Supplementary Method 1. EEG preprocessing pipeline

Continuous scalp electroencephalography (EEG) and subthalamic nucleus local field potential (STN-LFP) recordings acquired during walking were processed with a multistage pipeline designed to attenuate channel-specific noise, physiological artifacts and gait-related motion contamination while retaining synchronized, phase-resolved gait cycles for downstream analyses. Processing was performed in Python v3.9.19 using MNE-Python v1.7.1; AutoReject v0.4.2 was used for automated epoch-level quality control. All 64 EEG channels were cleaned before channels were grouped anatomically or a sensorimotor region of interest was defined.

Signal synchronization

EEG and three-dimensional motion-capture recordings were aligned using shared hardware triggers. At the beginning of each recording, the deep-brain stimulation amplitude was briefly reduced by 0.5 mA, producing a recognizable transient in both EEG and STN-LFP recordings. This transient was used for post hoc alignment of the two electrophysiological streams, thereby preserving a common time base for gait-event segmentation and paired quality control.

Channel-level quality control

Candidate bad EEG channels were identified from kurtosis, interchannel correlation, variance and amplitude criteria. Because electrodes on the outer ring of the cap were particularly susceptible to movement-related contamination during walking, these electrodes were excluded. Automated screening was complemented by visual inspection of the continuous time-domain signals, and channels showing persistent residual noise were removed before rereferencing and source separation.

Filtering, rereferencing and independent-component rejection

The retained EEG channels were filtered with a zero-phase 4–100 Hz band-pass filter and rereferenced to their common average. The 4-Hz high-pass cut-off was used to attenuate slow gait-related motion artifacts, which were most prominent below 4 Hz in the mobile recordings. Consequently, delta-band activity was not analyzed, and theta-band estimates close to the lower filter boundary were interpreted cautiously, particularly for STN-LFP signals.

Infomax independent component analysis (ICA) was then applied to the retained, rereferenced EEG data. ICLabel assigned each independent component probabilities for brain, muscle, eye, heart, line noise, channel noise and “other” classes. Components with a probability of at least 50% for muscle, eye, heart, line-noise or channel-noise classes were rejected. Components assigned to the “other” class at the same 50% threshold were inspected manually and were removed only when their spatial and temporal characteristics were judged to be non-neural. The remaining components were back-projected to the retained EEG channels to reconstruct the cleaned channel-level signals.

Gait-cycle segmentation and temporal normalization

Heel strike was identified from the post-swing minimum vertical position of the heel marker, whereas toe-off was identified using a sagittal-velocity criterion applied to the toe/hallux marker. Straight-walking data were segmented from one right heel strike to the next. Within each gait cycle, right heel strike, left toe-off, left heel strike and right toe-off defined initial double support, left swing, final double support and right swing, respectively. The four phases were linearly resampled separately such that their subsequent concatenation yielded a normalized gait cycle with a fixed duration of 1.1 s, selected by rounding the mean gait-cycle duration across both cohorts. This procedure preserved phase-boundary alignment across cycles and yielded exactly 2,200 EEG samples and 275 STN-LFP samples per normalized cycle at the respective acquisition rates.

Epoch-level artifact rejection and paired output

After gait-cycle segmentation, AutoReject v0.4.2 was used to identify residual artifact-contaminated EEG epochs. STN-LFP signals were band-pass filtered from 4 to 100 Hz to harmonize the analyzed frequency range and were screened for transient contamination. A gait cycle was excluded from both modalities when it was classified as artifactual in either EEG or STN-LFP, ensuring that all retained observations remained temporally matched for paired analyses.

The final output therefore comprised reconstructed channel-level EEG and synchronized STN-LFP gait cycles that passed channel-, component- and epoch-level quality control. The cleaned EEG channels were subsequently grouped by electrode location for sensorimotor analyses. Although the combination of channel screening, zero-phase filtering, common-average rereferencing, ICA-based component rejection and joint epoch exclusion substantially reduced non-neural contamination, gait-locked mechanical artifacts cannot be eliminated completely from mobile EEG; results near the lower frequency boundary were therefore interpreted with appropriate caution.

Supplementary Method 2. Gait-parameter definitions

This section defines the 37 kinematic features used in the present analysis and specifies how they were summarized and grouped into nine gait domains. All measures were derived from three-dimensional marker trajectories sampled at 100 Hz during the straight-walking portions of the 6-min overground trial. Heel strike and toe-off were identified as described in Methods 6.5. Only the parameters present in the final analysis matrix are listed here; phase coordination index measures and margin-of-stability variability measures from earlier parameter catalogs were not included in the analyzed 37-feature set.

Participant-level processing and derived indices

Left- and right-limb step or gait-cycle series were first computed separately for side-resolved measures. Before participant-level averaging, an observation was excluded when its distance from the within-series median exceeded four median absolute deviations. Unless stated otherwise, each retained parameter was then summarized as the arithmetic mean across valid steps or gait cycles. For HC-referenced stratification and patient-subgroup comparisons, left- and right-side summaries were averaged for spatiotemporal, foot-clearance and margin-of-stability measures. Asymmetry and continuous-relative-phase measures were intrinsically bilateral and were summarized once per participant.

Variability. For a retained sequence of observations *x*, variability was expressed as the coefficient of variation (CV):

$$\mathrm{CV}\ (\%) = 100 \times \mathrm{SD}(\mathrm{x}) \,/\, \mathrm{mean}(\mathrm{x}).$$

The CVs of cadence and walking speed formed the speed-variability domain. The remaining ten CV features formed the general variability domain. Margin-of-stability variability was not included.

Asymmetry. For each pair of matched left- and right-side observations, an unsigned asymmetry index was calculated as:

$$\mathrm{Asymmetry}\ (\%) = 100 \times [\max(\mathrm{L}, \mathrm{R}) - \min(\mathrm{L}, \mathrm{R})] \,/\, \max(\mathrm{L}, \mathrm{R}).$$

The gait-cycle indices were averaged across the trial. Larger values therefore denote a larger left–right difference, without encoding which side had the larger value.

Margin of stability. The extrapolated center of mass (XCoM) incorporated center-of-mass position and velocity according to the inverted-pendulum relationship:

$$\mathrm{XCoM} = \mathrm{CoM} + \mathrm{vCoM} \,/\, \sqrt{(\mathrm{g/l})},$$

where *v*CoM is center-of-mass velocity, *g* is gravitational acceleration and *l* is the effective pendulum length estimated from the center of mass to the malleolar midpoint. The anteroposterior and mediolateral margin-of-stability values were the signed distances between XCoM and the corresponding base-of-support boundary, defined using the first- and fifth-metatarsal markers, respectively. Positive MoS values indicated that the XCoM remained within the corresponding BoS boundary, whereas negative values indicated that the XCoM extended beyond that boundary.

Interlimb coordination. Upper-arm segment angles were defined from the shoulder to the medial elbow, and thigh segment angles from the anterior superior iliac spine to the midpoint of the medial and lateral femoral-condyle markers. Each gait-cycle trajectory was time-normalized to 101 samples. The analytic signal obtained by the Hilbert transform provided the instantaneous phase φ, and continuous relative phase (CRP) was the phase-difference trajectory for the selected limb pair:

$$\mathrm{CRP}(\mathrm{k}) = \varphi_1(\mathrm{k}) - \varphi_2(\mathrm{k}), \quad \mathrm{k} = 1, \ldots, 101.$$

For each gait cycle and limb pairing, the reported scalar was the root-mean-square deviation from the corresponding mean healthy-control CRP trajectory. Let C_k denote the cycle-level CRP value and H_k the healthy-control reference at normalized sample k:

$$\text{CRP deviation} = \sqrt{[(1/101)\sum_{k=1}^{101}(C_k - H_k)^2]}.$$

These cycle-level deviations were averaged within participant. Values are in radians; lower values indicate a CRP trajectory closer to the healthy-control reference. Four pairings were retained: bilateral upper limbs, bilateral lower limbs, contralateral limbs, and ipsilateral limbs.

Operational definitions of the gait measures

Table SM2-1 defines the base measures from which the 37 analysis features were constructed. A measure marked as left/right was computed separately by limb before the participant-level bilateral average described above.

Table SM2-1. Operational definitions, units and sidedness of the gait measures.

Measure	Operational definition	Unit	Sidedness
Cadence	Number of consecutive steps divided by their elapsed time and expressed per minute.	steps min^{-1}	Global
Double-limb stance time (DLST)	Interval from contralateral heel strike to ipsilateral toe-off during which both feet were in contact with the floor.	s	Left/right
Stride time	Interval between two consecutive heel strikes of the same foot.	s	Left/right
Stance time	Interval from heel strike to the subsequent toe-off of the same foot.	s	Left/right
Swing time	Interval from toe-off to the subsequent heel strike of the same foot.	s	Left/right
Step time	Interval from one heel strike to the immediately subsequent contralateral heel strike; assigned to the landing limb.	s	Left/right
Step length	Transverse-plane heel-to-heel distance between consecutive contralateral foot contacts; assigned to the landing limb.	cm	Left/right
Step width	Perpendicular transverse-plane distance from the landing heel to the progression line defined by consecutive contacts of the contralateral foot.	cm	Left/right
Stride length	Transverse-plane distance between two consecutive heel contacts of the same foot.	cm	Left/right
Walking speed	Horizontal displacement of the sacral reference marker between the first and last valid heel strikes, divided by elapsed time.	cm s^{-1}	Global
Maximum heel clearance (MHC)	Maximum vertical heel-marker excursion within a gait cycle relative to the heel-contact reference.	mm	Left/right
Minimum toe clearance (MTC)	Minimum vertical position of the third-metatarsal marker during the swing interval relative to the walking-surface reference.	mm	Left/right
Margin of stability, anteroposterior (MoS-AP)	Signed distance between anteroposterior XCoM and the first-metatarsal base-of-support boundary.	mm	Left/right
Margin of stability, mediolateral (MoS-ML)	Signed distance between mediolateral XCoM and the fifth-metatarsal base-of-support boundary.	mm	Left/right
Gait asymmetry	Unsigned relative left–right difference, normalized to the larger paired value; calculated for stance time, step length, step time, step width and swing time.	%	Bilateral
CRP deviation	Root-mean-square deviation of a 101-sample gait-cycle CRP trajectory from the corresponding mean healthy-control trajectory.	rad	Bilateral
Variability	Coefficient of variation across retained observations of the source measure: 100 × SD/mean.	%	By measure

Composition of the nine gait domains

Each of the 37 participant-level parameters was z-score standardized across the combined Parkinson's disease and healthy-control sample. Within each domain, the available constituent z scores were averaged with equal weight. A missing parameter was omitted from that participant's domain mean. No direction-of-effect sign inversion was applied; consequently, the sign of a domain score follows the natural direction of its constituent variables.

Table SM2-2. Exact composition of the nine domains. Parameter names reproduce the labels in the participant-level analysis matrix.

Domain	n	Constituent parameters (analysis-matrix labels)
Spatial	3	Step Length; Step Width; Stride Length
Rhythm	5	DLST; Stride Time; Stance Time; Swing Time; Step Time
Foot clearance	2	Maximum Heel Clearance; Minimum Toe Clearance
Speed	2	Cadence; Walking Speed
Asymmetry	5	Stance Time Asy; Step Length Asy; Step Time Asy; Step Width Asy; Swing Time Asy
Variability	10	Maximum Heel Clearance Var; Minimum Toe Clearance Var; DLST Var; Stride Time Var; Stance Time Var; Swing Time Var; Step Length Var; Step Time Var; Step Width Var; Stride Length Var
Interlimb coordination	4	arm&arm; Leg&Leg; ContraHand; IpsiHand
Speed variability	2	Cadence Var; Walking Speed Var
Margin of stability	2	MOSAP; MOSML
Total	**37**	**All participant-level parameters entered in the analysis matrix**

Note: In the analysis-matrix labels, "Asy" denotes the asymmetry index and "Var" denotes the coefficient of variation.

Side-specific domain scores for gait–neural analyses

For correlations with neural features, the same parameter-to-domain mapping was applied to the side-resolved gait matrix. Spatial, rhythm, foot-clearance, margin-of-stability and general-variability scores were generated separately for the left and right sides. The speed, speed-variability, asymmetry and interlimb-coordination domains remained participant-level measures because their constituent parameters were global or intrinsically bilateral. Eligible left- and right-side domain scores were paired with neural measures from the contralateral scalp composite; for unilateral STN-LFP analyses, the gait side contralateral to the recorded STN was used.

Abbreviations: AP, anteroposterior; BoS, base of support; CoM, center of mass; CRP, continuous relative phase; CV, coefficient of variation; HC, healthy control; MHC, maximum heel clearance; ML, mediolateral; MoS, margin of stability; MTC, minimum toe clearance; SD, standard deviation; STN-LFP, subthalamic nucleus local field potential; XCoM, extrapolated center of mass.

Supplementary Method 3. Clinical-score definitions

Clinical motor severity was summarized from Part III (Motor Examination) of the Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS). Each component rating ranges from 0 (normal) to 4 (severe). Clinical ratings were obtained at the most recent clinical visit before the gait-recording session. Five outcomes were analyzed: the standard Part III total score and four study-defined, Part III-derived symptom-domain subscores for bradykinesia, tremor, rigidity and axial/gait impairment. Higher values indicate greater motor impairment.

Score construction

The total score and each subscore were calculated as unweighted sums of the component ratings listed below. Bilateral and body-region-specific ratings were counted as separate components. No item weighting, z-score transformation or range normalization was applied.

Table SM3-1. Exact composition and complete-data ranges of the five clinical measures.

Measure	MDS-UPDRS Part III component ratings included in the sum	n	Possible range
Part III total	All component ratings in items 3.1–3.18, including all bilateral and body-region-specific ratings.	33	0–132
Bradykinesia	3.4 Finger tapping (right and left); 3.5 Hand movements (right and left); 3.6 Pronation–supination movements of the hands (right and left); 3.7 Toe tapping (right and left); 3.8 Leg agility (right and left).	10	0–40
Tremor	3.15 Postural tremor of the hands (right and left); 3.16 Kinetic tremor of the hands (right and left); 3.17 Rest tremor amplitude (lip/jaw and the right and left upper and lower extremities); 3.18 Constancy of rest tremor.	10	0–40
Rigidity	3.3 Rigidity of the neck and the right and left upper and lower extremities.	5	0–20
Axial/gait impairment	3.1 Speech; 3.2 Facial expression; 3.9 Arising from chair; 3.10 Gait; 3.11 Freezing of gait; 3.12 Postural stability; 3.13 Posture; 3.14 Global spontaneity of movement (body bradykinesia).	8	0–32

Note: Item numbering and titles follow the official MDS-UPDRS Part III Motor Examination. The possible ranges assume complete ratings for all components included in a score.

Relationship among the scores

$$\text{Part III total} = \text{bradykinesia} + \text{tremor} + \text{rigidity} + \text{axial/gait impairment}.$$

The four study-defined subscores were mutually non-overlapping and together included all 33 Part III component ratings. Thus, for a complete assessment, their sum equals the Part III total. Item 3.14 was assigned to the axial/gait impairment subscore rather than the bradykinesia subscore, reproducing the score allocation implemented in the analysis workbook.

Abbreviations: MDS-UPDRS, Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale.

Supplementary Table 1. Gait-domain scores in the HC-distant and HC-like Parkinson's disease subgroups and healthy controls

Values are standardized composite domain scores and are presented as mean (s.d.). Each gait parameter was z-standardized across the combined sample (10 patients and 10 healthy controls), and parameters assigned to the same domain were averaged within participant. HC-distant and HC-like subgroup values are descriptive; inferential columns compare all patients (n = 10) with healthy controls (n = 10).

Gait domain	HC-distant PD (n = 6)	HC-like PD (n = 4)	HC (n = 10)	All PD versus HC (n = 10 per group)		
	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Cliff's δ	*P*	FDR-adjusted *P*
Spatial	−0.697 (0.411)	0.361 (0.944)	0.274 (0.649)	−0.46	0.089	0.160
Rhythm	0.591 (1.022)	−0.754 (0.815)	−0.053 (0.676)	0.02	0.970	0.970
Foot clearance	−0.247 (0.846)	0.559 (0.366)	−0.075 (0.731)	0.20	0.473	0.532
Speed	−0.862 (0.608)	0.812 (0.890)	0.192 (0.618)	−0.24	0.385	0.495
Asymmetry	0.835 (0.381)	−0.049 (0.406)	−0.481 (0.247)	0.88	0.0010	**0.0091**
Variability	0.807 (0.656)	−0.247 (0.200)	−0.386 (0.217)	0.76	0.0046	**0.021**
Interlimb coordination	0.901 (0.892)	−0.292 (0.319)	−0.424 (0.337)	0.66	0.014	**0.042**
Speed variability	0.979 (1.107)	−0.409 (0.168)	−0.424 (0.323)	0.54	0.045	0.102
Margin of stability	−0.453 (0.972)	0.220 (0.393)	0.184 (0.559)	−0.36	0.186	0.279

Notes. Variability denotes the composite of non-speed variability measures; speed variability is reported separately. HC, healthy control; PD, Parkinson's disease; s.d., standard deviation; FDR, false discovery rate.

Statistical analysis. Two-sided P values were obtained using Mann–Whitney U tests comparing all patients with healthy controls. FDR-adjusted P values were calculated across the nine gait domains using the Benjamini–Hochberg procedure. Cliff's δ is positive when the domain score is higher in patients. Bold indicates FDR-adjusted $P < 0.05$.

Interpretation. Interlimb coordination, asymmetry and variability remained different after FDR correction; speed variability showed a nominal difference only ($P = 0.045$; FDR-adjusted $P = 0.102$). Thus, three of the four domains with the largest HC-distant versus HC-like differences also distinguished the overall PD cohort from healthy controls.

Supplementary Table 2. MDS-UPDRS Part III total and symptom-domain scores in the HC-like and HC-distant Parkinson's disease subgroups

Values are derived from the most recent pre-recording clinical visit and are reported as mean (s.d.) and median [interquartile range]. Higher scores indicate greater motor impairment.

Clinical measure	HC-like PD		HC-distant PD		Between-subgroup comparison	
	Mean (s.d.)	Median [IQR]	Mean (s.d.)	Median [IQR]	P	FDR-adjusted P
MDS-UPDRS Part III total	19.75 (8.10)	19.0 [13.0–26.5]	25.15 (16.05)	22.5 [10.0–44.0]	1.000	1.000
Bradykinesia	9.50 (7.00)	9.0 [4.0–15.0]	10.00 (8.69)	5.0 [4.0–15.8]	1.000	1.000
Tremor	1.00 (1.41)	0.5 [0.0–2.0]	2.25 (2.87)	1.5 [0.0–4.5]	0.829	1.000
Rigidity	3.25 (2.50)	3.5 [1.5–5.0]	2.50 (2.38)	1.5 [1.0–4.0]	0.714	1.000
Axial/gait impairment	6.00 (1.41)	5.5 [5.0–7.0]	10.40 (6.43)	14.0 [4.3–15.3]	0.556	1.000

Notes. Analyses used outcome-wise complete cases. One HC-distant participant lacked all MDS-UPDRS Part III item ratings and was excluded from all five outcomes. The four symptom-domain subscores are study-defined, mutually non-overlapping sums of MDS-UPDRS Part III component ratings. Their exact composition is provided in Supplementary Method 3. IQR, interquartile range; MDS-UPDRS, Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale; PD, Parkinson's disease; s.d., standard deviation.

Statistical analysis. Two-sided P values were obtained using Wilcoxon rank-sum (Mann–Whitney U) tests. FDR-adjusted P values were calculated across the five clinical comparisons using the Benjamini–Hochberg procedure. No comparison reached $P < 0.05$ before or after FDR correction.

Supplementary Table 3. Robustness of reported EEG–gait correlation coefficients to participant influence and bilateral-observation dependence

Primary estimates are retained for context. Robustness analyses report the mean correlation coefficient and 95% empirical sensitivity interval; no additional P values are reported or interpreted.

Association	Primary correlation coefficient (95% CI)	Primary P value; FDR-adjusted P value	Filtered sample size, observations (participants)	Leave-one-participant-out mean coefficient (95% ESI)	One-side-per-participant mean coefficient (95% ESI)
Rhythm — contralateral swing — alpha	0.449 [0.008, 0.744]	P = .047 FDR P = .618	20 (10)	0.450 [0.342, 0.599]	0.458 [0.286, 0.646]
Rhythm — contralateral swing — low beta	0.584 [0.190, 0.816]	P = .007 FDR P = .495	20 (10)	0.568 [0.451, 0.695]	0.606 [0.416, 0.769]
Rhythm — contralateral swing — low gamma	0.623 [0.249, 0.835]	P = .003 FDR P = .421	20 (10)	0.618 [0.538, 0.704]	0.635 [0.477, 0.799]
Rhythm — ipsilateral swing — low beta	0.543 [0.132, 0.794]	P = .013 FDR P = .500	20 (10)	0.544 [0.446, 0.668]	0.543 [0.388, 0.681]
Spatial — contralateral swing — low gamma	-0.448 [-0.743, -0.007]	P = .048 FDR P = .618	20 (10)	-0.403 [-0.497, -0.196]	-0.458 [-0.637, -0.286]
Spatial — ipsilateral stance — theta†	0.469 [0.019, 0.761]	P = .043 FDR P = .618	19 (10)	0.171 [0.031, 0.524]	0.405 [-0.131, 0.862]
Spatial — ipsilateral stance — high beta	0.602 [0.204, 0.829]	P = .006 FDR P = .495	19 (10)	0.536 [0.331, 0.635]	0.611 [0.300, 0.853]
Spatial — ipsilateral stance — low gamma	0.469 [0.019, 0.761]	P = .043 FDR P = .618	19 (10)	0.453 [0.293, 0.599]	0.440 [0.051, 0.706]
Variability — contralateral swing — low beta	0.538 [0.126, 0.792]	P = .014 FDR P = .500	20 (10)	0.526 [0.427, 0.600]	0.553 [0.408, 0.721]
Variability — contralateral swing — low gamma	0.772 [0.501, 0.905]	P <.001 FDR P = .033	20 (10)	0.772 [0.720, 0.824]	0.783 [0.653, 0.903]
Variability — contralateral swing — high gamma	0.500 [0.059, 0.778]	P = .029 FDR P = .613	19 (10)	0.540 [0.434, 0.630]	0.512 [0.181, 0.792]
Variability — ipsilateral swing — low beta	0.512 [0.090, 0.778]	P = .021 FDR P = .529	20 (10)	0.509 [0.388, 0.588]	0.519 [0.392, 0.648]
Speed — swing — low gamma	-0.654 [-0.909, -0.041]	P = .040 FDR P = .618	10 (10)	-0.616 [-0.809, -0.366]	Not applicable

Notes. CI, confidence interval; ESI, empirical sensitivity interval; filtered sample size is shown as retained observations (unique participants). Primary 95% CIs and P values are from the original analysis.

Primary analysis. The EEG analysis applied the original side-specific 5 × raw-MAD filter to both variables. Spearman r was selected for the correlation test.

Leave-one-participant-out influence analysis. Each of the 10 participants was omitted in turn. Data pairing was rebuilt, the modality-specific MAD filter was reapplied and the prespecified correlation-selection rule was repeated. Values are the arithmetic mean coefficient and 2.5th–97.5th percentiles across the 10 iterations.

One-side-per-participant sensitivity analysis. For bilateral EEG–gait associations, exactly one gait-side observation per participant was retained under all 2^{10} = 1,024 possible global left/right assignments. The same participant-side assignment was used across associations, no opposite-side substitution was made after filtering. This analysis was not applicable to speed, which already contributed one aggregated observation per participant.

Statistical interpretation. The 95% ESI is the 2.5th–97.5th percentile range across the specified deterministic perturbations. It describes coefficient sensitivity and is not an inferential CI. Additional P values are not reported because these analyses assess coefficient stability rather than new hypotheses.

† For the spatial–ipsilateral stance–theta association, the one-side-per-participant ESI crossed zero and the participant-omission mean was attenuated. This association was therefore less stable than the other EEG–gait associations.

Interpretation. Participant omission preserved the original coefficient direction for all 13 EEG–gait associations, with a mean absolute coefficient change of 0.042. One-side selection preserved direction for 11 of 12 applicable associations, with a mean absolute change of 0.017. The FDR-surviving variability–contralateral swing–low-gamma association remained closely centred on its primary estimate under both analyses. These findings support the stability of the overall effect-size pattern to participant influence and bilateral sampling, while the theta association marked above remains less robust and exploratory.

Supplementary Table 4. Robustness of reported STN-LFP–gait correlation coefficients to participant influence

Primary estimates are retained for context. Robustness analyses report the mean correlation coefficient and 95% empirical sensitivity interval; no additional P values are reported or interpreted.

Association	Primary correlation coefficient (95% CI)	Primary P value; FDR-adjusted P value	Filtered sample size, observations (participants)	Leave-one-participant-out mean coefficient (95% ESI)
Foot clearance — contralateral swing — low gamma	-0.857 [-0.979, -0.294]	P = .024 FDR P = .890	7 (7)	-0.849 [-0.930, -0.771]
Foot clearance — ipsilateral swing — high gamma	0.707 [0.005, 0.942]	P = .050 FDR P = .890	8 (8)	0.719 [0.662, 0.805]
Margin of stability — ipsilateral swing — low beta	0.649 [0.032, 0.908]	P = .042 FDR P = .890	10 (10)	0.489 [0.143, 0.785]
Spatial — ipsilateral swing — high gamma	0.929 [0.584, 0.990]	P = .007 FDR P = .890	7 (7)	0.867 [0.616, 0.943]
Asymmetry — swing — alpha	-0.786 [-0.967, -0.080]	P = .048 FDR P = .890	7 (7)	-0.705 [-0.829, -0.508]
Speed — swing — alpha	0.786 [0.080, 0.967]	P = .048 FDR P = .890	7 (7)	0.649 [0.365, 0.816]

Notes. CI, confidence interval; ESI, empirical sensitivity interval; filtered sample size is shown as retained observations (unique participants). Primary 95% CIs and P values are from the original analysis.

Primary analysis. The STN-LFP analysis applied the original paired 3 × raw-MAD filter to both variables. Spearman r was selected for correlation analysis.

Leave-one-participant-out influence analysis. Each of the 10 participants was omitted in turn. Data pairing was rebuilt, the modality-specific MAD filter was reapplied. Values are the arithmetic mean coefficient and 2.5th–97.5th percentiles across the 10 iterations.

One-side-per-participant sensitivity analysis. This analysis was not applicable because each reported STN-LFP–gait association already contained no more than one retained observation per participant; there was no bilateral duplication to remove.

Statistical interpretation. The 95% ESI is the 2.5th–97.5th percentile range across the specified deterministic perturbations. It describes coefficient sensitivity and is not an inferential CI. Additional P values are not reported because these analyses assess coefficient stability rather than new hypotheses.

Interpretation. Participant omission preserved the original coefficient direction for all six STN-LFP–gait associations, with a mean absolute coefficient change of 0.076. This supports stability of the reported effect-size pattern to participant influence but does not remove the uncertainty associated with the small retained sample sizes.

Supplementary Table 5. Demographic and clinical characteristics of the study participants

Panel a summarizes group-level demographics for the Parkinson's disease (PD) and healthy-control (HC) cohorts; panel b lists individual clinical characteristics and the subthalamic nucleus recording side for the PD cohort. Group-level values are mean (s.d.) or n (%), as indicated.

a, Group-level demographic characteristics

Characteristic	PD (n = 10)	HC (n = 10)	Between-group test	Two-sided *P* value
Participants, n	10	10	Not applicable	Not applicable
Age, years	61.7 (8.3)	67.4 (2.6)	Welch's t(10.7) = -2.07	0.063
Female sex, n	3	5	Fisher's exact test	0.65

b, Individual clinical characteristics of the PD cohort

PID	Sex	MDS-UPDRS III gait (item 3.10)	MDS-UPDRS III postural stability (item 3.12)	Total MDS-UPDRS III	STN recording side
201	M	1	2	23	L
202	M	1	1	14	R
203	F	1	1	10	L
204	M	3	1	29	L
205	M	2	1	22	R
206	M	2	2	44	R
207	F	3	1	45	R
208	M	3	1	24	R
209	M	2	0	12	L
210	F	1	0	8	R

Notes. Clinical MDS-UPDRS III scores were obtained at the most recent clinical visit before the measurement session. All PD recordings were acquired ON dopaminergic medication and ON deep-brain stimulation at individually optimized settings. Detailed participant-level stimulation parameters and levodopa-equivalent dose were not retrievable from the clinical records and are therefore not reported.

STN recording side. L and R denote the anatomical side of the bipolar STN recording, which was contralateral to the more clinically affected body side as defined from the lateralized MDS-UPDRS III motor score.

Statistical analysis. Age was compared using a two-sided Welch's t-test and sex distribution using a two-sided Fisher's exact test. The groups did not differ significantly in either comparison.

Abbreviations. DBS, deep-brain stimulation; F, female; HC, healthy control; L, left; M, male; MDS-UPDRS III, Movement Disorder Society-Sponsored Revision of the Unified Parkinson's Disease Rating Scale Part III; NA, not available; PD, Parkinson's disease; PID, participant identifier; R, right; s.d., standard deviation; STN, subthalamic nucleus.