

Supplementary Material

Intensive task-switching training and single-task training differentially affect behavioral and neural manifestations of cognitive control in children

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Supplementary Materials

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Supplementary Table 1. Details of the distribution of trials in single and mixed blocks for the three types of training games for the high-intensity single-tasking (SI) and high-intensity task-switching (SW) groups.

Training task	SI group		SW group	
	single	mixed	single	mixed
Face-scene task and unique tasks of the same structure	405	81	81	405
Monster task and unique tasks of the same structure	405	81	81	405
Robot tasks and unique tasks of the same structure	404	81	80	405

Supplementary Table 2. Model comparisons showing that for behavioral measures (accuracy, RT, HDDM parameters) the model including all interactions fit best or did not differ from best-fitting model. Models were compared using the LOO function within the loo package in R (Vehtari et al. 2022). ELPD difference indicates the difference between each model's Bayesian leave-one-out estimate of the expected log pointwise predictive density (ELPD) and the best fitting model, while ELPD difference is zero. SE indicates the standard error of this difference. Note that there is not a fixed ratio of SE to ELPD difference to indicate significant differences between models. Until these exist, developers' suggestions are that an ELPD difference around five times the SE can be interpreted as indicating differences between models. Note that models for accuracy and response time (RT) included all three groups and sessions A and D, while models for HDDM parameters (drift rate, boundary separation, and non-decision time) included the SI and SW group and all four sessions (A,B,C,D). Bold values indicate the best fitting model.

Model	Accuracy		RT		Drift rate		Boundary separation		Non-decision time	
	ELPD difference	SE	ELPD difference	SE	ELPD difference	SE	ELPD difference	SE	ELPD difference	SE
condition x session x group	0	0	0	0	0	0	0	0	-1.7	5.5
condition + session x group	-14.4	7.5	-54	11.1	-13.1	8.9	-92.7	15.1	-16.1	6.5
condition x session + group	-8.7	6.6	-0.5	4.7	-4.9	6.6	-6.8	6.3	0	0
session + condition x group	-14.4	7.2	-50	10.9	-5.4	7.9	-95.1	15.4	-12.8	7
condition + session + group	-15.8	7.9	-53.8	11.1	-11.9	9.2	-96.8	15.5	-13.6	6.4

Supplementary Table 3. Paired comparisons of posterior distributions of HDDM parameters. Bold values indicate comparisons for which the probability was above 95%.

Condition	Group	session	Drift rate (v)	Boundary separation (a)	Non-decision time (t)	
Single	SW > SI	A	0.8	0.589	0.508	
		B	0.608	0.402	0.772	
		C	0.581	0.445	0.692	
		D	0.994	0.994	0.383	
	SW	A > B	0.0	0.0	0.996	
		A > C	0.018	0.0	0.996	
		A > D	0.0	0.001	0.831	
	SI	A > B	0.0	0.0	0.961	
		A > C	0.001	0.0	0.975	
		A > D	0.0	0.001	0.9	
	Repeat	SW > SI	A	0.709	0.57	0.452
			B	0.996	0.99	0.699
C			0.948	0.688	0.564	
D			1.0	0.999	0.8	
SW		A > B	0.0	0.272	0.931	
		A > C	0.0	0.272	0.975	
		A > D	0.0	0.14	0.999	
SI		A > B	0.0	0.005	0.807	
		A > C	0.007	0.005	0.948	
		A > D	0.009	0.1	0.968	
Switch		SW > SI	A	0.761	0.283	0.961
			B	0.981	0.91	0.909
	C		0.994	0.605	0.936	
	D		0.999	0.861	0.999	
	SW	A > B	0.0	0.414	0.586	
		A > C	0.0	0.414	0.846	
		A > D	0.0	0.317	0.999	
	SI	A > B	0.0	0.005	0.72	
		A > C	0.007	0.005	0.881	
		A > D	0.003	0.1	0.966	

Supplementary Table 4. Changes in activation across all sessions (A–D) in the two training groups (SI vs. SW) for repeat and single trials in the regions of interest (ROIs) defined on the repeat > single contrast in the adult comparison sample. CI indicates 95% credible intervals; bold values indicate estimates whose 95%-CI did not include zero. Dorsal anterior cingulate cortex (dACC), dorsolateral prefrontal cortex (dlPFC), inferior frontal junction (IFJ), superior parietal lobe (SPL)

Effect	Left dACC		Left dlPFC		Left IFJ		Left SPL		Right dACC		Right dlPFC		Right IFJ		Right SPL	
	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI
Intercept	3.01	2.44	2.09	1.49	2.69	2.11	2.41	1.95	2.88	2.32	1.84	2.82	1.76	1.53	2.09	1.50
group: SW vs. SI	0.98	0.22	1.78	0.13	0.95	0.89	1.01	0.32	1.70	0.59	-0.08	1.27	0.92	-0.79	0.07	-0.73
session: B vs. A	0.05	-0.72	0.82	-1	-0.10	-0.59	-0.31	-0.93	0.31	0.11	-0.60	0.80	0.75	-0.4	0.27	0.89
session C vs. A	0.72	0.03	1.43	-0.21	0.57	-0.60	-0.73	-1.39	-0.09	0.26	-0.38	0.93	0.02	-0.21	0.09	-0.72
session D vs. A	-0.04	-0.76	0.69	-0.38	0.41	-0.10	-0.71	-1.33	-0.10	-0.38	-1.04	0.28	-0.4	-0.23	0.44	-2.08
condition: single vs. repeat	-1.23	-1.85	-0.63	-1.3	-1.95	-0.63	-1.4	-1.94	-0.86	-1.11	-1.68	-0.55	-1.17	-0.84	0.40	-1.99
group SW x session B	-0.64	-1.65	0.36	-0.09	1.06	0.09	-0.69	-1.56	0.20	-0.61	-1.55	0.32	0.43	-1.07	-1.53	-0.87
group SW x session C	-1.57	-2.53	-0.65	-0.95	0.11	-0.37	-0.47	-1.35	0.47	-0.99	-1.90	-0.10	-0.64	0.52	-0.69	-1.73
group SW x session D	-1.21	-2.19	-0.23	-0.63	-1.72	0.55	-0.71	-1.61	0.18	-0.82	-1.78	0.12	-0.96	-0.02	0.12	-0.91
group SW x single	-1.04	-1.89	-0.20	-0.14	0.77	0.01	-0.79	-1.57	0.01	-0.63	-1.43	0.14	-0.31	0.37	-0.04	1.04
session B x single	-0.49	-1.44	0.47	0.76	1.83	-0.39	0.34	-0.44	1.12	-0.39	-1.26	0.47	0.02	0.6	0.03	0.92
session C x single	-0.79	-1.71	0.11	0	1.00	-0.24	0.62	-0.17	1.42	-0.21	-1.05	0.64	-0.19	-0.21	1.41	1.40
session D x single	0.06	-0.85	0.99	0.37	1.33	-0.47	0.78	-0.00	1.57	0.21	-0.64	1.05	0.66	0.08	1.15	2.16
group SW x session B x single	0.83	-0.41	2.09	0.09	1.27	-0.29	0.26	-0.85	1.34	0.74	-0.39	1.92	0.53	-0.49	1.37	0.40
group SW x session C x single	1.26	0.05	2.50	0.69	-0.66	1.51	0.4	-0.74	1.51	0.91	-0.23	2.07	1.29	0.54	0.05	-1.23
group SW x session D x single	0.54	-0.72	1.78	-0.22	1.15	0.85	0.2	-0.95	1.32	0.51	-0.66	1.69	0.33	-0.4	-0.32	-1.66

Supplementary Table 5: Changes in activation across all sessions (A – D) in the two training groups (SI vs. SW) for switch and repeat trials in the ROIs defined on the switch > repeat contrast in the adult comparison sample. CI denotes 95%-Credible Intervals; bold values indicate estimates whose 95%-CI did not include zero. Supplementary motor area (SMA)

Effect	Left dACC		Left IFJ		Left Precuneus		Left SMA		Left SPL		Right dACC		Right Precuneus		Right SMA				
	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI			
Intercept	2.01	1.34	2.66	2.98	-0.81	-1.43	-0.19	2.62	1.94	3.28	1.74	1.17	2.29	0.53	1.96	1.29	2.63		
group: SW vs. SI	0.48	-0.40	1.39	1.58	0.36	-0.49	1.22	0.96	0.06	1.87	0.26	-0.51	1.03	0.66	-0.30	0.86	-0.05	1.77	
session: B vs. A	-0.03	-0.75	0.66	-0.99	0.51	-0.19	1.25	0.11	-0.69	0.90	0.03	-0.70	0.77	0.93	0.16	0.3	-0.47	1.07	
session C vs. A	0.84	0.08	1.60	-0.25	-1.02	0.94	0.67	0.67	-0.10	1.45	-0.48	-0.36	1.25	0.36	-0.63	0.4	-0.52	1.35	
session D vs. A	-0.1	-0.87	0.65	0.41	-0.43	1.20	0.38	-0.33	-0.33	1.16	-0.33	-0.18	-0.93	0.38	-0.47	-0.02	-0.91	0.90	
condition: switch vs. repeat	0.59	0.10	1.07	0.71	1.03	0.46	1.63	0.61	0.13	1.11	0.63	0.49	-0.02	1.01	0.83	0.25	0.62	0.09	1.16
group SW x session B	-0.22	-1.17	0.73	0.69	-0.39	1.77	0.26	-0.67	-1.69	0.37	1.11	-1.20	0.73	-0.39	-1.42	0.63	-1.01	-2.00	-0.02
group SW x session C	-1.3	-2.31	-0.31	-0.39	-1.42	0.61	0.07	-0.86	-1.90	0.19	-1.10	-1.86	0.32	-0.14	-1.49	1.19	-0.55	-1.78	0.70
group SW x session D	-0.51	-1.56	0.51	-1.2	-2.28	-0.08	0.1	-0.21	-1.33	0.93	-0.24	-1.48	0.60	-0.19	-1.39	0.99	-0.51	-1.78	0.74
group SW x single	0.01	-0.64	0.66	-0.19	-0.73	0.33	-0.34	-0.09	-0.76	0.55	-0.25	-0.06	0.32	-0.29	-1.10	0.52	-0.18	-0.89	0.54
session B x switch	-0.51	-1.21	0.20	-0.42	-1.04	0.15	-0.24	-0.75	-1.46	-0.05	-0.4	-1.21	0.36	0.08	-0.83	0.96	-0.79	-1.59	0.02
session C x switch	-0.56	-1.25	0.14	-0.29	-0.88	0.31	-0.46	-0.48	-1.19	0.22	-0.38	-0.98	0.25	-0.21	-1.07	0.63	-0.43	-1.19	0.34
session D x switch	0.09	-0.61	0.79	-0.41	-1.01	0.19	-0.52	-0.38	-1.08	0.32	-0.37	-0.96	0.19	0.07	-1.09	0.65	-0.64	-1.42	0.13
group SW x session B x switch	0.22	-0.73	1.18	0.12	-0.64	0.94	-0.23	-1.42	1.00	0.37	0.77	-0.17	1.74	0.56	-0.45	1.61	0.85	-0.21	1.89
group SW x session C x switch	0.41	-0.53	1.33	0.09	-0.67	0.87	0.2	0.22	-0.71	1.16	0.49	-0.31	1.31	0.07	-1.09	1.26	-0.03	-1.09	1.01
group SW x session D x switch	-0.08	-1.05	0.89	-0.21	-1.40	1.40	-0.33	0.53	-0.45	1.56	-0.50	-1.13	1.01	-0.26	-1.46	1.00	0.7	-0.42	1.80

Supplementary Table 6. Details on ROIs defined on the adult comparison sample

Contrast	Hemisphere	ROI	Size	Peak		
Repeat > single	left	dIPFC	243	-44	24	28
		IFJ	381	-42	4	32
		dACC	122	-4	12	52
		SPL	332	-28	-58	48
	right	dIPFC	239	48	30	26
		IFJ	410	38	0	40
		SPL	249	32	-52	50
		dACC	107	8	12	52
Switch > repeat	left	dACC	218	-6	10	50
		SMA	407	-6	8	52
		IFJ	102	-48	2	32
		SPL	509	-32	-52	58
	right	Precuneus	569	-10	-72	40
		dACC	123	12	20	36
		SMA	216	2	2	56
		Precuneus	451	20	-58	6

Supplementary Table 7. Model outputs of performance (accuracy and response times) across all sessions (A–D) in the two training groups (SW vs. SI) for single, repeat, and switch trials (repeat as reference level). CI denotes 95%-Credible Intervals; bold values indicate estimates whose 95%-CI did not include zero.

Effect	Accuracy			RT		
	Estimate	CI		Estimate	CI	
Intercept	0.81	0.77	0.86	1.47	1.41	1.52
condition: single vs. repeat	0.13	0.1	0.16	-0.28	-0.32	-0.23
condition: switch vs. repeat	-0.07	-0.11	-0.04	0.26	0.22	0.3
session: D vs. A	-0.02	-0.07	0.03	-0.02	-0.09	0.04
group: SI vs. PC	-0.02	-0.08	0.03	-0.01	-0.08	0.06
group: SW vs. PC	0.01	-0.04	0.07	0	-0.07	0.07
condition (single vs. repeat) x session (D vs. A)	-0.05	-0.1	0.01	0.01	-0.05	0.07
condition (switch vs. repeat) x session (D vs. A)	0.03	-0.02	0.08	-0.08	-0.14	-0.02
condition (single vs. repeat) x group (SI vs. PC)	-0.03	-0.07	0.01	0.03	-0.03	0.08
condition (switch vs. repeat) x group (SI vs. PC)	-0.01	-0.05	0.03	-0.01	-0.06	0.05
condition (single vs. repeat) x group (SW vs. PC)	-0.04	-0.08	0	0.02	-0.03	0.07
condition (switch vs. repeat) x group (SW vs. PC)	-0.02	-0.06	0.02	0.01	-0.04	0.06
session (D vs. A) x group (SI vs. PC)	0.03	-0.03	0.09	-0.07	-0.15	0.01
session (D vs. A) x group (SW vs. PC)	0.08	0.02	0.14	-0.09	-0.18	-0.01
condition (single vs. repeat) x group (SI vs. PC) x session (D vs. A)	0.07	0.01	0.13	0.05	-0.02	0.13
condition (switch vs. repeat) x group (SI vs. PC) x session (D vs. A)	-0.01	-0.07	0.05	-0.01	-0.09	0.07
condition (single vs. repeat) x group (SW vs. PC) x session (D vs. A)	0.01	-0.05	0.08	0.06	-0.02	0.14
condition (switch vs. repeat) x group (SW vs. PC) x session (D vs. A)	0.02	-0.04	0.08	-0.01	-0.08	0.07

Supplementary Table 8. Complete model outputs drift diffusion parameters (drift rate, boundary separation, non-decision time) across all sessions (A–D) in the two training groups (SW vs. SI) for single, repeat, and switch trials (repeat as reference level). CI denotes 95%-Credible Intervals; bold values indicate estimates whose 95%-CI did not include zero.

Effect	Drift rate (v)			Boundary separation (a)			Non-decision time (t)		
	Estimate	CI		Estimate	CI		Estimate	CI	
Intercept	0.93	0.78	1.08	2.07	2	2.14	0.79	0.75	0.83
condition: single vs. repeat	0.69	0.58	0.81	0.1	0.01	0.18	-0.1	-0.13	-0.06
condition: switch vs. repeat	-0.28	-0.39	-0.18	-0.17	-0.25	-0.09	0.22	0.17	0.27
session: B vs. A	0.27	0.13	0.41	0.04	-0.05	0.13	-0.05	-0.08	-0.02
session: C vs. A	0.28	0.13	0.43	0.08	-0.01	0.17	-0.07	-0.11	-0.04
session: D vs. A	-0.02	-0.19	0.14	-0.07	-0.17	0.03	-0.08	-0.11	-0.05
group: SW vs. SI	0.07	-0.15	0.29	0	-0.1	0.11	-0.01	-0.07	0.05
session B x single	0.29	0.13	0.44	0.53	0.42	0.65	-0.06	-0.1	-0.01
session B x switch	0.09	-0.05	0.24	-0.02	-0.14	0.1	0.02	-0.03	0.08
session C x single	0.04	-0.11	0.19	0.26	0.14	0.37	-0.03	-0.08	0.02
session C x switch	0.02	-0.13	0.16	-0.04	-0.15	0.08	0.02	-0.05	0.08
session D x single	0.03	-0.12	0.18	0.03	-0.09	0.14	0.04	-0.01	0.08
session D x switch	0.15	0.01	0.29	0.01	-0.1	0.12	-0.02	-0.08	0.04
single x group SW	0.02	-0.14	0.18	0	-0.12	0.12	0	-0.04	0.05
switch x group SW	0.02	-0.13	0.17	-0.05	-0.16	0.07	0.09	0.02	0.16
session B x group SW	0.24	0.04	0.45	0.2	0.06	0.32	0.01	-0.04	0.05
session C x group SW	0.13	-0.09	0.35	0.04	-0.1	0.17	0.01	-0.04	0.06
session D x group SW	0.34	0.1	0.58	0.22	0.07	0.36	-0.01	-0.05	0.04
session B x single x group SW	-0.3	-0.52	-0.08	-0.23	-0.4	-0.06	0.03	-0.03	0.1
session B x switch x group SW	-0.08	-0.28	0.13	-0.05	-0.22	0.12	-0.08	-0.16	0
session C x single x group SW	-0.17	-0.39	0.04	-0.06	-0.23	0.11	0.03	-0.04	0.1
session C x switch x group SW	0.05	-0.16	0.26	0.03	-0.14	0.19	-0.08	-0.16	0.01
session C x single x group SW	-0.14	-0.35	0.08	-0.01	-0.18	0.15	0.01	-0.06	0.07
session D x switch x group SW	-0.06	-0.27	0.15	-0.08	-0.25	0.08	-0.04	-0.12	0.05

Supplementary Table 9. Changes in activation between session A and D in all three groups (SI vs. PC [passive control group], SW vs. PC) for repeat and single trials in the ROIs defined on the repeat > single contrast at session A. CI denotes 95%-Credible Intervals; bold values indicate estimates whose 95%-CI did not include zero.

Effect	Left IFJ		Left SPL		left dlPFC		Right IFJ		Right SPL	
	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI
Intercept	0.62	0.11	1.13	0.5	1.45	0.7	0.5	0.05	0.56	0.04
group: SI vs. PC	0	-0.69	0.69	-0.61	0.69	1.3	-0.1	-0.72	0.01	-0.73
group: SW vs. PC	0.14	-0.53	0.83	-0.28	0.97	1.37	-0.45	-1.06	0.15	-0.57
session: D vs. A	0.28	-0.27	0.82	-0.2	1.04	1.33	0.15	-0.41	0.37	-0.31
condition: repeat vs. single	1.99	1.4	2.56	2.04	3.36	2.63	1.6	1	2.26	1.61
groupSI x sessionD	-0.22	-0.95	0.51	-1.24	0.51	0.4	-0.01	-0.78	-0.21	-1.15
groupSW x sessionD	-0.84	-1.6	-0.07	-1.75	-0.02	-0.5	-0.28	-1.05	-0.53	-1.44
group SI x repeat	-0.95	-1.7	-0.18	-1.93	-0.13	0.25	-0.69	-1.48	-0.47	-1.42
group SW x repeat	-1.06	-1.86	-0.26	-1.04	0.76	0.38	-0.81	-1.6	-0.55	-1.46
session D x repeat	-0.09	-0.89	0.7	-0.66	-1.59	0.02	-0.58	-1.43	-0.26	-2.15
group SI x session D x repeat	0.35	-0.76	1.43	-1.41	1.18	2.01	0.37	-0.77	-0.02	-1.45
groupSW x session D x repeat	0.71	-0.42	1.82	-0.48	0.8	2.25	0.46	-0.71	0.12	-1.22

Supplementary Table 10. Changes in activation across all sessions (A, B, C, and D) in the two practice groups (SI vs. SW) for repeat and single trials in the ROIs defined on the repeat > single contrast at session A. CI denotes 95%-Credible Intervals; bold values indicate estimates whose 95%-CI did not include zero.

Effect	Left IFJ		Left SPL		left dlPFC		Right IFJ		Right SPL	
	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI
Intercept	0.67	0.26	1.05	0.64	0.76	0.32	0.44	0.03	0.63	0.16
group: SW vs. SI	0.11	-0.46	0.28	-0.28	0	-0.64	-0.37	-0.90	0.09	-0.60
session: B vs. A	-0.03	-0.49	-0.03	-0.58	-0.25	-0.88	0.2	-0.30	0.49	-0.09
session C vs. A	-0.17	-0.62	-0.09	-0.67	-0.22	-0.85	-0.09	-0.61	-0.04	-0.62
session D vs. A	0.01	-0.45	0.04	-0.54	0.02	-0.61	0.14	-0.37	0.06	-0.57
condition: repeat vs. single	1.06	0.61	1.68	1.11	1.28	0.65	0.95	0.45	1.78	1.16
group SW x session B	-0.13	-0.72	-0.4	-1.18	0.08	-0.76	0	-0.69	-0.67	-1.47
group SW x session C	0.03	-0.58	-0.1	-0.90	-0.22	-1.06	0.4	-0.29	-0.11	-0.90
group SW x session D	-0.57	-1.20	-0.53	-1.32	-0.87	-1.79	-0.26	-0.98	-0.22	-1.07
group SW x repeat	-0.2	-0.87	0.83	-0.01	0.15	-0.70	-0.2	-0.93	-0.09	-0.93
session B x repeat	-0.57	-1.32	-0.33	-1.15	-0.98	-2.02	-0.47	-1.27	-0.37	-1.30
session C x repeat	0.16	-0.52	-0.69	-1.54	-0.03	-0.96	0.02	-0.75	-1.06	-2.03
session D x repeat	0.21	-0.48	-0.81	-1.67	-0.42	-1.38	-0.27	-1.05	-1.15	-2.09
group SW x session B x repeat	0.25	-0.75	-0.25	-1.40	0.03	-1.36	0.18	-0.87	-0.07	-1.30
group SW x session C x repeat	-0.25	-1.26	-0.59	-1.77	-0.83	-2.12	-0.72	-1.75	0.14	-1.12
group SW x session D x repeat	0.45	-0.55	-0.29	-1.51	0.31	-1.01	0.13	-0.91	0.11	-1.19
										1.37

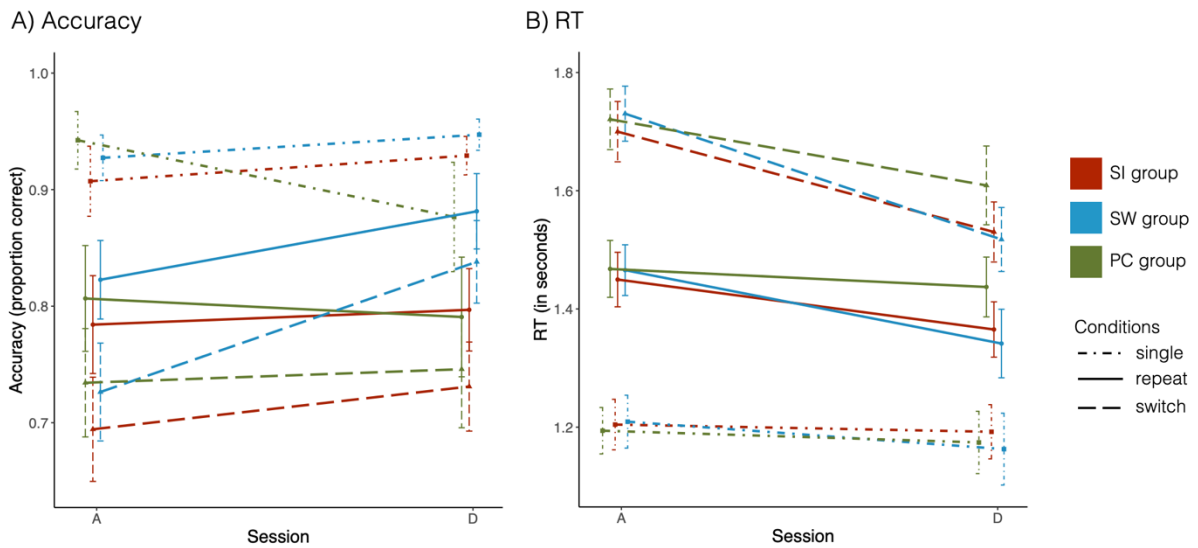
Supplementary Table 11. Changes in activation between session A and D in all three groups (SI vs. PC, SW vs. PC) for switch and repeat trials in the ROIs defined on the switch > repeat contrast at session A. CI denotes 95%-Credible Intervals; bold values indicate estimates whose 95%-CI did not include zero.

Effect	Left IFJ		Left SPL		left Precuneus		Right Precuneus		Right SPL			
	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI		
Intercept	3.45	2.42	3.34	2.71	-0.09	-0.80	1.03	0.19	1.87	0.09	-0.55	0.74
group: SI vs. PC	-1.07	-2.52	-0.79	-1.68	-1.16	-2.13	-1.59	-2.75	-0.5	-0.19	-1.05	0.67
group: SW vs. PC	-0.84	-2.21	-0.08	-0.95	-0.61	-1.54	-0.87	-2	0.25	-0.25	-1.1	0.58
session: D vs. A	0.16	-0.74	-0.35	-1.11	-0.34	-1.16	0.61	-1.48	0.29	-0.56	-1.28	0.16
condition: switch vs. repeat	0.24	-0.26	0.19	-0.25	0.37	-0.25	0.57	0.01	1.11	0.3	-0.14	0.74
groupSI x sessionD	-0.06	-1.31	-0.29	-1.34	1.26	0.13	1.13	-0.09	2.36	0.03	-0.97	1.04
groupSW x sessionD	-0.66	-1.83	-0.82	-1.85	1.36	0.18	0.9	-0.33	2.12	0.08	-0.92	1.07
group SI x switch	0.46	-0.18	0.62	0	0.72	-0.14	0.32	-0.46	1.13	0.16	-0.4	0.73
group SW x switch	0.31	-0.32	0.26	-0.38	0.58	-0.28	0.07	-0.69	0.83	0.08	-0.49	0.65
session D x switch	0.59	-0.12	0.07	-0.57	0.48	-0.39	0.29	-0.54	1.12	-0.34	-0.94	0.27
group SI x session D x switch	-0.86	-1.82	-0.56	-1.52	-0.97	-2.23	-0.46	-1.62	0.69	-0.06	-0.88	0.74
groupSW x session D x switch	-0.5	-1.39	-0.12	-1.03	-1.74	-2.98	-0.81	-1.94	0.3	-0.09	-0.89	0.71

Supplementary Table 12: Changes in activation across all sessions (A, B, C, and D) in the two practice groups (SI vs. SW) for switch and repeat trials in the ROIs defined on the switch > repeat contrast at session A. CI denotes 95%-Credible Intervals.

Effect	Left IFJ		Left SPL		left Precuneus		Right Precuneus		Right SPL		
	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	Estimate	CI	
Intercept	2.51	1.52	2.57	1.97	-1.86	-0.54	-0.41	-1.15	0.34	-0.03	0.46
group: SW vs. SI	0.21	-1.15	0.67	-0.15	-0.40	1.38	0.64	-0.45	1.68	-0.22	0.44
session: B vs. A	-1.03	-1.89	-0.39	-1.10	-0.03	1.6	0.95	0.21	1.69	-0.26	0.32
session C vs. A	-0.23	-1.11	-0.59	-1.34	-0.30	1.47	0.57	-0.40	1.56	-0.24	0.42
session D vs. A	-0.09	-1.03	-0.67	-1.37	-0.12	1.69	0.4	-0.47	1.28	-0.61	-0.06
condition: switch vs. repeat	0.66	0.29	0.76	0.36	0.53	1.73	0.98	0.42	1.56	0.44	0.79
group SW x session B	0.87	-0.22	0.01	-0.91	-0.84	1.28	-0.47	-1.47	0.54	0.13	0.89
group SW x session C	-0.47	-1.65	-0.39	-1.37	-1.25	1.1	-0.29	-1.63	1.06	0.12	0.78
group SW x session D	-0.59	-1.79	-0.5	-1.48	-0.99	1.45	-0.22	-1.44	1.04	0.24	1.03
group SW x switch	-0.1	-0.61	-0.29	-0.88	-1.00	0.64	-0.47	-1.27	0.32	-0.07	0.43
session B x switch	-0.26	-0.83	-0.51	-1.11	-1.12	0.66	0	-0.89	0.85	-0.28	0.23
session C x switch	0.09	-0.67	0.39	-0.98	-1.22	0.54	-0.31	-1.16	0.53	-0.42	0.11
session D x switch	-0.22	-0.82	-0.44	-1.04	-1.39	0.39	-0.27	-1.13	0.58	-0.39	0.12
group SW x session B x switch	-0.09	-0.86	0.35	-0.45	-1.82	0.58	-0.27	-1.42	0.91	-0.11	0.59
group SW x session C x switch	-0.08	-0.82	0.62	-0.17	-1.33	1.07	0.19	-0.99	1.36	0.1	0.84
group SW x session D x switch	0.28	-0.49	0.39	-0.44	-1.94	0.52	-0.14	-1.32	1.06	-0.01	0.71

Supplementary Figure 1: Training related change in condition-specific performance. Panel A shows accuracy, panel B shows RTs. Mixing costs (i.e., lower accuracy and longer RTs on repeat than single trials) and switch costs (i.e., lower accuracy and longer RTs on switch than repeat trials) were evident across both sessions and all groups. Switch costs in RTs decreased from session A to B across all groups. Overall performance improved from session A to D in accuracy (A) and RTs (B) in the SW group (blue) relative to the PC group (green). The SI group (red) did not differ in change from the PC group for switch and repeat trials, and maintained higher performance on single trials. Error bars denote 95%-confidence intervals.



Supplementary Results 1: Seed-to-voxel connectivity

Connectivity associated with mixing demand

Whole-brain seed-to-voxel analyses with seeds in the left IFJ and SPL for repeat > single did not reveal any clusters that showed changes in connectivity with training ($p < .05$ FDR-corrected, voxel threshold at $p < .001$ uncorrected). As noted in the preregistration, we additionally conducted seed-to-voxel analyses for regions that showed changes in activation with training. More specifically, we analyzed whole-brain connectivity for a seed in the left dIPFC. No clusters showed changes in connectivity with the dIPFC with training ($p < .05$ FDR-corrected, voxel threshold at $p < .001$ uncorrected).

Connectivity associated with switch demand

The whole-brain seed-to-voxel analysis with a seed in the left IFJ revealed a cluster in the left angular gyrus that showed changes in connectivity for switch > repeat with training ($p < .05$ FDR-corrected, voxel threshold at $p < .001$ uncorrected), such that condition differences increased from session A to C in the SI group and then decreased again at session D, while condition differences in the SW group only increased at session D (see Figure SR1.1). There was no significant cluster for the left SPL seed region.

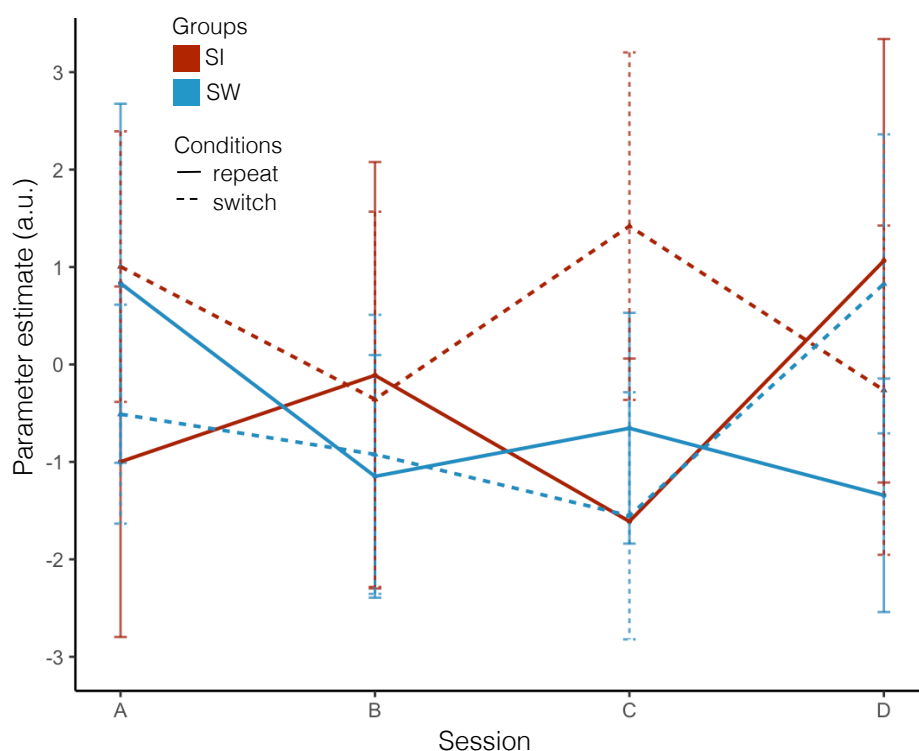


Figure SR1.1: Change in connectivity between the IFJ and a cluster in the left angular gyrus (AG). PPI parameters for the connection between the seed in the IFJ and the cluster in the left AG that showed change in the connectivity difference between repeat and switch trials. Error bars denote 95%-confidence intervals. The single-task (SI) practice group is shown in red and the task-switching practice group in blue. Connectivity for repeat trials is shown in the solid line and for switch trials in the long-dashed line for each session.

Supplementary Results 2: IFJ to IPFC connectivity

Objective. Based on previous findings in age differences between children and adults, where we showed that children showed a greater increase in connectivity between the IFJ and the lateral PFC from single to repeat blocks (Schwarze et al., 2023), we tested whether this connectivity changed with practice.

Methods. For our analyses to be less dependent on the precise location of the IPFC cluster at the first timepoint, we defined two anatomical ROIs (in the frontal polar cortex [FPC] and the middle frontal gyrus [MFG]) based on the Harvard-Oxford Atlas (Makris et al., 2006) thresholded at a probability of 30%. In our previous analyses, we had used these two anatomical regions to restrict the cluster that showed greater connectivity with the IFJ in children compared to adults. Thus, the analyses retained the general location of the cluster without being too dependent on the precise location. We extracted PPI parameters for these ROIs from the session-specific repeat > single PPI model described in the main analyses and subsequently analyzed these for changes between sessions A and D and for differences between the SI, the SW, and the PC groups. Models included random intercepts for participants and random slopes for sessions.

Results. Neither the IFJ to FPC, nor the IFJ to MFG connectivity showed changes with practice. However, connectivity for repeat trials was greater than for single trials across sessions and groups (FPC: est. = 1.48; 95%-CI: 0.19; 2.74; MFG: est. = 2.26; 95%-CI: 1.04; 3.50), suggesting that also after practice children involved these additional regions with increased mixing demand on repeat trials (see Table SR2.1).

Table SR2.1 Model outputs of PPI parameters across sessions A and D, the three groups (SI vs. PC, SW vs. PC), and repeat and single trials. CI denotes 95%-Credible Intervals; bold values indicate estimates whose 95%-CI did not include zero.

Effect	IFJ – FPC			IFJ – MFG		
	Estimate	CI	CI	Estimate	CI	CI
Intercept	-1.73	-2.86	-0.61	-1.84	-2.94	-0.73
group: SI vs. PC	0.33	-1.16	1.84	0.38	-1.11	1.87
group: SW vs. PC	1.17	-0.31	2.63	1.67	0.22	3.14
session: D vs. A	0.91	-0.49	2.32	1.08	-0.24	2.41
condition: repeat vs. single	1.48	0.19	2.74	2.26	1.04	3.5
groupSI x sessionD	-0.07	-1.98	1.82	-1.04	-2.85	0.78
groupSW x sessionD	-0.59	-2.46	1.27	-1.46	-3.3	0.31
group SI x repeat	0.4	-1.35	2.1	-0.56	-2.21	1.13
group SW x repeat	-0.25	-1.94	1.42	-1.02	-2.59	0.57
session D x repeat	-0.33	-2.19	1.48	-1.18	-2.93	0.57
group SI x session D x repeat	-0.31	-2.82	2.24	0.87	-1.57	3.25
group SW x session D x repeat	-0.33	-2.77	2.11	0.47	-1.83	2.79

Supplementary Results 3: Changes in deviation score and association with changes in connectivity

Hypotheses: For detailed hypotheses see pre-registrations at <https://osf.io/by4zq/>. In brief, based on results of the pre-training session (Schwarze et al., 2023), we expected changes in IFJ–IPFC connectivity to depend on how adult-like the pre-training activation of a child was (Hypothesis 5). Additionally, we expected the alignment of changes in activation pattern and connectivity to be associated with practice-related changes in performance (Hypothesis 6).

Methods:

For detailed methods, see pre-registrations at <https://osf.io/by4zq/>.

Deviation Score. Briefly, we computed functional activation deviation scores for repeat > single and switch > repeat activation based on Düzel et al. (2011; see also Fandakova et al. 2015) for each child relative to the adult average of the respective contrast. A more negative score represents more adult-like activation patterns, and a more positive score represents less adult-like patterns.

Deviation score and change in connectivity. To test whether change in IFJ–IPFC connectivity depended on how adult-like a child’s repeat > single activation at session A was, we performed Bayesian linear mixed modeling with IFJ–IPFC connectivity as the dependent variable, and condition (single vs. repeat), session (A vs. D), and deviation score at the first session (high vs. low, based on a median split) as fixed effects, allowing for all interactions. We analyzed only the two training groups (i.e., SW and SI). The model further included a random intercept of individuals and random slope of session.

Given that neither deviation scores nor IFJ–IPFC connectivity changed with practice, we did not further analyze the preregistered Hypothesis 6.

Results: Deviation scores did not change over the course of practice, neither for the repeat > single contrast (Figure SR3.1A), nor the switch repeat contrast (Figure SR3.1B; all 95%-CI included zero). Model outputs are shown in Table SR3.1 for comparisons of session A and D among the three groups (SI vs. PC and SW vs. PC) and in Table SR3.2 for comparisons across all sessions (A, B, C, and D) for the two practice groups (SW vs. SI). The change in connectivity between sessions A and D did not differ between children who showed more and those who showed less adult-like activation patterns at session A (see Table SR3.3).

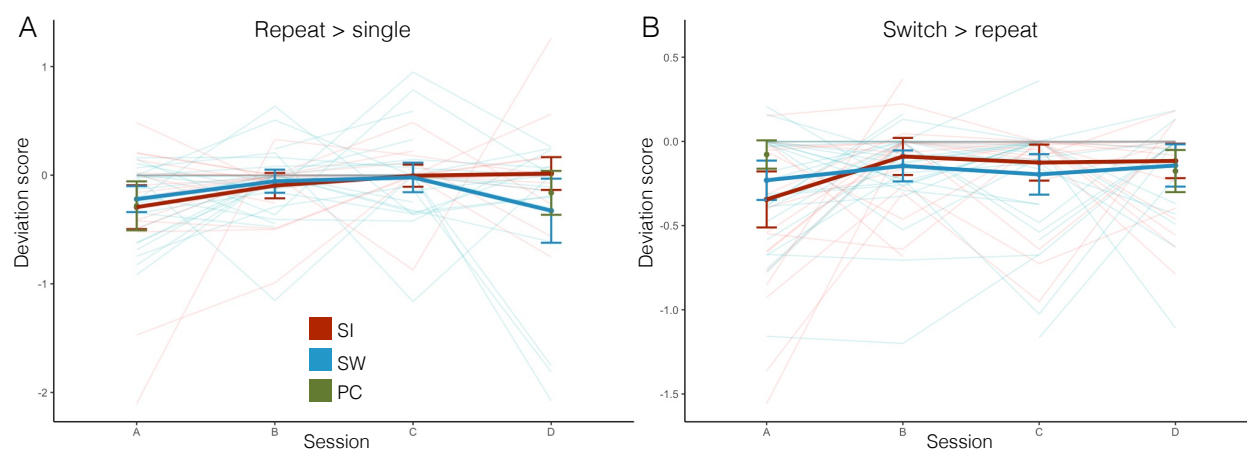


Figure SR3.1 Changes in deviation score. (A) Change in deviation score for the repeat > single contrast. (B) Change in deviation score for the switch > repeat contrast. Higher values denote less adult-like activation pattern. Thin lines show individual trajectories. The passive control (PC) group is shown in green, the single-task practice (SI) group in red, and the task-switching practice (SW) group in blue. Error bars denote 95%-confidence intervals.

Table SR3.1. Model output for comparisons of session A and D among the three groups (SI vs. PC and SW vs. PC). CI denotes 95%-Credible Intervals

Effect	Repeat > Single			Switch > Repeat		
	Estimate	CI		Estimate	CI	
Intercept	-0.01	-0.04	0.02	-0.01	-0.10	0.02
session: D vs. A	-0.01	-0.05	0.04	0	-0.06	0.06
group: SI vs. PC	-0.01	-0.07	0.03	-0.03	-0.22	0.01
group: SW vs. PC	0	-0.05	0.04	-0.01	-0.09	0.03
group SI x session D	0.02	-0.04	0.10	0.03	-0.03	0.23
group SW x session D	0.01	-0.05	0.08	0	-0.06	0.11

Table SR3.2. Model output for comparisons across all sessions (A, B, C, and D) for the two practice groups (SW vs. SI). CI denotes 95%-Credible Intervals

Effect	Repeat > Single			Switch > Repeat		
	Estimate	CI		Estimate	CI	
Intercept	-0.01	-0.05	0.01	-0.03	-0.07	-0.00
session B	0.01	-0.03	0.05	0.02	-0.04	0.08
session C	0.01	-0.02	0.06	0.02	-0.03	0.07
session D	0.01	-0.03	0.06	0.03	-0.02	0.08
group SW vs. SI	0.01	-0.03	0.05	0.02	-0.02	0.07
session B x group SW	0	-0.06	0.04	-0.05	-0.13	0.01
session C x group SW	-0.01	-0.07	0.04	-0.03	-0.09	0.03
session D x group SW	-0.01	-0.07	0.05	-0.03	-0.09	0.03

Table SR3.3. Model output for connectivity at session A and D predicted by deviation score (median split) at session A across both practice groups. CI denotes 95%-Credible Intervals; bold values indicate estimates whose 95%-CI did not include zero.

Effect	IFJ – FPC			IFJ – MFG		
	Estimate	CI		Estimate	CI	
Intercept	-0.52	-1.54	0.5	0.08	-1.01	1.18
session: D vs. A	-0.12	-1.55	1.28	-1.19	-2.61	0.21
condition: repeat vs. single	1.13	-0.02	2.29	0.52	-0.63	1.67
deviation score group: more vs. less adult-like	-0.78	-2.18	0.6	-1.46	-2.94	-0.02
session D x repeat	0.13	-1.7	2	0.83	-0.98	2.69
session D x group more adult-like	1.47	-0.44	3.39	1.86	-0.05	3.78
group more adult-like x repeat	0.77	-0.78	2.34	1.7	0.16	3.25
session D x repeat x group more adult-like	-1.45	-3.96	1.03	-2.39	-4.95	0.12

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