# Supplementary Information: Results

# The Structural Connectivity of Subthalamic Deep Brain Stimulation Correlates with Impulsivity in Parkinson's

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**Supplementary Table 1 | Details of Participants Developing Clinically-Significant Neuropsychiatric Symptoms (Cases)**

| ID | Gender | Presenting Symptoms | DBS Manipulation |
|---|---|---|---|
| **1*^** | Male | Euphoria, hypersexuality, loss of empathy, rapid speech, verbal disinhibition, marital discord. | Active contact on both electrodes moved dorsally & amplitude reduced. Bipolar configuration employed on right STN electrode. |
| **2*^** | Male | Irritability, hypersexuality, rapid speech, marital breakdown. | Active contact on left STN electrodes moved dorsally. Bipolar configuration employed on right STN electrode. Amplitude reduced both electrodes. |
| **3^** | Male | Irritability, hypersexuality, aggression, marital breakdown. | Amplitude in both electrodes reduced. |
| **4^** | Male | Reckless decision making (real-estate), loss of empathy, marital discord. | Active contact on both electrodes moved dorsally & amplitude reduced. Bipolar configuration employed on right STN electrode. |
| **5^** | Female | Irritability, verbal disinhibition, marital discord. | Amplitude in both electrodes reduced. |
| **6*^** | Male | Irritability, psychomotor agitation, reduced need for sleep, rapid speech, aggression. | Active contact on right STN electrode moved dorsally. Bipolar configuration both electrodes. |
| **7^** | Male | Irritability, hypersexuality, divorced spouse. | Bipolar configuration employed on right STN electrode. |
| **8*^** | Female | Irritability, compulsive shopping (second-hand goods), marital breakdown. | Active contact on both electrodes moved dorsally. |
| **9^** | Male | Euphoria, left spouse for a new relationship. | Active contact on right STN electrode moved dorsally and bipolar configuration employed. |
| **10^** | Female | Euphoria, irritability, compulsive shopping (internet). | Active contact on right STN electrode moved dorsally and bipolar configuration employed. |
| **11^** | Female | Irritability, psychomotor agitation, reduced need for sleep. | Active contact on right STN electrode moved dorsally & amplitude reduced. |
| **12** | Female | Irritability, emotional lability, pressured speech, reduced need for sleep, compulsive internet use. | Amplitude in both electrodes reduced. |
| **13** | Male | Verbal disinhibition, hypersexuality, alcohol abuse. | Amplitude in both electrodes reduced. |
| **14** | Female | Increased goal-directed activity, compulsive shopping (motorbikes), hobbyism, reckless driving, obtained new tattoos. | Active contact on right STN electrode moved dorsally; current steering used to avoid medial STN. |
| **15** | Female | Irritability, uncharacteristic swearing, compulsive shopping (furniture). | Active contact on right electrode moved dorsally. |
| **16** | Male | Use of pornography & adult dating websites, impulsive travel overseas, impulsive financial decisions, marital breakdown. | Active contact on right electrode moved dorsally and bipolar configuration employed. Amplitude in both electrodes reduced. |
| **17** | Male | Euphoria, impulsively left work to start own business leading to financial hardship. | Amplitude in both electrodes reduced. |

*These participants reported in more detail in (Mosley *et al.*, 2019).

^These participants included in (Mosley *et al.*, 2018).

**Supplementary Table 2 | Stimulation Parameter Changes for Participants Developing Clinically-Significant Neuropsychiatric Symptoms (Cases)***

| ID | Subthalamic Stimulation at Onset of Neuropsychiatric Symptoms | Subthalamic Stimulation at 3-Month Follow Up after Remission of Acute Symptoms |
|---|---|---|
| **1** | Medtronic:<br>Right STN: Case + 9- / 2.3 V / 60 µs / 130 Hz<br>Left STN: Case + 1- / 1.6 V / 60 µs / 130 Hz | Right STN: 9+ 10- / 2.1 V / 60 µs / 130 Hz<br>Left STN: Case + 2- / 1.7 V / 60 µs / 130 Hz |
| **2** | Boston Scientific:<br>Right STN: Case + 10- / 1.8 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 3.2 mA / 60 µs / 130 Hz | Right STN: 9 + 10- / 1.7 mA / 60 µs / 130 Hz<br>Left STN: Case + 3- / 2.7 mA / 60 µs / 130 Hz |
| **3** | Medtronic:<br>Right STN: Case + 9- / 2.6 V / 60 µs / 130 Hz<br>Left STN: Case + 1- / 2.6 V / 60 µs / 130 Hz | Right STN: Case + 9- / 2.2 V / 60 µs / 130 Hz<br>Left STN: Case + 1- / 2.2 V / 60 µs / 130 Hz |
| **4** | Boston Scientific:<br>Right STN: Case + 9- / 2.6 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 2.6 mA / 60 µs / 130 Hz | Right STN: 10+ 11- / 1.7 mA / 60 µs / 130 Hz<br>Left STN: Case + 3- / 1.8 mA / 60 µs / 130 Hz |
| **5** | Boston Scientific:<br>Right STN: Case + 9- / 3.0 mA / 60 µs / 130 Hz<br>Left STN: Case + 1- / 3.0 mA / 60 µs / 130 Hz | Right STN: Case + 9- / 2.6 mA / 60 µs / 130 Hz<br>Left STN: Case + 1- / 2.6 mA / 60 µs / 130 Hz |
| **6** | Medtronic:<br>Right STN: Case + 9- / 2.0 V / 60 µs / 130 Hz<br>Left STN: Case + 2- / 2.8 V / 60 µs / 130 Hz | Right STN: 10+ 11- / 2.1 V / 60 µs / 130 Hz<br>Left STN: 1+ 2- / 2.9 V / 60 µs / 130 Hz |
| **7** | Boston Scientific:<br>Right STN: Case + 10- / 2.5 mA / 60 µs / 130 Hz<br>Left STN: Case + 3- / 2.7 mA / 60 µs / 130 Hz | Right STN: 9+ 10- 12- / 2.7 mA / 60 µs / 130 Hz<br>Left STN: Case + 3- / 2.0 mA / 60 µs / 130 Hz |
| **8** | Boston Scientific:<br>Right STN: Case + 11- / 1.7 mA / 60 µs / 130 Hz<br>Left STN: Case + 3- / 1.6 mA / 60 µs / 130 Hz | Right STN: Case + 12- / 1.9 mA / 60 µs / 130 Hz<br>Left STN: Case + 5- / 1.8 mA / 60 µs / 130 Hz |
| **9** | Boston Scientific:<br>Right STN: Case + 10- / 2.5 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 1.9 mA / 60 µs / 130 Hz | Right STN: 10+ 11- / 3.4 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 2.3 mA / 60 µs / 130 Hz |
| **10** | Boston Scientific:<br>Right STN: Case + 10- / 1.7 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 1.6 mA / 60 µs / 130 Hz | Right STN: 11+ 12- / 2.0 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 1.7 mA / 60 µs / 130 Hz |
| **11** | Boston Scientific:<br>Right STN: Case + 10- / 2.7 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 1.2 mA / 60 µs / 130 Hz | Right STN: Case + 11- / 2.4 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 1.2 mA / 60 µs / 130 Hz |
| **12** | Boston Scientific:<br>Right STN: Case + 10- / 2.9 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 2.8 mA / 60 µs / 130 Hz | Right STN: Case + 10- / 2.6 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 2.5 mA / 60 µs / 130 Hz |
| **13** | Boston Scientific:<br>Right STN: Case + 10- / 3.9 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 2.8 mA / 60 µs / 130 Hz | Right STN: Case + 10- / 3.2 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 2.4 mA / 60 µs / 130 Hz |
| **14** | Abbott:<br>Right STN: Case + 10- (a+b+c) / 2.5 mA / 60 µs / 130 Hz<br>Left STN: Case + 3- (b) / 2.5 mA / 60 µs / 130 Hz | Right STN: Case + 11- (a+b) / 2.0 mA / 60 µs / 130 Hz<br>Left STN: Case + 3- (b) / 2.5 mA / 60 µs / 130 Hz |
| **15** | Boston Scientific:<br>Right STN: Case + 10- / 1.5 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- 3- / 1.5 mA / 60 µs / 130 Hz | Right STN: Case + 11- / 1.6 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- 3- / 1.9 mA / 60 µs / 130 Hz |
| **16** | Boston Scientific:<br>Right STN: Case + 10- / 2.5 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 2.5 mA / 60 µs / 130 Hz | Right STN: 10+ 11- / 2.3 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- / 2.2 mA / 60 µs / 130 Hz |
| **17** | Abbott:<br>Right STN: Case + 11- (a+b+c) / 2.0 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- (a+b+c) / 1.5 mA / 60 µs / 130 Hz | Right STN: Case + 11- (a+b+c) / 1.5 mA / 60 µs / 130 Hz<br>Left STN: Case + 2- (a+b+c) / 1.3 mA / 60 µs / 130 Hz |

*Electrode contacts are specified as follows:

Medtronic: 0-3 (left) and 8-11 (right) in ventral to dorsal direction
Boston Scientific: 1-8 (left) and 9-16 (right) in ventral to dorsal direction
Abbott: 1-4 (left) and 9-12 (right) in ventral to dorsal direction. Contacts 2 & 3 on the left electrode and contacts 10 & 11 on the right electrode are divided into three segments (a, b & c).

When reporting stimulation parameters, Case + indicates the implantable pulse generator is set as the anode and monopolar stimulation is being delivered. Bipolar stimulation results from activation of a separate electrode contact as the anode adjacent to the cathode. This configuration delivers a more focussed stimulation field.

**Supplementary Table 3 | Postoperative Demographic, Neuropsychiatric Variables & Gambling Behaviours by Post-DBS Caseness & Pre-DBS ICB status**

| **Demographic, Neuropsychiatric & Gambling Variables Assessed Post-DBS** | | |
|---|---|---|
| **Demographic Variable** | **Case+ vs. Case– †** | **ICB+ vs. ICB– †** |
| **Gender** | $\chi^2$ (1) = 0.15<br>*corr. p* = 0.70 | $\chi^2$ (1) = 7.20<br>*corr. p* = 0.044 * |
| **Age (Years)** | *t* = 1.10<br>*corr. p* = 0.41 | *t* = 2.78<br>*corr. p* = 0.044 * |
| **Hoehn & Yahr Stage** | *t* = -1.03<br>*corr. p* = 0.41 | *t* = -1.54<br>*corr. p* = 0.35 |
| **Years Since Diagnosis** | *t* = 1.09<br>*corr. p* = 0.41 | *t* = -0.80<br>*corr. p* = 0.49 |
| **Assessment Instrument** | **Case+ vs. Case– †** | **ICB+ vs. ICB– †** |
| **Levodopa equiv. daily dose** | *t* = -1.50<br>*corr. p* = 0.47 | *t* = -1.85<br>*corr. p* = 0.24 |
| **BIS Attentional** | *t* = 2.41<br>*corr. p* = 0.20 | *t* = -1.52<br>*corr. p* = 0.25 |
| **BIS Non-Planning** | *t* = -0.42<br>*corr. p* = 0.85 | *t* = -0.56<br>*corr. p* = 0.67 |
| **BIS Motor** | *t* = -0.051<br>*corr. p* = 0.96 | *t* = -1.52<br>*corr. p* = 0.25 |
| **QUIP-RS Total** | *t* = 1.16<br>*corr. p* = 0.54 | *t* = -2.37<br>*corr. p* = 0.13 |
| **Delay Discount *k*** | *t* = 0.68<br>*corr. p* = 0.83 | *t* = 2.64<br>*corr. p* = 0.11 |
| **Hayling AB Error Score** | *t* = -0.49<br>*corr. p* = 0.85 | *t* = -0.53<br>*corr. p* = 0.67 |
| **ELF Rule Violations** | *t* = -1.13<br>*corr. p* = 0.54 | *t* = -0.82<br>*corr. p* = 0.60 |
| **Virtual Casino** | **Case+ vs. Case– †** | **ICB+ vs. ICB– †** |
| **Average Bet Size (AUD)** | *t* = 0.096<br>*corr. p* = 0.96 | *t* = -1.46<br>*corr. p* = 0.25 |
| **Double or Nothing Gamble (Percent)** | *t* = 2.07<br>*corr. p* = 0.24 | *t* = -0.26<br>*corr. p* = 0.80 |

† FDR-corrected with Benjamini and Hochberg method (1995), with $\alpha = 0.05$.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$

BIS = Barratt Impulsiveness Scale; ELF = Excluded Letter Fluency Task; ICB = Impulse Control Behaviours; QUIP-RS = Questionnaire for Impulsive-Compulsive disorders in PD Rating Scale

**Supplementary Table 4 | Connectivity Weights in Response Inhibition Latent Variable BIS**

| Fibre Tract | Weight |
|---|---|
| Left VAT - IFG | -0.88 |
| Left VAT - SMA | 0.76 |
| Right VAT - IFG | 0.43 |
| Right VAT - SMA | 0.15 |

IFG = inferior frontal gyrus, SMA = pre-supplementary motor area, VAT = volume of activated tissue

For the winning model, there was no significant effect of gender ($p$ = 0.55) or disease subtype ($p$ = 0.059). The left ($p$ = 0.012) hemisphere in isolation evidenced a significant effect but the right ($p$ = 0.58) did not.

**Supplementary Table 5 | Connectivity Weights in Reward Evaluation Latent Variable ELF Rule Violations**

| Fibre Tract | Weight |
|---|---|
| Left VTA - VAT | 0.52 |
| Left VAT - vmPFC | 0.36 |
| Left VAT - OFC | -0.0022 |
| Left VAT - VS | 0.45 |
| Right VTA - VAT | -0.11 |
| Right VAT - vmPFC | 0.75 |
| Right VAT - OFC | -1.00 |
| Right VAT - VS | -0.0076 |

OFC = orbitofrontal cortex, vmPFC = ventromedial prefrontal cortex, VS = ventral striatum, VAT = volume of activated tissue, VTA = ventral tegmental area

For the winning model, there was no significant effect of gender ($p$ = 1.0) or disease subtype ($p$ = 0.74). Both the left ($p$ = 0.043) and the right ($p$ = 0.046) hemispheres in isolation evidenced a significant effect.

**Supplementary Table 6 | Connectivity Weights in Reward Evaluation Latent Variable Delay Discount *k***

| Fibre Tract | Weight |
|---|---|
| Left VTA - VAT | 0.44 |
| Left VAT - vmPFC | 0.016 |
| Left VAT - OFC | -0.32 |
| Left VAT - VS | 0.036 |
| Right VTA - VAT | 0.79 |
| Right VAT - vmPFC | 0.28 |
| Right VAT - OFC | 0.30 |
| Right VAT - VS | -0.56 |

OFC = orbitofrontal cortex, vmPFC = ventromedial prefrontal cortex, VS = ventral striatum, VAT = volume of activated tissue, VTA = ventral tegmental area

For the winning model, there was no significant effect of gender ($p$ = 0.85) or disease subtype ($p$ = 0.81). Neither the left ($p$ = 0.40) nor the right ($p$ = 0.071) hemispheres in isolation evidenced a significant effect.

**Supplementary Table 7 | Connectivity Weights in Reward Evaluation Latent Variable Bet Size**

| Fibre Tract | Weight |
|---|---|
| Left VTA - VAT | 0.33 |
| Left VAT - vmPFC | -1.21 |
| Left VAT - OFC | 0.52 |
| Left VAT - VS | 0.47 |
| Right VTA - VAT | 0.015 |
| Right VAT - vmPFC | 0.54 |
| Right VAT - OFC | 0.49 |
| Right VAT - VS | -0.30 |

OFC = orbitofrontal cortex, vmPFC = ventromedial prefrontal cortex, VS = ventral striatum, VAT = volume of activated tissue, VTA = ventral tegmental area

For the winning model, there was no significant effect of gender ($p$ = 0.53) or disease subtype ($p$ = 0.054). Neither the left ($p$ = 0.17) nor the right ($p$ = 0.086) hemisphere in isolation evidenced a significant effect.

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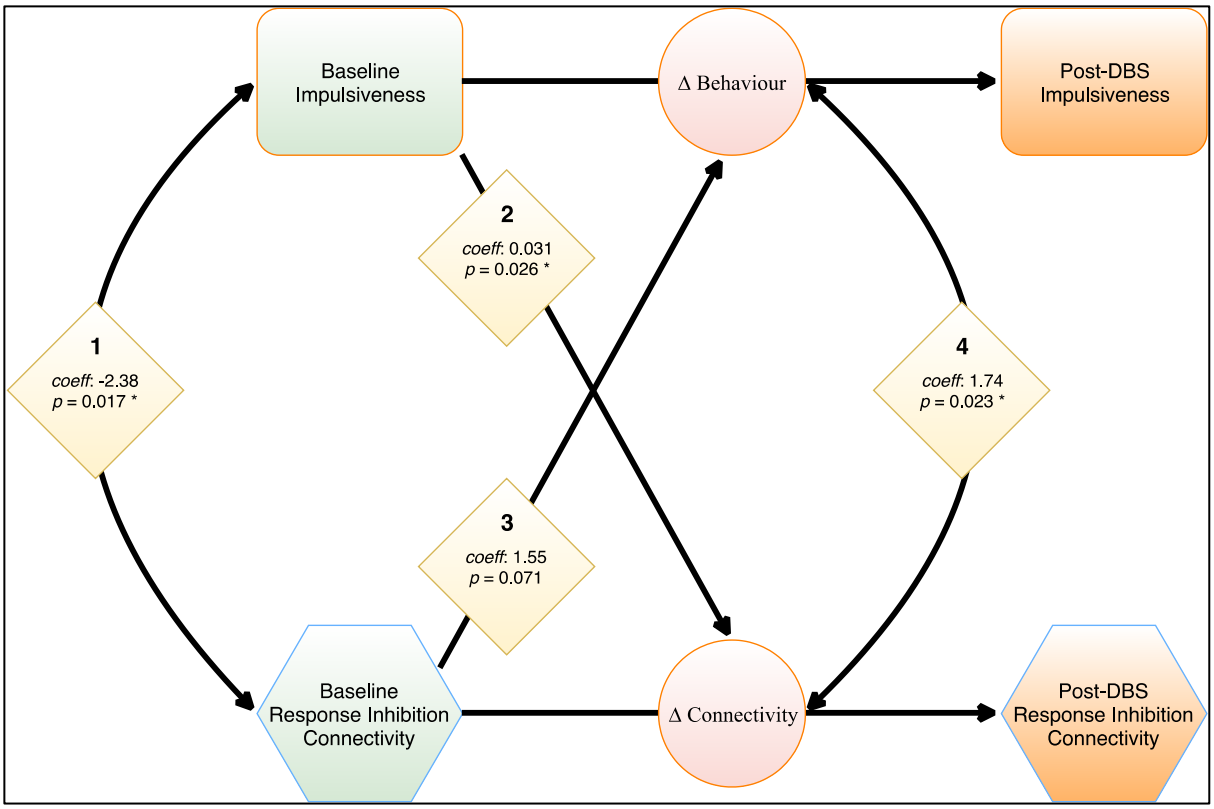
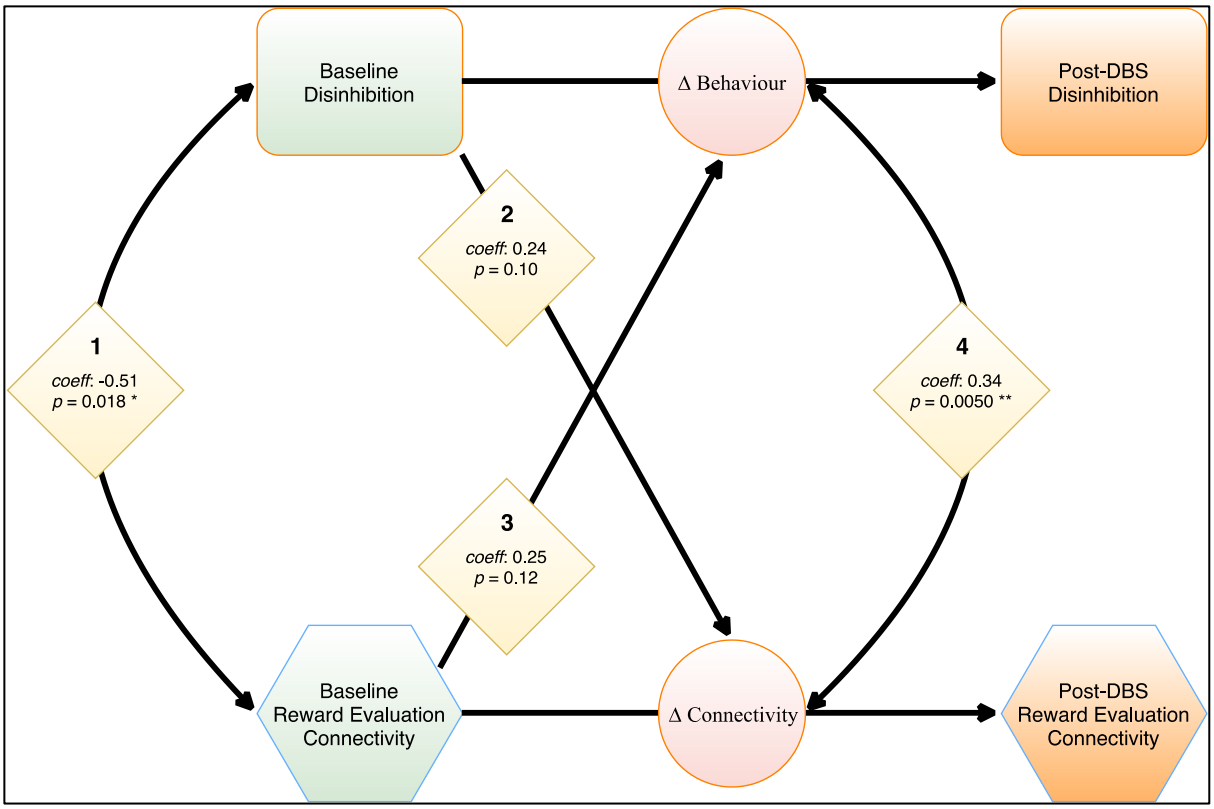



**Supplementary Figure 4 | Cross Lagged Model Results: BIS**

Coefficients:

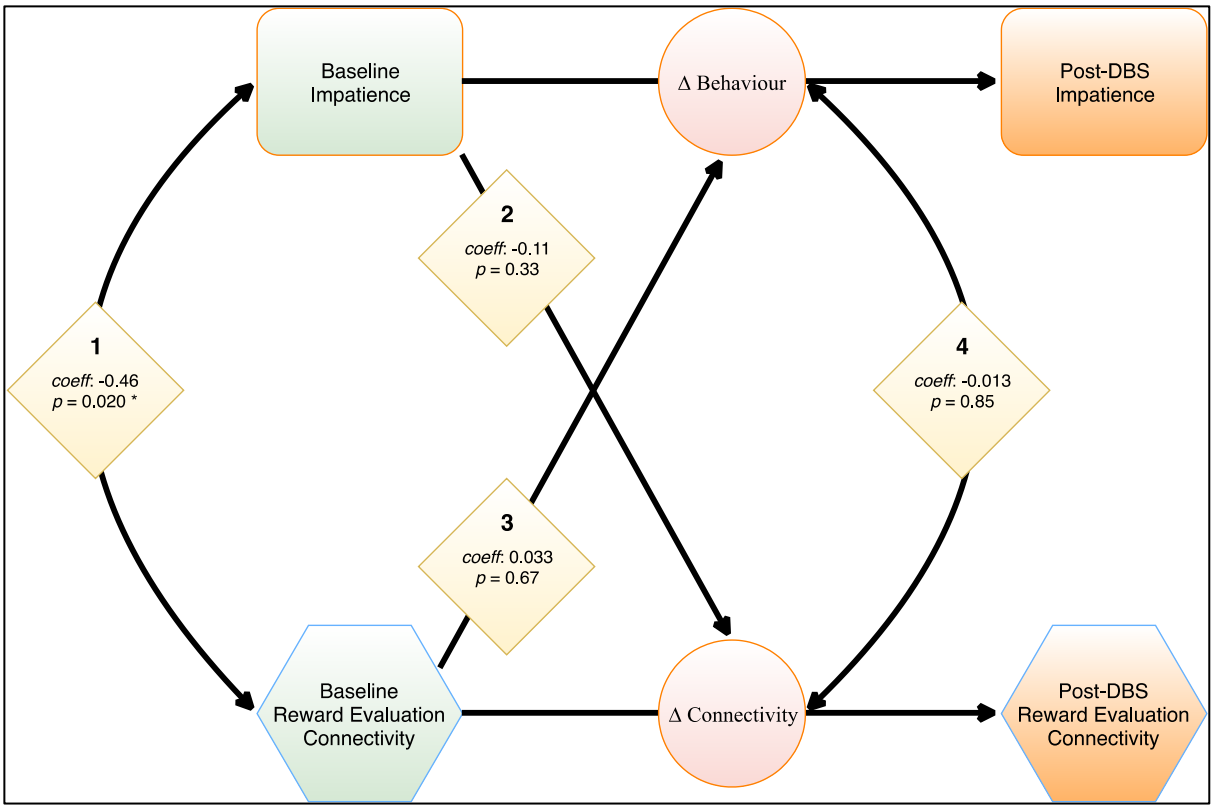
1. Connectivity-behaviour covariance at baseline ($Connectivity_{t1} \sim Behaviour_{t1}$)
2. Behaviour to connectivity coupling ($Behaviour_{t1} \rightarrow \Delta Connectivity$)
3. Connectivity to behaviour coupling ($Connectivity_{t1} \rightarrow \Delta Behaviour$)
4. Correlated change in connectivity and behaviour ($\Delta Connectivity \sim \Delta Behaviour$)




**Supplementary Figure 5 | Cross Lagged Model Results: ELF Rule Violations**

Coefficients:

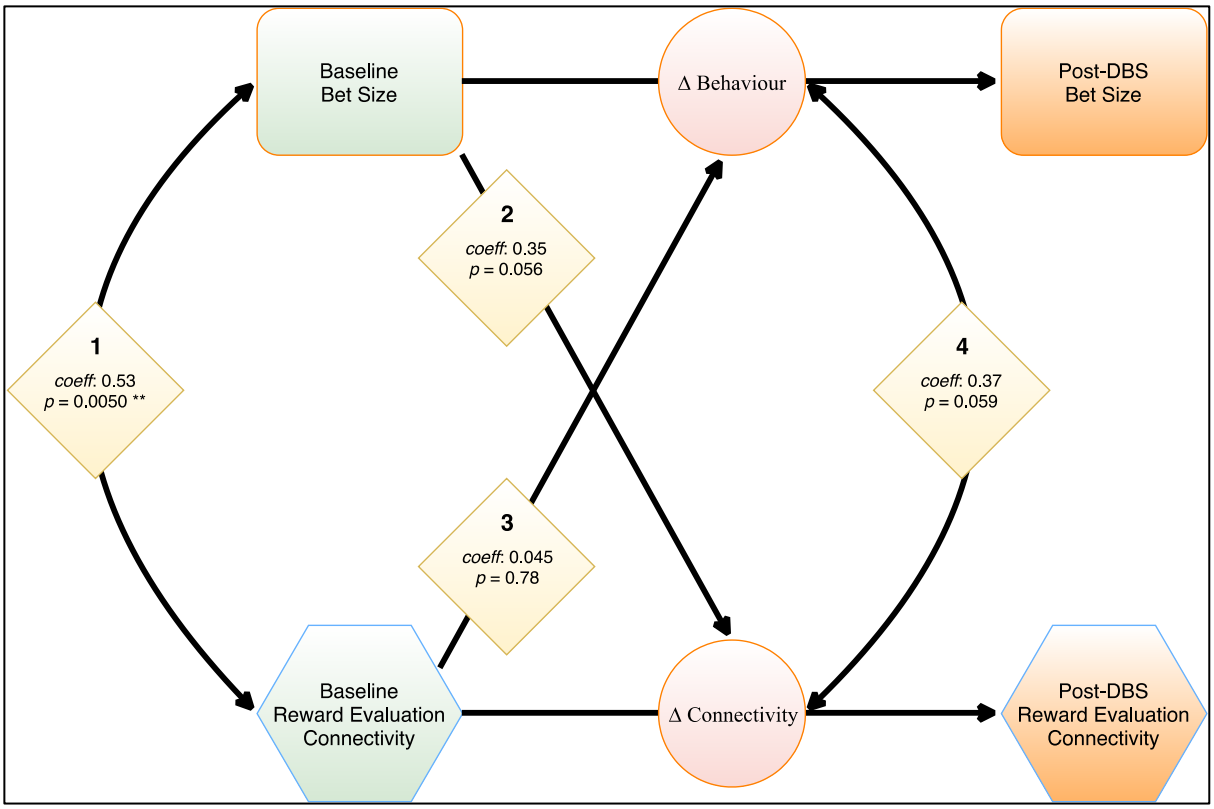
1. Connectivity-behaviour covariance at baseline ($Connectivity_{t1} \sim Behaviour_{t1}$)
2. Behaviour to connectivity coupling ($Behaviour_{t1} \rightarrow \Delta Connectivity$)
3. Connectivity to behaviour coupling ($Connectivity_{t1} \rightarrow \Delta Behaviour$)
4. Correlated change in connectivity and behaviour ($\Delta Connectivity \sim \Delta Behaviour$)




**Supplementary Figure 6 | Cross Lagged Model Results: Delay Discount *k***

Coefficients:

1. Connectivity-behaviour covariance at baseline ($Connectivity_{t1} \sim Behaviour_{t1}$)
2. Behaviour to connectivity coupling ($Behaviour_{t1} \rightarrow \Delta Connectivity$)
3. Connectivity to behaviour coupling ($Connectivity_{t1} \rightarrow \Delta Behaviour$)
4. Correlated change in connectivity and behaviour ($\Delta Connectivity \sim \Delta Behaviour$)




**Supplementary Figure 7 | Cross Lagged Model Results: Bet Size**

Coefficients:

1. Connectivity-behaviour covariance at baseline ($Connectivity_{t1} \sim Behaviour_{t1}$)
2. Behaviour to connectivity coupling ($Behaviour_{t1} \rightarrow \Delta Connectivity$)
3. Connectivity to behaviour coupling ($Connectivity_{t1} \rightarrow \Delta Behaviour$)
4. Correlated change in connectivity and behaviour ($\Delta Connectivity \sim \Delta Behaviour$)

**Supplementary Table 8 | Correlation of Postoperative Motor Symptoms with Neuropsychiatric Variables & Gambling Behaviours**

| **Neuropsychiatric & Gambling Variables Assessed Post-DBS** | |
|---|---|
| **Assessment Instrument** | **Pearson Correlation with Post-DBS UPDRS Score †<br>Degrees of Freedom = 53** |
| **BIS** | *r* = 0.41<br>*corr. p* = 0.0048 ** |
| **QUIP-RS Total** | *r* = 0.072<br>*corr. p* = 0.80 |
| **Delay Discount *k*** | *r* = -0.14<br>*corr. p* = 0.46 |
| **Hayling AB Error Score** | *r* = 0.42<br>*corr. p* = 0.0048 ** |
| **ELF Rule Violations** | *r* = -0.20<br>*corr. p* = 0.28 |
| **Virtual Casino** | **Pearson Correlation with Post-DBS UPDRS Score †<br>Degrees of Freedom = 53** |
| **Average Bet Size (AUD)** | *r* = 0.040<br>*corr. p* = 0.88 |
| **Double or Nothing Gamble (Percent)** | *r* = 0.42<br>*corr. p* = 0.0048 ** |

† FDR-corrected with Benjamini and Hochberg method (1995), with $\alpha = 0.05$.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$

BIS = Barratt Impulsiveness Scale; ELF = Excluded Letter Fluency Task; QUIP-RS = Questionnaire for Impulsive-Compulsive disorders in PD Rating Scale; UPDRS = Unified Parkinson's Disease Rating Scale Part III Motor Examination

**Supplementary Table 9 | Modelling of Motor, Neuropsychiatric & Gambling Outcomes Related to Focal Stimulation of the Subthalamic Nucleus**

| **Motor, Neuropsychiatric & Gambling Variables Assessed Post-DBS** | |
|---|---|
| **Assessment Instrument** | **Anatomical Variables After Optimisation** |
| **BIS** | Nil |
| **QUIP-RS Total** | Nil |
| **Delay Discount *k*** | Nil |
| **Hayling AB Error Score** | Nil |
| **ELF Rule Violations** | Nil |
| **Virtual Casino** | **Anatomical Variables After Optimisation** |
| **Average Bet Size (AUD)** | Nil |
| **Double or Nothing Gamble (Percent)** | Nil |
| **Motor Symptoms** | **Anatomical Variables After Optimisation** |
| **Percentage Reduction UPDRS Part III Scores 'On' Stimulation Versus 'On' Medication** | Distance: Left Motor STN Centroid<br>LASSO Intercept = 25.67<br>LASSO Coefficient = -4.56<br>GLM $z$ = -8.63<br>GLM $p$ = 0.0025 **<br><br>Dispersion of Stimulation: Left Motor STN<br>LASSO Intercept = 25.67<br>LASSO Coefficient = 0.046<br>GLM $z$ = 0.37<br>GLM $p$ = 0.018 * |

*$p$ < 0.05. **$p$ < 0.01. ***$p$ < 0.001

BIS = Barratt Impulsiveness Scale; ELF = Excluded Letter Fluency Task; ICB = Impulse Control Behaviours; QUIP-RS = Questionnaire for Impulsive-Compulsive disorders in PD Rating Scale; UPDRS = Unified Parkinson's Disease Rating Scale Part III Motor Examination

**Supplementary Table 10 | Differences in Focal Subthalamic Stimulation between Case Positive and Case Negative Participants**

| Subthalamic Subregion Stimulation (Affective, Associative, Motor) | |
|---|---|
| **Distance of Active Contact to Centre of STN Subregion** | **Case+ vs. Case– †** |
| **Distance to Left Affective Centroid** | *t* = 1.26<br>*corr. p* = 0.38 |
| **Distance to Right Affective Centroid** | *t* = 3.40<br>*corr. p* = 0.0080 ** |
| **Distance to Left Associative Centroid** | *t* = 0.80<br>*corr. p* = 0.57 |
| **Distance to Right Associative Centroid** | *t* = 1.06<br>*corr. p* = 0.45 |
| **Distance to Left Motor Centroid** | *t* = -2.09<br>*corr. p* = 0.092 |
| **Distance to Right Motor Centroid** | *t* = -4.67<br>*corr. p* = 0.00030 *** |
| **Distribution of VAT Within STN Subregion** | **Case+ vs. Case– †** |
| **VAT Overlap Left Affective Subregion** | *t* = 0.32<br>*corr. p* = 0.85 |
| **VAT Overlap Right Affective Subregion** | *t* = -0.74<br>*corr. p* = 0.93 |
| **VAT Overlap Left Associative Subregion** | *t* = -0.089<br>*corr. p* = 0.93 |
| **VAT Overlap Right Associative Subregion** | *t* = -0.29<br>*corr. p* = 0.85 |
| **VAT Overlap Left Motor Subregion** | *t* = 2.18<br>*corr. p* = 0.092 |
| **VAT Overlap Right Motor Subregion** | *t* = 3.80<br>*corr. p* = 0.0031 ** |

† FDR-corrected with Benjamini and Hochberg method (1995), with $\alpha = 0.05$.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$

VAT = Volume of Activated Tissue

**Supplementary Table 11 | Differences in Frontostriatal Connectivity between Case Positive and Case Negative Participants**

| **Frontostriatal Connectivity with the Subthalmic Stimulation Field** | |
|---|---|
| **Response Inhibition Network** | **Case+ vs. Case– †** |
| **Left VAT - IFG** | *t* = 0.77<br>*corr. p* = 0.63 |
| **Left VAT - SMA** | *t* = 1.23<br>*corr. p* = 0.63 |
| **Right VAT - IFG** | *t* = 1.18<br>*corr. p* = 0.63 |
| **Right VAT - SMA** | *t* = 0.83<br>*corr. p* = 0.63 |
| **Reward Evaluation Network** | **Case+ vs. Case– †** |
| **Left VTA - VAT** | *t* = 1.32<br>*corr. p* = 0.63 |
| **Left VAT - vmPFC** | *t* = 0.055<br>*corr. p* = 0.96 |
| **Left VAT - OFC** | *t* = 0.58<br>*corr. p* = 0.68 |
| **Left VAT - VS** | *t* = -0.91<br>*corr. p* = 0.63 |
| **Right VTA - VAT** | *t* = 0.73<br>*corr. p* = 0.63 |
| **Right VAT - vmPFC** | *t* = -0.11<br>*corr. p* = 0.96 |
| **Right VAT - OFC** | *t* = 0.76<br>*corr. p* = 0.63 |
| **Right VAT - VS** | *t* = 0.92<br>*corr. p* = 0.63 |

† FDR-corrected with Benjamini and Hochberg method (1995), with $\alpha = 0.05$.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$

VAT = Volume of Activated Tissue

**Supplementary Table 12 | Differences in Local Subthalamic Stimulation between Cases at Onset of Neuropsychiatric Symptoms and after Remission due to Changed Stimulation**

| Subthalamic Subregion Stimulation (Affective, Associative, Motor) | |
|---|---|
| **Distance of Active Contact to Centre of STN Subregion** | **Active vs. Remitted Symptoms †** |
| **Distance to Left Affective Centroid** | *t* = -1.36<br>*corr. p* = 0.48 |
| **Distance to Right Affective Centroid** | *t* = -1.03<br>*corr. p* = 0.50 |
| **Distance to Left Associative Centroid** | *t* = -1.05<br>*corr. p* = 0.50 |
| **Distance to Right Associative Centroid** | *t* = 2.08<br>*corr. p* = 0.32 |
| **Distance to Left Motor Centroid** | *t* = -0.58<br>*corr. p* = 0.74 |
| **Distance to Right Motor Centroid** | *t* = 1.33<br>*corr. p* = 0.48 |
| **Distribution of VAT Within STN Subregion** | **Active vs. Remitted Symptoms †** |
| **VAT Overlap Left Affective Subregion** | *t* = -0.21<br>*corr. p* = 0.86 |
| **VAT Overlap Right Affective Subregion** | *t* = 2.48<br>*corr. p* = 0.14 |
| **VAT Overlap Left Associative Subregion** | *t* = 0.18<br>*corr. p* = 0.86 |
| **VAT Overlap Right Associative Subregion** | *t* = -1.55<br>*corr. p* = 0.48 |
| **VAT Overlap Left Motor Subregion** | *t* = -0.51<br>*corr. p* = 0.74 |
| **VAT Overlap Right Motor Subregion** | *t* = 1.01<br>*corr. p* = 0.50 |

† FDR-corrected with Benjamini and Hochberg method (1995), with $\alpha = 0.05$.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$

VAT = Volume of Activated Tissue

**Supplementary Table 13 | Differences in Frontostriatal Connectivity between Cases at Onset of Neuropsychiatric Symptoms and after Remission due to Changed Stimulation**

| **Frontostriatal Connectivity with the Subthalamic Stimulation Field** | |
|---|---|
| **Response Inhibition Network** | **Active vs. Remitted Symptoms †** |
| **Left VAT - IFG** | *t* = -0.41<br>*corr. p* = 0.92 |
| **Left VAT - SMA** | *t* = 0.45<br>*corr. p* = 0.92 |
| **Right VAT - IFG** | *t* = -0.029<br>*corr. p* = 0.98 |
| **Right VAT - SMA** | *t* = 0.78<br>*corr. p* = 0.92 |
| **Reward Evaluation Network** | **Active vs. Remitted Symptoms †** |
| **Left VTA - VAT** | *t* = 0.48<br>*corr. p* = 0.72 |
| **Left VAT - vmPFC** | *t* = -0.86<br>*corr. p* = 0.56 |
| **Left VAT - OFC** | *t* = 0.82<br>*corr. p* = 0.56 |
| **Left VAT - VS** | *t* = 0.87<br>*corr. p* = 0.56 |
| **Right VTA - VAT** | *t* = -0.37<br>*corr. p* = 0.72 |
| **Right VAT - vmPFC** | *t* = -0.89<br>*corr. p* = 0.56 |
| **Right VAT - OFC** | *t* = 3.26<br>*corr. p* = 0.039 * |
| **Right VAT - VS** | *t* = 2.09<br>*corr. p* = 0.21 |

† FDR-corrected with Benjamini and Hochberg method (1995), with $\alpha = 0.05$.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$

VAT = Volume of Activated Tissue

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