
Figure S2 Control experiments S1 and S2. **A** Right arm mean absolute MPE (solid lines) and standard error (shading) for pairs of batches averaged over all 6 subjects for Experiment S1 (bimanual contexts Δ90º and Δ0º). The results for the three contexts are overlaid. **B** Right arm mean absolute MPE for Experiment S2 (bimanual contexts Δ180º and Δ90º), plotted as in A.

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			MPE Exp 1 (Δ180°/Δ0°)	MPE Exp 2 (Δ180°/Δ0°)	MPE Exp 3 (Δ180°/Δ0°)	SAE Exp 4 (Δ180°/Δ0°)	MPE Exp S1 (Δ90°/Δ0°)	MPE Exp S2 (Δ180°/Δ90°)
Context A	**Left**	Null	1.05±0.06	1.04±0.10	0.93±0.11	3.83±1.33	1.18±0.11	1.65±0.26
		Initial	2.68±0.27	0.96±0.12	2.94±0.30	25.23±1.63	2.24±0.06	3.18±0.46
		Final	2.43±0.23	0.78±0.06	2.77±0.38	26.61±1.19	1.96±0.11	3.09±0.69
	Right	Null	1.01±0.11	0.80±0.07	0.79±0.09	3.64±0.59	1.00±0.06	1.27±0.18
		Initial	2.74±0.23	1.91±0.13	2.65±0.28	27.04±1.03	2.10±0.12	2.90±0.23
		Final	2.39±0.26	1.89±0.12	2.47±0.41	26.82±0.98	1.92±0.15	2.93±0.45
Context B	**Left**	Null	0.95±0.06	0.79±0.08	0.91±0.12	6.09±1.17	0.82±0.07	1.10±0.15
		Initial	2.70±0.24	0.75±0.07	2.76±0.46	25.68±1.24	1.99±0.14	2.61±0.33
		Final	2.57±0.13	0.72±0.05	2.54±0.25	25.55±1.58	2.18±0.15	2.98±0.43
	Right	Null	0.91±0.07	0.80±0.06	0.68±0.10	5.37±1.27	0.71±0.05	1.03±0.15
		Initial	2.61±0.20	2.05±0.10	2.40±0.40	25.80±0.82	2.04±0.23	2.67±0.34
		Final	2.46±0.14	1.73±0.08	2.24±0.25	25.29±1.18	2.02±0.17	2.74±0.35
Context A/B	**Left**	Null	1.00±0.07	0.90±0.09	0.97±0.11	4.10±0.93	0.91±0.04	1.21±0.23
		Initial	2.65±0.23	0.83±0.09	2.75±0.28	26.10±1.17	1.92±0.10	2.45±0.23
		Final	1.65±0.27	0.83±0.08	2.55±0.42	18.71±1.81	1.33±0.13	1.77±0.25
	Right	Null	0.96±0.06	0.79±0.08	0.78±0.05	1.98±0.48	0.95±0.07	0.90±0.07
		Initial	2.44±0.17	1.93±0.12	2.34±0.22	24.76±1.50	1.96±0.22	2.41±0.19
		Final	1.54±0.20	1.24±0.10	2.23±0.38	19.39±1.63	1.22±0.13	1.76±0.20

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94 **Table S1** Absolute MPE and absolute SAE values for the bimanual context switching

95 experiments 1-4 and for control experiments S1 and S2. Values are subject means and

96 standard errors in the Null, initial exposure and final exposure phases for the left and

97 right arms and for the three sets.

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	Exp 5 Dynamic Transfer		Exp 6 Visuomotor Transfer	
	Left MPE	Right MPE	Left SAE	Right SAE
Null	0.63±0.25	0.53±0.28	-0.43±1.77	0.29±1.00
Δ180° Initial	3.42±0.21	3.64±0.19	-27.32±2.08	-26.42±2.02
Δ180° Final	1.12±0.49	0.70±0.39	-8.26±2.21	-6.23±0.98
Δ0° Initial	2.28±0.23	1.78±0.29	-17.53±1.88	-12.63±1.80
Δ0° Final	0.78±0.43	0.37±0.20	3.58±2.14	-4.08±1.98
Δ0° Null Initial	-2.59±0.49	3.09±0.28	24.66±2.05	23.83±1.47
Δ0° Null Final	-0.97±0.26	0.70±0.15	11.85±1.98	11.49±0.94
Δ180° Null	-1.40±0.43	-1.23±0.26	14.81±1.84	14.74±1.53

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101 **Table S2** Signed MPE and signed SAE values for the context transfer experiments 5

102 and 6. Values are subject means and standard errors in the Null, initial exposure and

103 final exposure phases for the left and right arms and for the two movement contexts.

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