

Static and dynamic comparison of nonlinear system dynamics across tasks

To investigate both static and dynamic differences in nonlinear system dynamics across various tasks, we analyzed the variation in condition differences (joint – solitary) for nonlinear measures and their power spectral densities (PSDs) across seven tasks using an LMM. The fixed effects in the model included the between-subject factor *Sex* (female vs. male) and the within-subject factors *Task* (seven levels: KISS, EC, EO, SP, CP, RM, MS) and *Site* (F, C, P, LT, RT), along with their interactions. Random effects were specified to account for the repeated-measures structure of the data.

Because this model targets the interaction between condition and task, it directly captures how the joint–solitary differences vary across different types of social engagement. However, to aid interpretation and to identify the specific contribution of each task to the observed interaction effects, we additionally conducted follow-up analyses focusing on the *joint* condition alone. These supplementary models tested the variation in nonlinear measures across tasks under joint performance conditions only, thereby offering a clearer picture of task-specific modulation of interpersonal dynamics.

The results—reflecting task-related changes in dimensionality and nonlinear coupling across joint and solitary conditions, as well as their differences during kissing, resting state (EC vs. EO), pendulum observation (SP vs. CP), and music listening (RM vs. MS)—are presented in Supplementary Table 3 and Supplementary Figure 2. Although the solitary condition was not analyzed separately in the statistical models, its box plots are included to provide a more comprehensive visual overview. For clarity and focus, the current analysis is limited to power spectral density (PSD) values in the slow frequency band (f1), which previously revealed the most prominent differences.

As shown in Supplementary Table 3, the main effect *Condition* was significant for all within- and between-brain measures, both for condition differences and for the joint condition alone, with the exception of $PCCD_{f1}$ within brains under the joint condition. For within-brain

measures—particularly for condition differences—there was also a significant *Sex* $\times$ *Task* interaction, indicating sex-specific differences in neural dynamics (see Supplementary Table 3 for details). Notably, dynamic complexity (*PD2*) was highest during resting with EO and during both pendulum conditions compared to all other conditions, which were conducted with EC. However, the largest joint–solitary differences in *PD2* occurred during kissing. In contrast, within-brain coupling exhibited the opposite pattern, being higher during EC conditions (e.g., rest with EC, kissing, and music listening) than during EO conditions. Between-brain coupling was generally highest in EC conditions, with the largest condition differences during kissing—particularly for PSD measures (*PTI_{f1}* and *PCCD_{f1}*). Sidak-adjusted post hoc comparisons for the main effect of *Condition* largely confirmed these patterns (see Supplementary Tables 4 and 5 for details).

Linear synchronization analyses

Methods

To complement the nonlinear analyses, we additionally computed the *Phase Synchronization Index (PSI)* as a conventional linear measure of intra- and inter-brain synchronization (cf. [16]). *PSI* was calculated within two frequency bands—*theta* (3.5–6.5 Hz) and *alpha* (6.5–13.5 Hz)—which were previously found to be relevant during kissing [11].

EEG signals were first band-pass filtered using an elliptic infinite impulse response filter centered at $f_c = 5$ Hz for theta and $f_c = 10$ Hz for alpha. The instantaneous phase of each signal was then extracted via the fast Hilbert transform. *PSI* was computed according to the following formula:

$$PSI_{mn}(f_i) = \left| \frac{1}{K} \sum_{k=1}^K e^{j(\varphi_m(f_i, k) - \varphi_n(f_i, k))} \right|, \quad (1)$$

where $\varphi_m(f_i, k)$ and $\varphi_n(f_i, k)$ denote the instantaneous phases of signals m and n at frequency f_i across K data points within a given segment.

PSI was calculated using a moving time window of 2000 ms width and a 200-ms time delay between all electrode pairs within and between the participants' brains. Overall, 91 time windows related to the corresponding EEG sequence were collected by this shifting procedure. For statistical analyses, *PSI* values were first averaged across all time windows and then averaged across all connections from each electrode to all other electrodes either within the same brain (intra-brain *PSI*) or across brains (inter-brain *PSI*). These values were then aggregated across the five regional sites defined in the main *Methods* section (F, C, P, LT, and RT).

Like nonlinear coupling measures, *PSI* values were statistically analyzed using the same Linear Mixed Model (LMM) design. Fixed effects included the between-subject factor *Sex* (female vs. male) and the within-subject factors *Condition* (joint vs. solitary), *Site* (F, C, P, LT, RT), and *Task* (Rest: EC vs. EO; Pendulum: SP vs. CP; Music: RM vs. MS), along with their interactions. For the kissing task, only the within-subject factors *Condition* and *Site* were

included. Fixed effects included the between-subject factor *Sex* (female vs. male) and the within-subject factors *Condition* (joint vs. solitary), *Task* (Rest: EC vs. EO; Pendulum: SP vs. CP; Music: RM vs. MS), and *Site* (F, C, P, LT, RT), along with their interactions. For the kissing task, only the within-subject factors *Condition* and *Site* were included.

Results

The results of linear synchronization measured by *PSI* for theta and alpha frequency bands, comparing solitary and joint conditions during kissing, resting state, pendulum observation, and music listening, are presented in Supplementary Figure 1.

Kissing: The LMM revealed a significant main effect of the *Condition* for *PSI* within brains in both theta ($F_{1,234.0} = 36.16, P < 0.001$, partial $\eta^2 = 0.134$) and alpha frequency bands ($F_{1,234.0} = 30.49, P < 0.001$, partial $\eta^2 = 0.115$), as well as for *PSI* between brains in the theta frequency bands ($F_{1,234.0} = 4.49, P = 0.035$, partial $\eta^2 = 0.019$). All measures were significantly higher in the *joint* compared to the *solitary* condition. For *PSI* within brains, there was also a significant main effect of *Site* (theta: $F_{4,234.0} = 10.38, P < 0.001$, partial $\eta^2 = 0.151$; alpha: $F_{4,234.0} = 19.05, P < 0.001$, partial $\eta^2 = 0.246$), with higher values observed at frontal and parietal sites, and a significant *Sex* $\times$ *Condition* interaction (theta: $F_{1,234.0} = 11.34, P < 0.001$, partial $\eta^2 = 0.046$; alpha: $F_{1,234.0} = 9.38, P = 0.002$, partial $\eta^2 = 0.039$). Sidak-adjusted post hoc tests indicated that *PSI* within brains was significantly higher in the joint compared to the solitary condition for females only (theta: $M_{diff} = 0.049, P < 0.001, df = 234.0$; alpha: $M_{diff} = 0.061, P < 0.001, df = 234.0$).

Resting state: The LMM for *PSI* within brains revealed significant main effects of *Condition* (theta: $F_{1,494.0} = 43.80, P < 0.001$, partial $\eta^2 = 0.081$; alpha: $F_{1,494.0} = 28.58, P < 0.001$, partial $\eta^2 = 0.055$), *Task* (theta: $F_{1,494.0} = 30.54, P < 0.001$, partial $\eta^2 = 0.058$; alpha: $F_{1,494.0} = 152.62, P < 0.001$, partial $\eta^2 = 0.236$), *Site* (theta: $F_{4,494.0} = 28.79, P < 0.001$, partial $\eta^2 = 0.189$; alpha: $F_{4,494.0} = 31.28, P < 0.001$, partial $\eta^2 = 0.202$), and *Sex* for the alpha band ($F_{1,26.01} = 5.77, P = 0.024$, partial $\eta^2 = 0.083$), as well as significant interactions *Task* $\times$ *Condition* for both

frequencies (theta: $F_{1,494.0} = 62.31$, $P < 0.001$, partial $\eta^2 = 0.112$; alpha: $F_{1,494.0} = 4.47$, $P = 0.035$, partial $\eta^2 = 0.009$), and $Sex \times Task$ ($F_{1,494.0} = 6.16$, $P = 0.013$, partial $\eta^2 = 0.012$), $Task \times Site$ ($F_{4,494.0} = 2.96$, $P = 0.020$, partial $\eta^2 = 0.023$), and $Task \times Sex \times Condition$ ($F_{4,494.03} = 7.35$, $P = 0.007$, partial $\eta^2 = 0.015$) for the alpha band. *PSI* values were higher in the *joint* compared to the *solitary* condition for the both frequency bands, higher in EO than EC for theta, but inverse for alpha, and highest at frontal and parietal sites for both frequencies.

Alpha *PSI* was higher in males than females. Sidak-adjusted post hoc tests confirmed higher *PSI* in the *joint* compared to the *solitary* condition during rest with EO in theta ($M_{diff} = 0.038$, $P < 0.001$, $df = 494.0$) and in both tasks for alpha (EC: $M_{diff} = 0.015$, $P = 0.023$, $df = 494.0$; EO: $M_{diff} = 0.033$, $P < 0.001$, $df = 494.0$).

In the alpha frequency band, Sidak-adjusted post hoc tests showed that *PSI* values were significantly higher in males than females during rest with EC ($M_{diff} = 0.051$, $P = 0.006$, $df = 29.88$) and at frontal ($M_{diff} = 0.050$, $P = 0.011$, $df = 42.97$), central ($M_{diff} = 0.042$, $P = 0.034$, $df = 42.97$), and parietal ($M_{diff} = 0.051$, $P = 0.011$, $df = 42.97$) sites, and that *PSI* values were significantly higher in the *joint* compared to the *solitary* condition in females during both tasks (EC: $M_{diff} = 0.034$, $P < 0.001$, $df = 494.0$; EO: $M_{diff} = 0.028$, $P = 0.002$, $df = 494.0$) and in males only during rest with EO ($M_{diff} = 0.039$, $P < 0.001$, $df = 494.0$).

The LMM for *PSI* between brains revealed significant main effects of *Condition* at the alpha frequency ($F_{1,494.0} = 10.93$, $P < 0.001$, partial $\eta^2 = 0.022$) and *Task* at both frequencies (theta: $F_{1,494} = 34.53$, $P < 0.001$, partial $\eta^2 = 0.065$; alpha: $F_{1,494.0} = 255.40$, $P < 0.001$, partial $\eta^2 = 0.341$). Alpha *PSI* was higher in the *joint* than *solitary* condition, while theta *PSI* was higher in EO compared to EC, with the inverse pattern for alpha.

Pendulum observation: An LMM for *PSI* within brains revealed significant main effects of *Sex* ($F_{1,26.0} = 5.71$, $P = 0.024$, partial $\eta^2 = 0.18$) and *Site* ($F_{4,494.0} = 6.17$, $P < 0.001$, partial $\eta^2 = 0.048$), as well as a significant $Task \times Sex \times Condition$ interaction ($F_{1,494.03} = 10.39$, $P = 0.001$, partial $\eta^2 = 0.021$) for theta frequency, and a significant main effect of *Site* ($F_{4,494.0} =$

7.15, $P < 0.001$, partial $\eta^2 = 0.055$) for alpha. *PSI* was higher in females than in males in the theta frequency band and highest at frontal and parietal regions for both frequencies. Sidak-adjusted post hoc tests indicated that *PSI* values in the theta frequency band were significantly higher in the *solitary* compared to the *joint* condition in males during rest with EO ($M_{diff} = 0.017$, $P = 0.002$, $df = 494.0$).

An LMM for *PSI* between brains revealed significant main effects of *Condition* ($F_{1,494.09} = 4.28$, $P = 0.039$, partial $\eta^2 = 0.009$) and *Task* ($F_{1,494.09} = 4.73$, $P = 0.030$, partial $\eta^2 = 0.009$) at the alpha frequency and a significant interaction *Task* $\times$ *Condition* ($F_{1,494} = 34.53$, $P < 0.001$, partial $\eta^2 = 0.065$) at the theta frequency. Alpha *PSI* was higher in the *joint* compared to the *solitary* condition and higher in EO than EC task. Sidak-adjusted post hoc test did not reveal any significant differences in terms of the *Task* $\times$ *Condition* interaction.

Music listening: An LMM for *PSI* within brains revealed significant main effects of *Condition* ($F_{1,494.0} = 17.46$, $P < 0.001$, partial $\eta^2 = 0.034$) and *Site* ($F_{4,494.0} = 26.92$, $P < 0.001$, partial $\eta^2 = 0.179$), as well as a significant interaction *Sex* $\times$ *Condition* ($F_{1,494.0} = 5.05$, $P = 0.025$, partial $\eta^2 = 0.010$) for theta frequency, and significant main effects of *Condition* ($F_{1,494.0} = 19.45$, $P < 0.001$, partial $\eta^2 = 0.038$), *Task* ($F_{1,494.0} = 5.78$, $P = 0.017$, partial $\eta^2 = 0.012$), and *Site* ($F_{4,494.0} = 94.57$, $P < 0.001$, partial $\eta^2 = 0.434$), as well as a significant interaction *Sex* $\times$ *Site* ($F_{4,494.0} = 3.49$, $P = 0.008$, partial $\eta^2 = 0.027$) for alpha frequency. *PSI* values were higher in the *joint* compared to the *solitary* condition and highest at frontal and parietal brain regions in both frequency bands, and significantly higher when listening to the *Radetzky March*. Sidak-adjusted post hoc tests indicated that *PSI* values in theta band were significantly higher in the *joint* compared to the *solitary* condition in males but not in females and that *PSI* values in alpha band were significantly higher in males compared to females at frontal and parietal brain regions.

An LMM for *PSI* between brains revealed a significant main effect of *Task* ($F_{1,494.0} = 10.33$, $P < 0.001$, partial $\eta^2 = 0.020$) and a significant *Task* $\times$ *Condition* interaction ($F_{1,494.0} = 11.32$, P

< 0.001 , partial $\eta^2 = 0.022$) at the theta frequency and significant main effects of *Condition* ($F_{1,494} = 51.74$, $P < 0.001$, partial $\eta^2 = 0.095$) and *Site* ($F_{4,494.0} = 3.04$, $P = 0.017$, partial $\eta^2 = 0.024$) at the alpha frequency. Theta *PSI* was higher during listening to MS than the RM, while alpha *PSI* was significantly higher in the *joint* compared to the *solitary* condition and highest at parietal sites. Sidak-adjusted post hoc test indicated higher theta *PSI* in the *solitary* compared to the *joint* condition during listening to MS ($M_{diff} = 0.004$, $P = 0.003$, $df = 494.0$).

Supplementary Table 1. Results of post hoc comparisons for all PSD measures showing significant three-way *Sex* $\times$ *Condition* $\times$ *Task* interactions

Measure	female				male			
	T1		T2		T1		T2	
	M_{diff}	<i>P</i> value	M_{diff}	<i>P</i> value	M_{diff}	<i>P</i> value	M_{diff}	<i>P</i> value
Resting state								
<i>PD2</i> _{f1}	n.s.		104.24	0.010	125.66	0.002	n.s.	
<i>PD2</i> _{f3}	n.s.		−1.93	0.015	−3.09	0.001	n.s.	
<i>Within brains</i>								
<i>PTI</i> _{f1}	−112.39	0.015	n.s.		132.77	0.004	−131.02	0.005
<i>PTI</i> _{f3}							4.92	0.026
<i>PCCD</i> _{f1}	−139.65	0.001	n.s.		97.65	0.015	−97.31	0.015
<i>PCCD</i> _{f2}	−15.73	0.021	n.s.		n.s.		n.s.	
<i>PCCD</i> _{f3}	n.s.		n.s.		n.s.		6.15	0.025
Pendulum observation								
<i>PD2</i> _{f2}	n.s.		n.s.		n.s.		−26.20	0.003
<i>Within brains</i>								
<i>PTI</i> _{f2}	n.s.		n.s.		24.41	0.003	−34.28	0.001
<i>PCCD</i> _{f1}	126.88	0.001	n.s.		n.s.		n.s.	
<i>PCCD</i> _{f3}	−6.81	0.001	n.s.		n.s.		−6.13	0.003
<i>Between brains</i>								
<i>PCCD</i> _{f3}	−5.02	0.004	n.s.		n.s.		−5.79	0.001
Music listening								
<i>PD2</i> _{f1}	n.s.		n.s.		n.s.		−97.59	0.006
<i>PD2</i> _{f2}	n.s.		n.s.		n.s.		26.20	0.003
<i>PD2</i> _{f3}	n.s.		−2.26	0.006	n.s.		2.97	0.001
<i>Within brains</i>								
<i>PTI</i> _{f1}	−81.23	0.018	n.s.		150.97	0.001	n.s.	
<i>PTI</i> _{f2}	n.s.		−28.59	0.001	n.s.		25.31	0.003
<i>PTI</i> _{f3}	n.s.		n.s.		n.s.		4.45	0.036
<i>PCCD</i> _{f1}	−76.65	0.011	78.95	0.009	133.99	0.001	n.s.	

PSD = Power Spectral Density; T1 = task 1 (EC, SP, or RM); T2 = task 2 (EO, CP, or MS); M_{diff} = mean difference (joint – solitary); *PD2* = Pointwise Dimension; *PTI* = Pointwise Transinformation; *PCCD* = Pointwise Conditional Coupling Divergence; f1 = 0.15–0.5 Hz, f2 = 0.5–2 Hz, and f3 = 2–8 Hz; n.s. = non-significant.

Supplementary Table 2. Results of linear mixed-effects models (LMM) for all measures showing a significant interaction of the factor *Condition* with covariates derived from the psychological ratings

Measures	<i>Condition</i> × <i>F1</i>			<i>Condition</i> × <i>F2</i>			<i>Condition</i> × <i>F3</i>		
	<i>F</i> value	<i>P</i> value	Partial η^2	<i>F</i> value	<i>P</i> value	Partial η^2	<i>F</i> value	<i>P</i> value	Partial η^2
<i>PD2</i>	4.46	0.036	0.018	4.76	0.030	0.019	n.s.		
<i>PD2</i> _{f1}	5.59	0.019	0.023	n.s.			n.s.		
<i>PD2</i> _{f2}	n.s.			n.s.			12.61	<0.001	0.050
<i>PD2</i> _{f3}	n.s.			n.s.			18.36	<0.001	0.071
Within brains:									
<i>PTI</i>	12.63	<0.001	0.050	n.s.			n.s.		
<i>PTI</i> _{f1}	62.57	<0.001	0.207	4.81	0.029	0.020	n.s.		
<i>PTI</i> _{f2}	n.s.			5.95	0.015	0.024	45.09	<0.001	0.158
<i>PTI</i> _{f3}				23.39	<0.001	0.089	4.47	0.035	0.018
<i>PCCD</i>	28.38	<0.001	0.106	n.s.			n.s.		
<i>PCCD</i> _{f1}	72.09	<0.001	0.231	20.49	<0.001	0.079	4.38	0.037	0.018
<i>PCCD</i> _{f2}	n.s.			n.s.			70.37	<0.001	0.227
<i>PCCD</i> _{f3}	6.34	0.012	0.026	7.63	0.006	0.031	n.s.		
Between brains:									
<i>PTI</i>	22.24	<0.001	0.085	6.46	0.012		n.s.		
<i>PTI</i> _{f1}	50.11	<0.001	0.173	n.s.			n.s.		
<i>PTI</i> _{f2}	n.s.			n.s.			19.13	<0.001	0.074
<i>PTI</i> _{f3}	n.s.			10.12	0.002		n.s.		
<i>PCCD</i>	20.34	<0.001	0.078	n.s.			n.s.		
<i>PCCD</i> _{f1}	62.37	<0.001	0.206	n.s.			n.s.		
<i>PCCD</i> _{f2}	n.s.			n.s.			12.38	<0.001	0.049
<i>PCCD</i> _{f3}	4.14	0.043	0.017	n.s.			n.s.		

Covariates derived from subjective ratings: F1 = Romantic Bond; F2 = Relational Dominance; F3 = Kiss Quality; *PD2* = Pointwise Dimension; *PTI* = Pointwise Transinformation; *PCCD* = Pointwise Conditional Coupling Divergence; f1 = 0.15–0.5 Hz, f2 = 0.5–2 Hz, and f3 = 2–8 Hz; n.s. = non-significant.

Supplementary Table 3. Results of linear mixed-effects models (LMM) for all measures showing a significant main effect of Task and a significant *Sex* × *Task* interaction

Measures	Effects					
	<i>Task</i>			<i>Task</i> × <i>Sex</i>		
	<i>F</i> value	<i>P</i> value	Partial η^2 (<i>df</i>)	<i>F</i> value	<i>P</i> value	Partial η^2 (<i>df</i>)
Condition differences (joint – solitary)						
<i>PD2</i>	4.35	<0.001	0.028 (6,884.0)	4.35	<0.001	0.029 (6,884.0)
<i>PD2</i> _{f1}	3.96	<0.001	0.060 (6,373.7)	4.57	<0.001	0.068 (6,373.7)
<i>Within brains</i>						
<i>PTI</i>	5.60	<0.001	0.037 (6,884.0)	3.95	<0.001	0.026 (6,884.0)
<i>PCCD</i>	3.15	0.005	0.021 (6,884.0)	4.82	<0.001	0.032 (6,884.0)
<i>PTI</i> _{f1}	2.15	0.046	0.028 (6,450.7)	10.90	<0.001	0.127 (6,450.7)
<i>PCCD</i> _{f1}	2.77	0.012	0.035 (6,454.2)	14.68	<0.001	0.162 (6,454.2)
<i>Between brains</i>						
<i>PTI</i>	7.56	<0.001	0.049 (6,884.0)	n.s.		
<i>PCCD</i>	6.57	<0.001	0.043 (6,884.0)	n.s.		
<i>PTI</i> _{f1}	13.77	<0.001	0.166 (6,414.1)	n.s.		
<i>PCCD</i> _{f1}	13.59	<0.001	0.158 (6,434.9)	n.s.		
Joint condition						
<i>PD2</i>	117.51	<0.001	0.444 (6,884.0)	4.62	<0.001	0.030 (6,884.0)
<i>PD2</i> _{f1}	5.58	<0.001	0.158 (6,461.3)	3.35	0.003	0.042 (6,461.3)
<i>Within brains</i>						
<i>PTI</i>	22.91	<0.001	0.135 (6,884.0)	n.s.		
<i>PCCD</i>	6.63	<0.001	0.043 (6,884.1)	n.s.		
<i>PTI</i> _{f1}	3.11	0.005	0.031 (6,587.4)	3.96	<0.001	0.039 (6,587.4)
<i>PCCD</i> _{f1}	n.s.			5.71	<0.001	0.060 (6,541.3)
<i>Between brains</i>						
<i>PTI</i>	8.60	<0.001	0.055 (6,884.1)	n.s.		
<i>PCCD</i>	6.05	<0.001	0.039 (6,884.0)	n.s.		
<i>PTI</i> _{f1}	14.68	<0.001	0.143 (6,530.0)	n.s.		
<i>PCCD</i> _{f1}	6.63	<0.001	0.072 (6,513.0)	n.s.		

df = degrees of freedom; *PD2* = Pointwise Dimension; *PTI* = Pointwise Transinformation; *PCCD* = Pointwise Conditional Coupling Divergence; f1 = 0.15–0.5 Hz, f2 = 0.5–2 Hz, and f3 = 2–8 Hz; n.s. = non-significant.

Supplementary Table 4. Post hoc comparisons across the seven tasks for dimensionality (*PD2* and *PD2_{fl}*) and within-brain coupling measures (*PTI*, *PCCD*, *PTI_{fl}*, *PCCD_{fl}*)

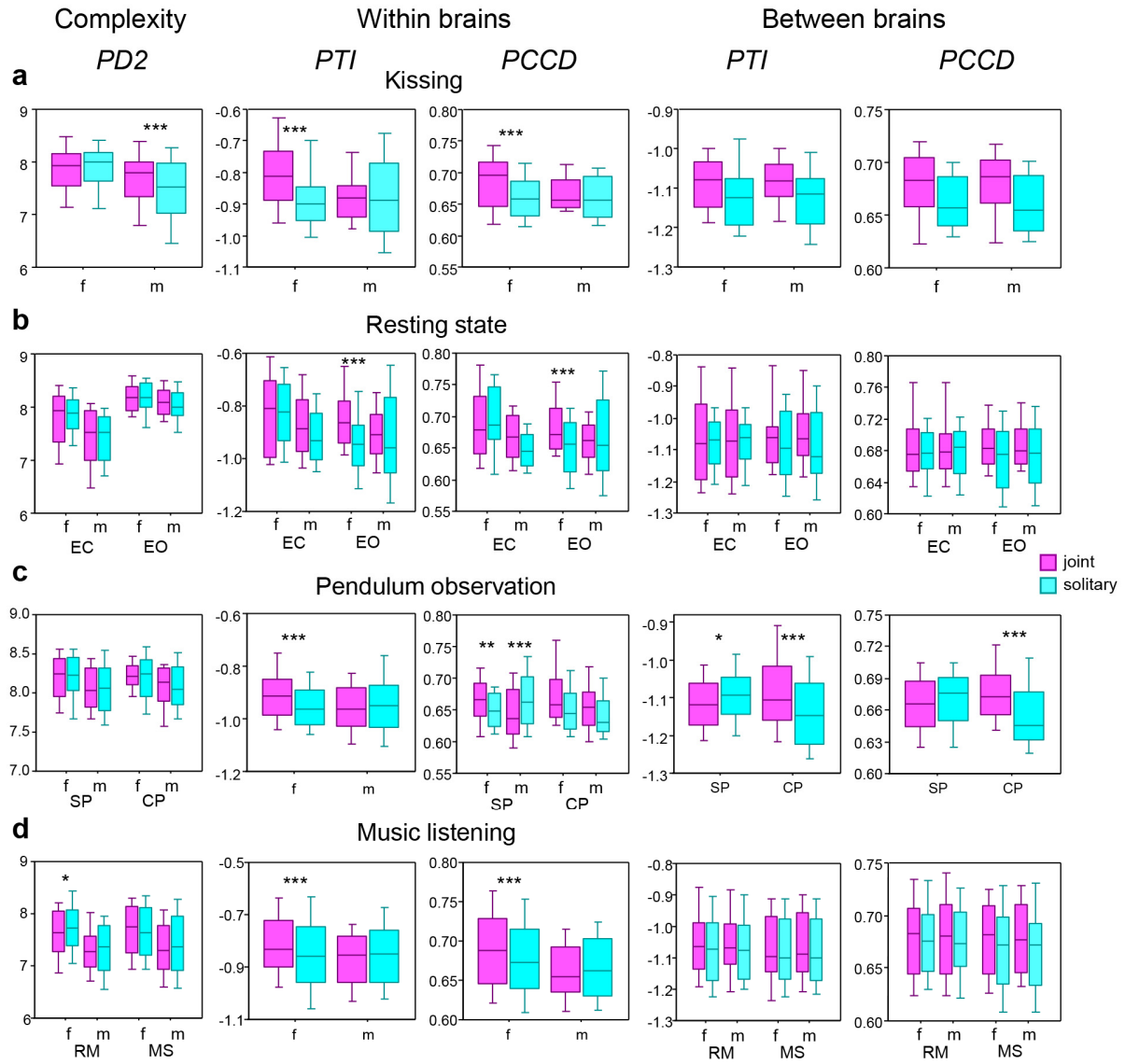
Tasks	<i>PD2</i>	<i>PTI</i>	<i>PCCD</i>	<i>PD2_{fl}</i>	<i>PTI_{fl}</i>	<i>PCCD_{fl}</i>
Condition differences (joint – solitary)						
KISS vs. EC	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
KISS vs. EO	n.s.	n.s.	n.s.	n.s.	121.0*	n.s.
KISS vs. SP	n.s.	0.052*	n.s.	132.6*	n.s.	n.s.
KISS vs. CP	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
KISS vs. RM	0.184***	n.s.	n.s.	n.s.	n.s.	n.s.
KISS vs. MS	n.s.	n.s.	n.s.	158.0**	n.s.	n.s.
EC vs. EO	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
EC vs. SP	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
EC vs. CP	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
EC vs. RM	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
EC vs. MS	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
EO vs. SP	n.s.	0.072***	n.s.	n.s.	n.s.	n.s.
EO vs. CP	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
EO vs. RM	0.132*	n.s.	n.s.	n.s.	n.s.	n.s.
EO vs. MS	n.s.	0.058**	n.s.	n.s.	n.s.	n.s.
SP vs. CP	n.s.	-0.064***	-0.024**	n.s.	n.s.	n.s.
SP vs. RM	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
SP vs. MS	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
CP vs. RM	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
CP vs. MS	n.s.	0.050*	n.s.	n.s.	n.s.	n.s.
RM vs. MS	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Joint condition						
KISS vs. EC	0.149**	n.s.	n.s.	n.s.	n.s.	n.s.
KISS vs. EO	-0.380***	n.s.	n.s.	n.s.	n.s.	n.s.
KISS vs. SP	-0.364***	0.106***	0.021***	104.6*	n.s.	n.s.
KISS vs. CP	-0.366***	0.074***	n.s.	126.8**	n.s.	n.s.
KISS vs. RM	0.251***	n.s.	n.s.	129.1***	n.s.	n.s.
KISS vs. MS	0.321***	n.s.	n.s.	130.1***	n.s.	n.s.
EC vs. EO	-0.529***	n.s.	n.s.	n.s.	n.s.	n.s.
EC vs. SP	-0.514***	0.100***	0.026***	n.s.	n.s.	n.s.
EC vs. CP	-0.515***	0.069***	n.s.	n.s.	164.2**	n.s.
EC vs. RM	0.171***	n.s.	n.s.	n.s.	n.s.	n.s.
EC vs. MS	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
EO vs. SP	n.s.	0.073***	0.018**	n.s.	n.s.	n.s.
EO vs. CP	n.s.	0.042*	n.s.	n.s.	n.s.	n.s.
EO vs. RM	0.700***	-0.047**	n.s.	n.s.	n.s.	n.s.
EO vs. MS	0.631***	n.s.	n.s.	n.s.	n.s.	n.s.
SP vs. CP	n.s.	n.s.	n.s.	n.s.	133.4*	n.s.
SP vs. RM	0.685***	-0.120***	-0.023***	n.s.	n.s.	n.s.
SP vs. MS	0.615***	-0.098**	-0.020***	n.s.	n.s.	n.s.
CP vs. RM	0.686***	-0.088***	n.s.	n.s.	n.s.	n.s.
CP vs. MS	0.617***	-0.066***	n.s.	n.s.	n.s.	n.s.
RM vs. MS	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

KISS = kissing; EC = rest with eyes closed; EO = rest with eyes open; SP = simple pendulum, CP = chaotic pendulum; RM = Radetzky March; MS = Moonlight Sonata; *PD2* = Pointwise Dimension; *PTI* = Pointwise Transinformation; *PCCD* = Pointwise Conditional Coupling Divergence; fl = 0.15–0.5 Hz; n.s. = non-significant. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; n.s. = non-significant.

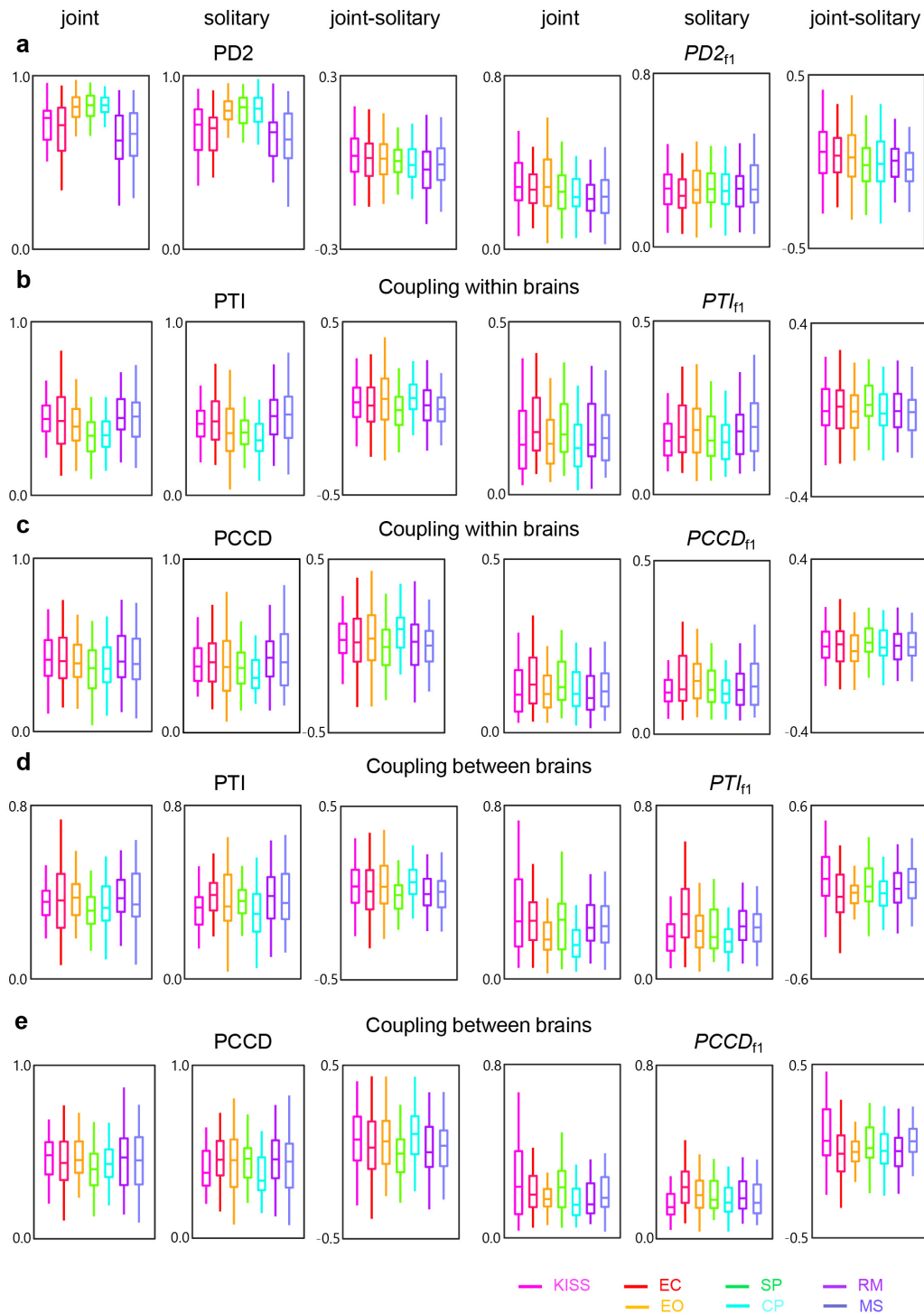
Supplementary Table 5. Post hoc comparisons across the seven tasks for between-brain coupling measures (*PTI*, *PCCD*, *PTI_{fl}*, *PCCD_{fl}*)

Tasks	<i>PTI</i>	<i>PCCD</i>	<i>PTI_{fl}</i>	<i>PCCD_{fl}</i>
Condition differences (joint – solitary)				
KISS vs. EC	n.s.	n.s.	204.4***	149.4***
KISS vs. EO	n.s.	n.s.	208.1***	158.3***
KISS vs. SP	0.061***	0.022***	106.1*	80.98**
KISS vs. CP	n.s.	n.s.	175.5***	132.5***
KISS vs. RM	n.s.	n.s.	n.s.	104.5***
KISS vs. MS	n.s.	n.s.	n.s.	n.s.
EC vs. EO	n.s.	n.s.	n.s.	n.s.
EC vs. SP	n.s.	n.s.	-98.36*	-68.44*
EC vs. CP	n.s.	n.s.	n.s.	n.s.
EC vs. RM	n.s.	n.s.	-110.6**	n.s.
EC vs. MS	n.s.	n.s.	-141.5**	-96.47*
EO vs. SP	0.069***	n.s.	n.s.	n.s.
EO vs. CP	n.s.	n.s.	n.s.	n.s.
EO vs. RM	n.s.	n.s.	-114.3*	n.s.
EO vs. MS	n.s.	0.020***	145.2***	-105.4***
SP vs. CP	-0.077***	-0.025***	n.s.	n.s.
SP vs. RM	n.s.	n.s.	n.s.	n.s.
SP vs. MS	n.s.	n.s.	n.s.	n.s.
CP vs. RM	n.s.	0.016*	n.s.	n.s.
CP vs. MS	0.049**	n.s.	-112.6**	-79.5**
RM vs. MS	n.s.	n.s.	n.s.	n.s.
Joint condition				
KISS vs. EC	n.s.	n.s.	n.s.	n.s.
KISS vs. EO	-0.042**	n.s.	171.7***	93.9***
KISS vs. SP	n.s.	0.014**	n.s.	n.s.
KISS vs. CP	n.s.	n.s.	199.9***	103.5***
KISS vs. RM	-0.035*	n.s.	n.s.	n.s.
KISS vs. MS	n.s.	n.s.	n.s.	n.s.
EC vs. EO	n.s.	n.s.	150.5***	n.s.
EC vs. SP	0.051***	0.018***	n.s.	n.s.
EC vs. CP	n.s.	n.s.	178.6***	n.s.
EC vs. RM	n.s.	n.s.	n.s.	n.s.
EC vs. MS	n.s.	n.s.	n.s.	n.s.
EO vs. SP	0.071***	0.021***	n.s.	n.s.
EO vs. CP	0.037*	n.s.	n.s.	n.s.
EO vs. RM	n.s.	-0.015**	-148.4***	n.s.
EO vs. MS	n.s.	-0.013*	-146.7***	-72.5**
SP vs. CP	n.s.	n.s.	131.7**	n.s.
SP vs. RM	-0.064***	n.s.	n.s.	n.s.
SP vs. MS	-0.048***	n.s.	n.s.	n.s.
CP vs. RM	n.s.	n.s.	-176.5***	n.s.
CP vs. MS	n.s.	n.s.	-174.9***	-82.0***
RM vs. MS	n.s.	n.s.	n.s.	n.s.

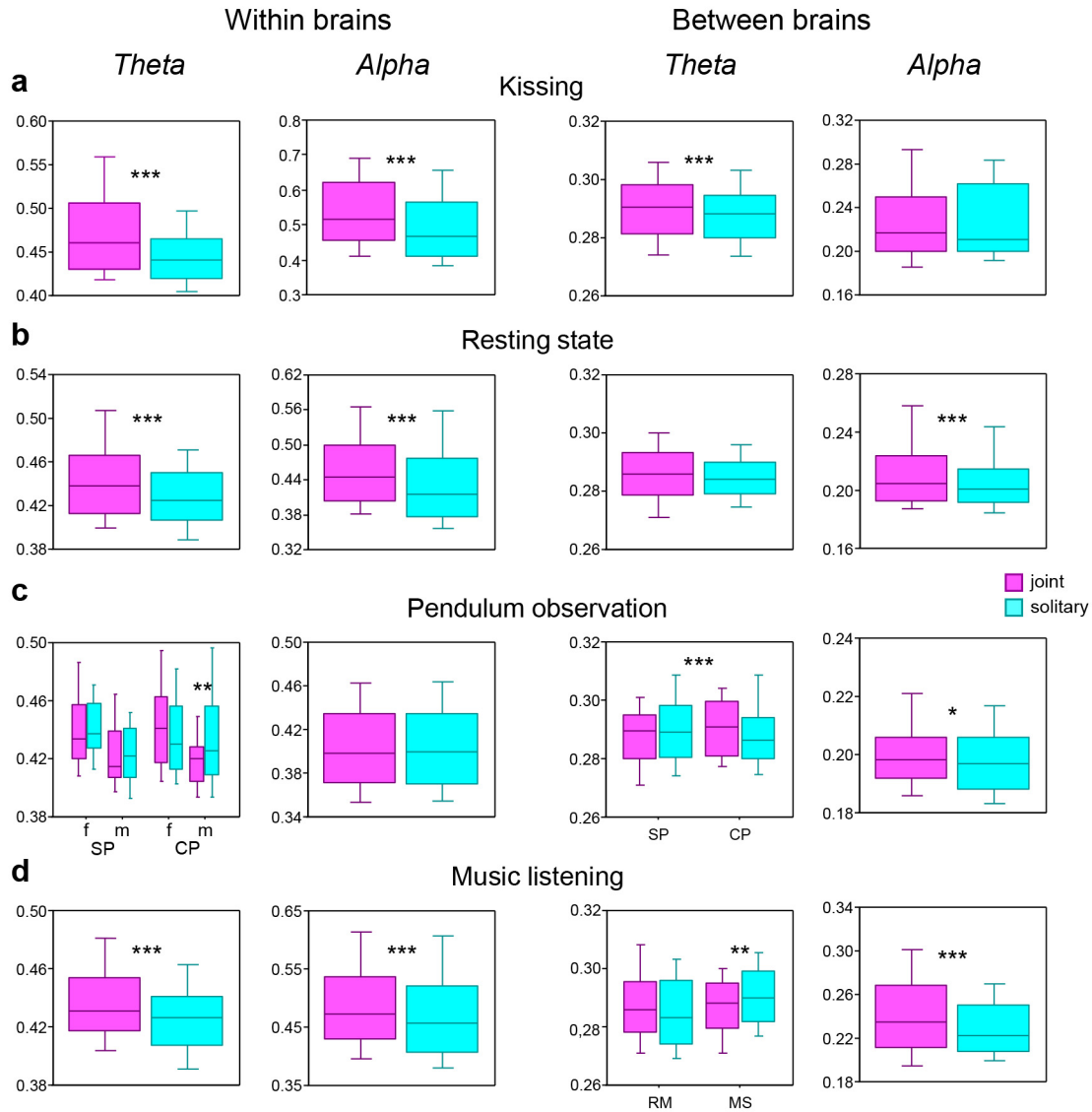
KISS = kissing; EC = rest with eyes closed; EO = rest with eyes open; SP = simple pendulum, CP = chaotic pendulum; RM = Radetzky March; MS = Moonlight Sonata; *PD2* = Pointwise Dimension; *PTI* = Pointwise Transinformation; *PCCD* = Pointwise Conditional Coupling Divergence; fl = 0.15–0.5 Hz; n.s. = non-significant. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; n.s. = non-significant.



Supplementary Figure 1. Comparison of dimensionality and nonlinear coupling measures across different tasks, sexes, and conditions. **a** Box plots of dimensionality (*PD2*) and coupling measures (*PTI*, *PCCD*) within and between brains for females (f) and males (m) during joint (romantic kissing) versus solitary (kissing one's own hand) conditions. **b** Corresponding box plots during resting state with eyes closed (EC) and eyes open (EO) for females (f) and males (m) in joint (focusing on the partner) versus solitary (focusing on own breathing) conditions. **c** Corresponding box plots during observation of simple pendulum for males (m) and females (f) during single pendulum (SP) and chaotic pendulum (CP) in joint versus solitary conditions. **d** Corresponding box plots for males (m) and females (f) during music listening to the Radetzky March (RM) and *Moonlight Sonata* (MS) in joint versus solitary conditions. *p < 0.05, **p < 0.01, ***p < 0.001.



Supplementary Figure 2. Comparison of dimensionality and coupling measures, as well as low-frequency PSD values, across all tasks for joint and solitary conditions and their differences. **a** Box plots of dimensionality ($PD2$) and corresponding low-frequency PSD values ($PD2_{f1}$) for joint and solitary conditions, along with their differences. **b** Box plots of within-brain coupling (PTI) and corresponding low-frequency PSD values (PTI_{f1}) for joint and solitary conditions and their differences. **c** Box plots of within-brain coupling ($PCCD$) and corresponding low-frequency PSD values ($PCCD_{f1}$) for joint and solitary conditions and their differences. **d** Box plots of between-brain coupling (PTI) and corresponding low-frequency PSD values (PTI_{f1}) for joint and solitary conditions and their differences. **e** Box plots of between-brain coupling ($PCCD$) and corresponding low-frequency PSD values ($PCCD_{f1}$) for joint and solitary conditions and their differences. For visualization purposes, PSD values were min-max normalized in the box plots, whereas statistical analyses were performed on the original values.



Supplementary Figure 3. Comparison of linear synchronization (*PSI*) across tasks and conditions. **a** Box plots of *PSI* within and between brains at theta and alpha frequencies during *joint* (romantic kissing) versus *solitary* (kissing one's own hand) conditions. **b** Box plots of *PSI* within and between brains at theta and alpha frequencies during the resting state in *joint* (focusing on the partner) versus *solitary* (focusing on own breathing) conditions. **c** Box plots of *PSI* within and between brains at theta and alpha frequencies during observation of simple pendulum (SP) and chaotic pendulum (CP) in *joint* versus *solitary* conditions (females = f; males = m). **d** Corresponding box plots during music listening to the Radetzky March (RM) and *Moonlight Sonata* (MS) in *joint* versus *solitary* conditions. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.