**Human decisions about when to act originate within a basal forebrain-nigral circuit**

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The Data folder contains three file types:

1) Behavioural data in .xls format

2) Brain data in .mat and .nii.gz formats

1. All behavioural data could be found in an Excel file called ‘BehavData.xls’. Each row is one trial and the columns are described by the header. Note that the parameters of interest are normalised. The main behavioural results of the manuscript could be reproduced by using the values in the provided Excel file with the following linear mixed-effect model:

$$actTime\_{t}=β\_{0}+ β\_{1}reward\_{t}+ β\_{2}probChange\_{t }+ β\_{3}noise\_{t }+ β\_{4}(reward\_{t}\*probChange\_{t})+ β\_{5}(noise\_{t}\*probChange\_{t})+ β\_{6}rewardOutcome\_{t-1 }+ β\_{7}actTime\_{t-1 }+ β\_{8}totalTime\_{t}+μ\_{0}+ μ\_{1}reward\_{t}+ μ\_{2}probChange\_{t }+ μ\_{3}noise\_{t }+ μ\_{4}(reward\_{t}\*probChange\_{t})+ μ\_{5}(noise\_{t}\*probChange\_{t})+ μ\_{6}rewardOutcome\_{t-1 }+ μ\_{7}actTime\_{t-1 }+e,$$

where $β\_{0-8}$ are the fixed effects, $μ\_{0}$ is by-subject random intercept, and $μ\_{1-7}$ are by-subject random slopes. Total time passed from beginning of the testing session (*totalTime*) was added to the model as a covariate of no interest.

1. There are two types of brain data for each subject in .mat and .nii.gz formats. The number in the file shows the subject number (S). Subject#4 was excluded from all neural analyses due to excessive head motion (absolute mean displacement > 2mm).

a) Unthresholded z-stat (\*.nii.gz) for each of the contrasts of the whole-brain GLM:

$GLM1: BOLD= β\_{0}+ β\_{1} stim+ β\_{2} totaltime+ β\_{3} actTimeLong+ β\_{4} actTimeShort+β\_{5} mainAct+ β\_{6} mainOut + β\_{7} reward,$

where $BOLD$ is a t x 1 (t time samples) column vector containing the times series data for a given voxel. *stim* is an unmodulated regressor representing the main effect of stimulus presentation (all event amplitudes set to one). *totaltime* is a parametric regressor representing the time passed since the beginning of the scanning session. *actTimeLong* and *actTimeShort* are parametric regressors representing *actTime* on trials where rate of change in reward probability was positive (long *actTime* was the correct strategy) and negative (short *actTime* was the correct strategy), respectively. *mainAct* is an unmodulated regressor representing the main effect of responding. *mainOut* is an unmodulated regressor representing the main effect of outcome. *reward* is a parametric regressor with four levels (large, medium, low and no-reward) representing the reward outcome on the current trial. All regressors were modelled as a boxcar function with constant duration of 1 s convolved with a double-gamma hemodynamic response function (HRF). Regressors 1-2 were time-locked to the onset of the trial. Regressor 3-5 started 1 s before participants made a response by pressing the response key and continued for 1 s. Regressors 6-7 were time-locked to the onset of the outcome phase.

b) Up-sampled, normalised, and epoched time-series data (\*.mat) extracted from each ROI: S\*\_ROI\_epoched.mat

The main time-series results could be reproduced by the following GLMs. In each GLM, $BOLD$ is a *i x t* (*i* trial, *t* time samples) matrix containing the times series data for a given ROI (\*.mat files). The values for independent variables within each regressor could be found at the BehavData.xls file.

*GLM2.1:* $BOLD=β\_{1} observed\\_actTime+ β\_{2} totaltime+ β\_{3} constant$,

Where *observed\_actTime* is the time passed in seconds (log normalised) from beginning of the trial to the moment participants made a response. *totaltime* is a confounding regressor and accounts for the time passed since the beginning of the scanning session. *constant* is an unmodulated constant regressor.

*GLM2.2:* $BOLD=β\_{1}reward\_{t}+ β\_{2}probChange\_{t }+ β\_{3}noise\_{t }+ β\_{4}rewardOutcome\_{t-1 }+ β\_{5}actTime\_{t-1 }+ β\_{6}rewardOutcome\_{t }+ β\_{7}totalTime\_{t} + β\_{8} constant$,

where *rewardt*, *probChanget* and *noiset* are contextual factors on the current trial; *rewardOutcomet-1* and *actTimet-1* are contextual factors on the past trial; and *rewardOutcomet* is the reward outcome on the current trial.

*GLM2.3:* $BOLD=β\_{1 }deterministic\\_actTime\_{present+past }+ β\_{2} observed\\_actTime+ β\_{3} totaltime+ β\_{4} constant$,

where *deterministic\_actTimepresent+past* is the predicted *actTime* from the Cox regression model relating to both present and past contextual factors.

*GLM2.4:* $BOLD=β\_{1 }deterministic\\_actTime\_{present }+ β\_{2 }deterministic\\_actTime\_{past }+ β\_{3} observed\\_actTime+ β\_{4} totaltime+ β\_{5} constant$,

where *deterministic\_actTimepresent* and *deterministic\_actTimepast* are the predicted *actTime* from the Cox regression model relating to present and past contextual factors respectively.

*GLM2.5:* $BOLD\_{ROI}= β\_{1} BOLD\_{seed}+ β\_{2} deterministic\\_actTime\_{present+past}+ β\_{3} PPI+ β\_{4} observed\\_actTime + β\_{5} totaltime+ β\_{6} constant$,

where $BOLD\_{ROI}$ is BOLD activity at ROIs, $BOLD\_{seed}$ is BOLD activity at BF, and *PPI* is the interaction between $BOLD\_{seed}$ and *deterministic\_actTimepresent+past.*

Any request for additional pre-processed or supplementary data that is not already provided, should be directed to and will be fulfilled by the corresponding author: nima.khalighinajed@psy.ox.ac.uk