

## Supplementary materials

Supplementary Table 1. Features of sleep macrostructure by group and p-value of ANCOVA including level of education as covariate.

	Cognition +		Cognition -		p
	Mean	SD	Mean	SD	
Total sleep duration (min)	423.3	± 75.5	427.5	± 77.0	0.741
Total W duration (min)	55.1	± 49.8	69.0	± 45.0	0.026 *
Total REM duration (min)	60.2	± 29.4	64.0	± 28.9	0.718
Total N1 duration (min)	75.8	± 48.8	80.7	± 51.8	0.453
Total N2 duration (min)	200.7	± 55.4	188.6	± 59.3	0.083
Total N3 duration (min)	30.9	± 33.6	25.3	± 27.9	0.418
Relative W duration (%)	12.9	± 10.6	16.4	± 10.6	0.016 *
Relative REM duration (%)	14.0	± 6.0	14.9	± 6.1	0.671
Relative N1 duration (%)	17.8	± 10.5	18.5	± 10.3	0.582
Relative N2 duration (%)	47.7	± 11.3	44.2	± 12.1	0.028 *
Relative N3 duration (%)	7.4	± 8.1	5.9	± 6.4	0.327
Number of W episodes	14.4	± 5.2	14.1	± 5.4	0.888
Number of REM episodes	4.5	± 1.8	4.6	± 2.1	0.727
Number of N1 episodes	16.5	± 5.4	16.2	± 4.8	0.636
Number of N2 episodes	10.3	± 3.9	10.3	± 3.7	0.602
Number of N3 episodes	4.1	± 3.4	3.7	± 3.3	0.643
Mean W duration (min)	10.8	± 5.7	12.1	± 5.0	0.066
Mean REM duration (min)	19.9	± 5.7	21.3	± 8.2	0.394
Mean N1 duration (min)	13.8	± 7.2	14.5	± 10.9	0.392
Mean N2 duration (min)	34.1	± 17.8	30.3	± 11.7	0.090
Mean N3 duration (min)	15.1	± 7.2	14.4	± 6.4	0.652
Sleep latency (min)	12.9	± 13.1	14.9	± 16.0	0.528
REM sleep latency (min)	90.9	± 52.5	91.7	± 58.0	0.789
Sleep efficiency (%)	84.4	± 10.9	80.7	± 11.2	0.018 *

\*Cognition +: positive cognitive change. \*Cognition -: negative cognitive change. \*p: p-values of ANCOVA.

Supplementary Table 2. Feature of EEG rhythmicity during N2 sleep by group and p-value of ANCOVA including level of education as covariate.

Band-power in N2	Channel	Cognition +		Cognition -		p
		Mean	SD	Mean	SD	
Slow waves (0.5–1.5 Hz)	F3	93.5	± 70.7	117.3	± 87.4	0.022 *
	F4	99.1	± 76.4	121.4	± 88.2	0.028 *
	C3	64.1	± 48.5	74.9	± 47.2	0.044 *
	C4	64.0	± 45.5	77.9	± 46.0	0.016 *
	O1	17.2	± 15.3	25.8	± 19.4	0.001 *
	O2	21.0	± 21.2	26.2	± 19.2	0.047 *
Delta (1.5–4 Hz)	F3	156.4	± 117.2	173.1	± 98.5	0.180
	F4	172.1	± 127.1	183.8	± 103.2	0.280
	C3	123.6	± 89.7	128.7	± 68.5	0.298
	C4	128.2	± 93.9	138.5	± 76.2	0.209
	O1	28.3	± 26.3	36.2	± 23.1	0.024 *
	O2	34.0	± 33.4	39.1	± 27.5	0.203
Theta (4–7.5 Hz)	F3	50.1	± 29.1	54.7	± 19.7	0.170
	F4	57.2	± 35.3	59.9	± 22.0	0.368
	C3	50.1	± 31.5	51.6	± 20.5	0.543
	C4	52.3	± 33.6	56.2	± 25.4	0.254
	O1	20.4	± 19.2	25.0	± 18.8	0.129
	O2	25.3	± 25.3	28.4	± 26.2	0.402
Alpha (7.5–11 Hz)	F3	25.0	± 18.3	29.2	± 17.6	0.093
	F4	28.3	± 23.1	30.7	± 18.1	0.304
	C3	24.4	± 15.6	26.9	± 17.7	0.260
	C4	24.8	± 16.1	28.1	± 17.6	0.166
	O1	9.2	± 7.6	11.3	± 8.8	0.090
	O2	10.6	± 8.9	12.2	± 10.4	0.244
Sigma (11–15 Hz)	F3	19.2	± 12.2	20.2	± 10.4	0.604
	F4	20.9	± 13.5	21.7	± 11.9	0.747
	C3	20.5	± 13.2	21.3	± 11.9	0.551
	C4	21.0	± 13.6	22.3	± 12.3	0.515
	O1	5.9	± 5.1	6.6	± 4.4	0.280
	O2	6.6	± 5.9	6.9	± 4.7	0.628
Beta (15–30 Hz)	F3	14.7	± 9.4	13.1	± 5.9	0.113
	F4	15.8	± 10.6	14.0	± 6.5	0.111
	C3	14.5	± 8.1	13.8	± 7.0	0.509
	C4	14.7	± 7.7	14.5	± 7.4	0.694
	O1	5.6	± 4.8	6.0	± 4.4	0.589
	O2	6.1	± 5.3	6.1	± 4.5	0.869

'Cognition +': positive cognitive change. 'Cognition -': negative cognitive change. 'p': p-values of ANCOVA.

Supplementary Table 3. Features of functional connectivity in REM by group and p-value of ANCOVA including level of education as covariate.

Coherence in REM	Channel	Cognition +		Cognition -		p
		Mean	SD	Mean	SD	
Slow waves (0.5–1.5 Hz)	F3-F4	0.76	± 0.13	0.76	± 0.13	0.755
	C3-C4	0.80	± 0.11	0.78	± 0.11	0.318
	O1-O2	0.69	± 0.14	0.65	± 0.18	0.066
Delta (1.5–4 Hz)	F3-F4	0.83	± 0.09	0.81	± 0.11	0.258
	C3-C4	0.82	± 0.09	0.78	± 0.11	0.021 *
	O1-O2	0.67	± 0.13	0.62	± 0.17	0.017 *
Theta (4–7.5 Hz)	F3-F4	0.81	± 0.09	0.80	± 0.10	0.306
	C3-C4	0.75	± 0.12	0.71	± 0.12	0.032 *
	O1-O2	0.59	± 0.15	0.55	± 0.16	0.059
Alpha (7.5–11 Hz)	F3-F4	0.76	± 0.10	0.74	± 0.11	0.219
	C3-C4	0.66	± 0.14	0.61	± 0.14	0.030 *
	O1-O2	0.53	± 0.15	0.51	± 0.17	0.264
Sigma (11–15 Hz)	F3-F4	0.71	± 0.11	0.70	± 0.11	0.346
	C3-C4	0.63	± 0.15	0.56	± 0.14	0.017 *
	O1-O2	0.51	± 0.16	0.49	± 0.16	0.292
Beta (15–30 Hz)	F3-F4	0.60	± 0.13	0.59	± 0.13	0.846
	C3-C4	0.55	± 0.16	0.50	± 0.13	0.034 *
	O1-O2	0.46	± 0.16	0.46	± 0.17	0.713

\*Cognition +: positive cognitive change. \*Cognition -: negative cognitive change. \*p: p-values of ANCOVA.