



Data Article

Correlation between the brain activity with gait imagery and gait performance in adults with Parkinson's disease: A data set



Daisuke Nishida^{a,b,c}, Katsuhiko Mizuno^{a,b,c,*}, Emi Yamada^d,
Tetsuya Tsuji^c, Takashi Hanakawa^{e,f}, Meigen Liu^c

^a Department of Physical Rehabilitation, National Center Hospital, National Center of Neurology and Psychiatry, Tokyo, Japan

^b Department of Rehabilitation, Saiseikai Kanagawa-ken Hospital, Kanagawa, Japan

^c Department of Rehabilitation Medicine, School of Medicine Keio University, Tokyo, Japan

^d Department of Clinical Physiology, School of Medicine Kyushu University, Fukuoka, Japan

^e Department of Advanced Neuroimaging, Integrative Brain Imaging Center, National Center of Neurology and Psychiatry, Tokyo, Japan

^f Department of Integrated Neuroanatomy and Neuroimaging, Kyoto University Graduate School of Medicine, Kyoto, Japan

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ABSTRACT

This article describes data related to the research study entitled “The neural correlate of gait improvement by rhythmic sound stimulation in adults with Parkinson's disease – A functional magnetic resonance imaging study” [1]. We evaluated gait performance using the 10-meter walk test (10MWT) in adults with Parkinson's disease (PD) and age-matched healthy controls (HC). Gait speed (GS) and step length (SL) were calculated from the results of the 10MWT. We also evaluated neural activities in regions that were significantly activated by gait imagery in adults with PD using functional magnetic resonance imaging (fMRI). The correlation among GS, SL, and activation of blood oxygenation level-dependent (BOLD) signals by gait imagery in adults with PD. Both GS and SL were smaller in adults with PD than in HCs. The left parietal operculum (PO), left supplementary motor area

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* Corresponding author at: Department of Physical Rehabilitation, National Center Hospital, National Center of Neurology and Psychiatry, Tokyo, Japan, 4-1-1 Ogawa-higashi-cho, Kodaira, Tokyo 187-8551.

E-mail addresses: mizuno.katsuhiko@ncnp.go.jp, mizuno.katsuhiko@gmail.com (K. Mizuno).

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(SMA), and right cerebellum were activated by gait imagery in adults with PD. No significant correlation was found in any pair of gait performance and neural activation of such regions. This data set could be reused for studies to investigate the relationship between gait performance and neural activities in adults with PD.

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Specifications Table

Subject	Neuroscience: Behavioral
Specific subject area	Parkinson's disease, paradoxical gait, Functional magnetic resonance imaging,
Type of data	Table Graph
How data were acquired	1.5-T MR scanner (SIGNA Excite, Optima MR450w 1.5 T, GE Healthcare, Milwaukee, WI, USA)
Data format	Data analysis software: SPM12, Matlab 2018a, SPSS23
Parameters for data collection	Raw and analyzed data
Description of data collection	Twenty-seven adults with Parkinson's disease (PD) and 25 age-matched healthy controls were recruited. Gait performance was evaluated with 10MWT. Neural activities with gait imagery were measured as the specific contrasts of blood oxygenation level-dependent (BOLD) signal with gait imagery and at rest in adults with PD using functional magnetic resonance imaging (fMRI). Gait speed and step length were calculated by the results of 10MWT. The data of fMRI were collected using a 1.5 Tesla MR scanner. The adults with PD were asked to perform a gait imagery task with white noise in the MR scanner. The BOLD signals were measured during gait imagery and resting conditions. The left parietal operculum, left supplementary motor area, and right cerebellum were significantly activated by gait imagery in adults with PD. We investigated correlation between gait performance and activation by gait imagery in adults with PD.
Data source location	Yokohama, Kanagawa-Prefecture, Japan
Data accessibility	Data is within this article.
Related research article	Nishida D, Mizuno K, Yamada E, et al. The neural correlates of gait improvement by rhythmic sound stimulation in adults with Parkinson's disease – A functional magnetic resonance imaging study. <i>Parkinsonism & Related Disorders</i> 2021;84:91–97. https://doi.org/10.1016/j.parkreldis.2021.02.010

Value of the Data

- These data would contribute to the understanding the neural mechanism of gait disturbance in adults with PD.
- The dataset will be beneficial for the researchers investigating the relationship between the behavior and brain activation patterns in the adults with PD.
- These data could be used for studies that investigate the effects of external or internal cueing (e.g., rhythmic sounds), or specific intervention (ex, rehabilitation) on behaviours and brain activation patterns.

1. Data Description

We performed a 10-meter walk test (10MWT) on adults with Parkinson's disease (PD) and on age-matched healthy controls (HC). Gait speed (GS) was significantly slower, and step length (SL) was significantly shorter in adults with PD than in HCs (Table 1, $p < 0.05$, unpaired t -test).

Table 1

Gait performance of adults with PD and healthy controls.

	Adults with PD	Healthy controls	<i>p</i>
N	27	25	
Age (years)	74.6 ± 6.8	71.8 ± 5.5	0.16
10MWT gait speed (m/s)	0.91 ± 0.30	1.41 ± 0.20	1.3×10^{-7}
10MWT step length (meters)	0.50 ± 0.20	0.67 ± 0.09	5.7×10^{-4}

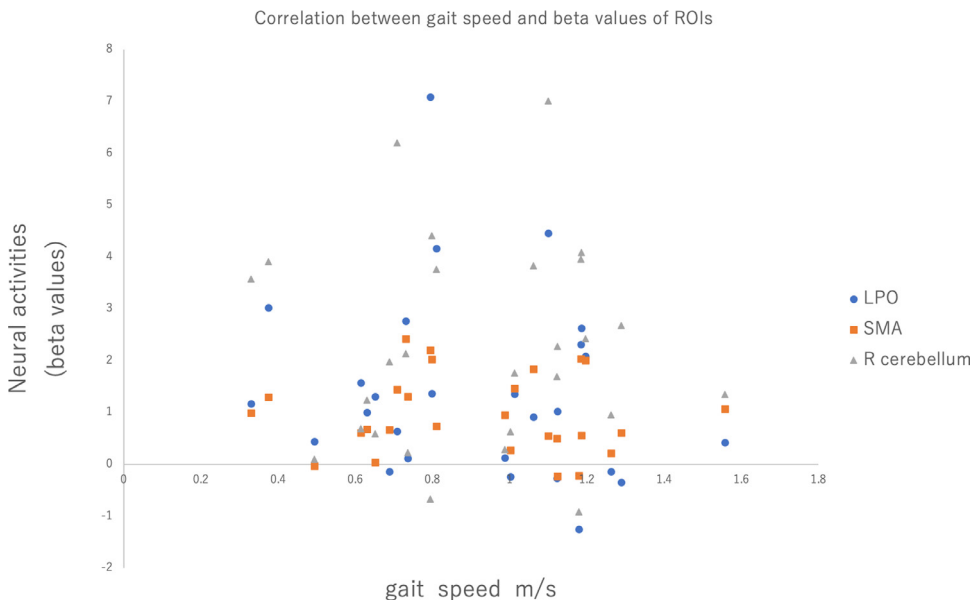
PD: Parkinson's disease; 10MWT: 10-meter walk test.

Comparison between the two groups was performed using unpaired *t*-test. The level of statistical significance for the variables was set at $p < 0.05$.**Table 2**

Correlation between gait performance and neural activity of regions that activated by gait imagery in adults with PD.

	Lt. PO [-44 -34 20]		Lt. SMA [-8 -6 60]		Rt. cerebellum [18 -80 -18]	
	<i>r</i>	<i>p</i>	<i>R</i>	<i>p</i>	<i>r</i>	<i>p</i>
10MWT gait speed (m/s)	-0.157	0.434	-0.218	0.275	0.051	0.802
10MWT step length (meters)	-0.095	0.639	-0.191	0.339	-0.017	0.931

Lt. PO: left parietal operculum, Lt. SMA: left supplementary motor area, Rt. cerebellum: right cerebellum.

Significant correlation (Spearman correlation coefficient) set at $p < 0.05$.**Fig. 1.** Correlation between gait speed and neural activity of left parietal operculum (LPO), supplementary motor area (SMA), and right cerebellum.

In adults with PD, the left parietal operculum (PO), left supplementary motor area (SMA), and right cerebellum were significantly activated by gait imagery. [Table 2](#) and [Figs. 1–2](#) showed the correlations among GS, SL, and neural activity of these three regions. No significant correlation was found between any pair of gait performance and neural activity of the left PO, left SMA, or right cerebellum (Spearman's correlation, $p > 0.05$).

Raw data is indicated as supplementary data.

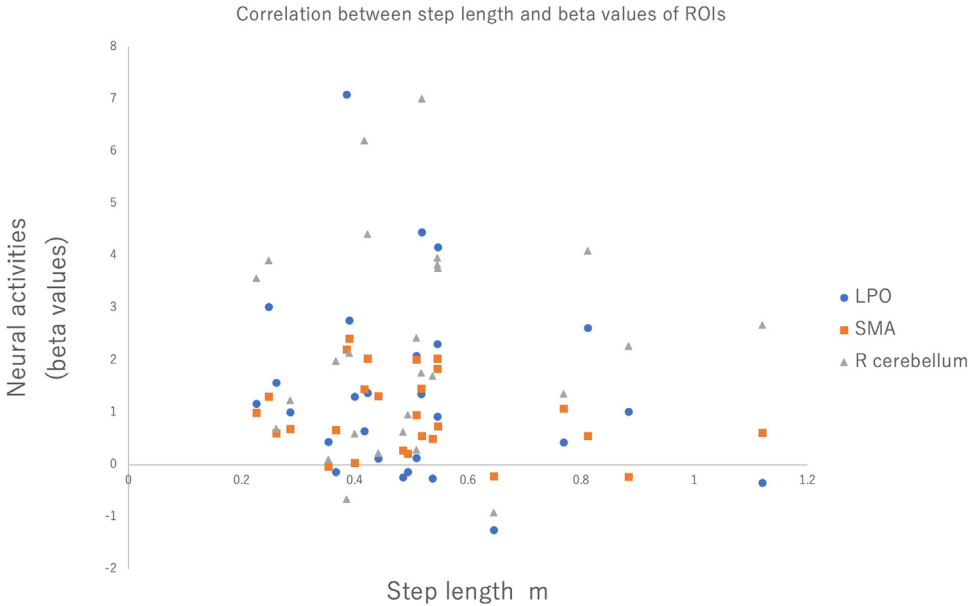


Fig. 2. Correlation between step length and neural activity of left parietal operculum(LPO), supplementary motor area (SMA), and right cerebellum.

Scatterplot of neural activities (beta values) of the contrast between gait imagery and rest from the each area (y-axis) against gait speed (x-axis); Spearman's correlation $r = -0.157$, $p = 0.434$, $r = -0.218$, $p = 0.275$, and $r = 0.051$, $p = 0.802$, respectively.

Scatterplot of neural activities (beta values) of the contrast between gait imagery and rest from the left operculum (y-axis) against step length (x-axis); Spearman's correlation: $r = -0.095$, $p = 0.639$, $r = -0.191$, $p = 0.339$, and $r = -0.017$, $p = 0.931$, respectively.

2. Experimental Design, Materials and Methods

2.1. Participants

Twenty-seven adults with PD were recruited for this study. We screened 87 adults with PD at the Saiseikai Kanagawa-ken Hospital from June 2016 to March 2018, and selected the participants according to the following inclusion criteria; 1) clinically diagnosed idiopathic PD based on the Movement Disorder Society (MDS) clinical diagnosis guidelines [2], 2) Hoehn-Yahr stages [3] ranging from 2 to 3, 3) ability to walk by themselves, and 4) step length was increased by 5% or more when walking with rhythmic auditory stimulation (RAS) compared to walking without it. The evaluation was executed within 2 h after taking anti-parkinsonian medications. We also recruited 25 healthy, right-handed, older adults as age-matched controls. We excluded some participants according to following exclusion criteria: 1) any previous or current known neurological or psychiatric disorders (except for PD), 2) cognitive disturbance, or 3) contraindication to MRI (i.e., claustrophobia, metal devices, etc.).

2.2. Experimental design

A 10-meter walk test (10MWT) was used to assess gait performance [4]. Adults with PD were asked to walk with and without rhythmic auditory stimulation (RAS). Participants walked a

distance of 14 m for the 10MWT. The time and number of steps were evaluated at the middle 10 m to exclude steps during acceleration and deceleration. The gait performance was evaluated by manually. We calculated the step length and gait speed using these data. The RAS consisted of an electrically synthesized beep sound with a 0.1-s square wave and a pitch of 1175 Hz (D7), presented at 100 beats per minute (bpm).

Before fMRI scanning, participants were trained on how to properly imagine walking in an MR scanner. For training, we showed them a video clip showing the view when a person was walking down the corridor of our hospital at a speed of 1 meter per second, and the participants were asked to count the steps taken in the video. After this training, all participants had imagined their gait for 20 s without visual cues. We confirmed that during interviews, they could imagine their gait along the corridor as they walked at their own gait speed.

2.3. fMRI procedure

The fMRI scans were performed on a 1.5 T MR scanner using a standard head coil (SIGNA Excite, Optima MR450w 1.5 T, GE Healthcare, Milwaukee, WI, USA). The participants were placed in the supine position in the MR scanner, and foam padding was used to restrict head movement. Participants wore headphones to listen to the white noise.

To ensure that participants could hear instructions and white noise correctly, we asked participants whether they could listen to the instructions in the MRI chamber during a dummy scan before the actual fMRI scanning. In addition, during the entire measurement, the sound was continually monitored by the examiner. Brain images were obtained using an echo-planar imaging (EPI) sequence. EPI sequences comprised axial slices covering almost the entire brain: 37 axial slices with 4-mm thickness without gaps, repetition time (TR) = 2500 ms; echo time (TE) = 30 ms, and flip angle (FA) = 90°. Anatomical images were acquired using a gradient echo sequence made of axial slices covering almost the entire brain: 124 axial slices with 1.4-mm thickness without gaps, TR = 11.84 ms, TE = 5.144 ms, inversion time (TI) = 400 ms, FA = 25°, voxel size = 3.75 × 3.75 × 4.0 mm³.

The adults with PD were asked to perform gait imagery or rest with their eyes open in the MR scanner. During the measurements, they heard white noise to cancel MR scanning noise. We measured neural activities under two conditions: white noise with gait imagery (NI) and white noise at rest (N). In the NI condition, adults with PD were asked to imagine walking down a corridor of the rehabilitation room at their own pace without counting their imaginary steps as trained outside of the MR scanner. In the N, they were asked to relax with their eyes open in the MR scanner. The instructions for gait imagery or rest were provided by the researcher. Each task lasted for 20 s, and each fMRI run lasted 4 min. fMRI measurements of each condition were carried out in a semi-random order, and were repeated three times.

2.4. Data analyses

The fMRI data were processed using a general linear model using Statistical Parametric Mapping (SPM 12, Wellcome Center for Human Neuroimaging, University College London, London, UK; <http://www.fil.ion.ucl.ac.uk>) implemented on MATLAB (MathWorks Inc., Natick, MA, USA). Head motion correction was performed by realigning all functional volumes to the first volume of the functional series and by co-registering the anatomical volume. All co-registered images were normalized to the Montreal Neurological Institute (MNI) template provided by the SPM 12. Images were smoothed by a Gaussian kernel of 8-mm full-width at half-maximum after normalization. A general linear model with a delayed boxcar waveform was used to estimate the task-specific effects. The boxcar waveform was convolved with a canonical hemodynamic response function. Significance was determined on a voxel-by-voxel basis using a t-statistic, which showed regions of significant condition-associated signal changes. The threshold for statistical

significance was set to $p < 0.001$, uncorrected, and $p < 0.05$, when corrected for multiple comparisons at the peak level over the whole brain using family-wise error (FWE).

For the within-group analysis, a one-sample t -test model was used to compare the brain activation patterns in each task (NI, N). Using contrasts, we evaluated (NI – N) and we extracted beta values of each participant, which represent neural activity of the regions of interest (ROIs) [5].

We also evaluated the correlation between gait performance and beta values of regions that were significantly activated by gait imagery (NI-N) in the adults with PD. As the regions of interest (ROIs), we selected the left parietal operculum, supplementary motor area (SMA), and right cerebellum based on the results of the present and previous studies [1]. We extracted the beta values of the contrast (NI-N) in these regions [1]. We then evaluated the correlation between gait performance data (gait speed and step length) and neural activation values using SPSS23 (Spearman's correlation coefficient; $p < 0.05$).

Ethical Statement

The experiments were performed in accordance with the Declaration of Helsinki and were approved by the Saiseikai Kanagawa-ken Hospital Research Ethics Committee (approval number: 16–15, 2016). All participants provided written informed consent.

CRedit Author Statement

Nishida: conception, Statistical analysis, writing-original draft preparation; **Mizuno:** conception, data analysis, writing-original draft preparation; **Yamada:** conception; **Tsuji:** organization, review; **Hanakawa:** conception, data analysis; **Liu:** organization, review.

Declaration of Competing Interest

Nothing

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Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:[10.1016/j.dib.2021.106993](https://doi.org/10.1016/j.dib.2021.106993).

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