PsPM 5.1.0 Release notes

17th June 2021

Contents

1 PsPM Version 3.0

Import

New data types were implemented

- Noldus Observer compatible
- Eyelink

Untested data types

CNT data import has not been not tested – please contact the developers with sample data files.

Filtering for SCR models

Previous versions of PsPM have used a bi-directional high pass filter of 0.0159 for all SCR analyses. We have recently shown a better predictive validity for GLM with a unidirectional filter of 0.05 Hz [1]. This also implies that different filters are used for different models. These are now set as defaults, and the way the default settings are implemented has changed. It is now possible to alter the filter settings in the model definition, although we discourage this.

New SF method

A matching pursuit algorithm is now implemented to approximate the number of spontaneous fluctuations (SF) in skin conductance [2].

General linear modelling (GLM)

Parametric modulators

Parametric modulators (pmods) are z-normalised before being entered into the design matrix. This is to account for possibly very large or very small numbers – a badly scaled design matrix can cause induced instability in the inversion. The parameter estimates of the pmods were not transformed back in previous versions, i. e. the parameter estimates of the pmods were independent of the scaling of the pmods. This is appropriate as long as they are the same for all datasets, or if analysis is done strictly on a within-subject level. Some researchers have reported designs in which inference was to be drawn on parameter estimates of pmods on a between-group level, and where the pmods systematically differed between these groups. To account for this possibility, the parameter estimates are now transformed back, such that they refer to the pmods in their original scaling/units.

Parametric confounds

Previous versions of PsPM contained an option to include a parametric modulator across all event types, to account for confounds across all conditions. For example, in an experiment with 5 conditions, one could have included 5 regressors, plus one reaction time confound

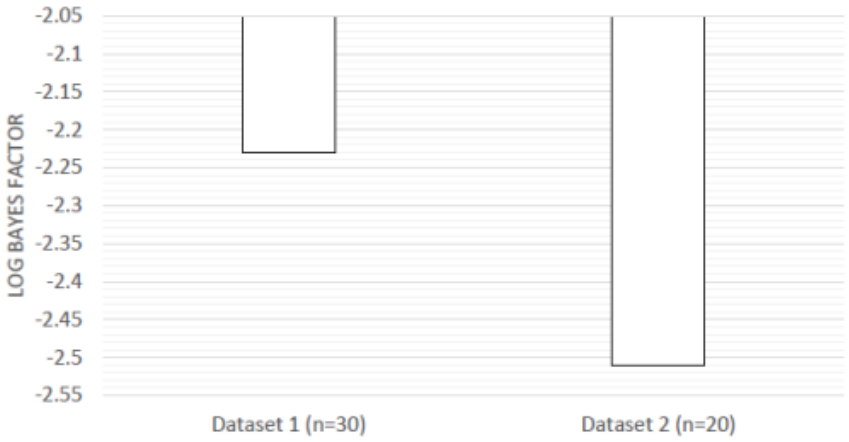

Figure 1.1: Model comparison between old and new versions of the VBA toolbox, based on two delay fear conditioning datasets. The log Bayes factor quantifies the difference between negative log likelihood (nLL) of parameter estimates obtained from model inversion using the old and new version of VBA. A difference in nLL above 3 indicates significant differences in model evidence which is not exceeded for either data set. Analysis and figure contributed by Matthias Staib.

across all events, without including an associated regressor that contains the event onsets for all these events. This option was removed.

Design matrix filtering

Previous versions of PsPM filtered the design matrix after orthogonalisation of basis sets. This can introduce unwanted dependencies between regressors. PsPM 3.0 filters the regressors first, then orthogonalises the basis sets.

File format

Some minor changes have been made to the data format. In particular, marker channels from previous versions can not be read with the current version - such data files have to be re-imported. Model files have changed drastically, and model files from previous versions can not be read with the current version of the software.

VB inversion

The VBA toolbox (`http://mbb-team.github.io/VBA-toolbox/`) was updated in October 2014 [3]. This update incorporates bugfixes in this toolbox and slightly changed the model estimates in our test models. In terms of predictive validity, we noted that there was no consistent benefit of the old or new version of this code (Figure 1.1).

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Import

New data types were implemented

- DATAQ Windaq (no ActiveX needed)
- European Data Format (EDF)

Tools

'Preprocess respiration traces' replaces 'Convert Respiration to Respiration Period'. It supports conversions into the following datatypes:

- Respiration preriod (old funtionality)
- Respiration amplitude
- Respiration line length
- Respiration time stamp

First level contrast

Z-score parameter estimates

The function `pspm_con1` now supports z-scoring trial-by-trial parameter estimates. If selected, all parameter estimates for the same event type, across all trials, will be z-scored before computing the contrast. This option is currently only available for non-linear models.

Review first level model

Next to the regressors on the x- and y-axes, orthogonality plots newly display regressor names along the y-axes.

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GLM

Problem with multiple sessions in Design matrix fixed.

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General linear modelling (GLM)

New modalities

For the first time in PsPM, we introduce models for data types other than SCR:

- GLM for evoked HPR

- GLM for fear-conditioned HPR
- GLM for evoked RA
- GLM for fear-conditioned RA
- GLM for evoked RFR
- GLM for evoked RP
- GLM for fear-conditioned PS

Tools & Data preprocessing

Tools are split up into Tools & Data preprocessing. The content of each section is listed below. New functions are written in green.

Tools

- Display data
- Rename file
- Split sessions
- Artefact removal
- Downsample data
- Interpolate missing data
- Extract segments
- Segment mean

Data preprocessing

- Preprocess heart data
- Preprocess respiration data
- Prepare illuminance GLM
- Find valid fixations
- Convert pupil data
- Find startle sound onsets

Data preparation

Import

Support for Philips Scanphyslog files and for bioread-converted AcqKnowledge files has been added to the import function.

Figure 5.1: Model comparison between old and new versions of the VBA toolbox, based on one delay fear conditioning dataset (Dataset 2, see earlier comparison). The log Bayes factor quantifies the difference between negative log likelihood (nLL) of parameter estimates obtained from model inversion using the old and new version of VBA. A difference in nLL above 3 indicates significant differences in model evidence which is not exceeded for the used dataset.

5 PsPM Version 4.0

Change from scr_ to pspm_

The prefix scr_ has been exchanged with pspm_. This applies to all functions contained in PsPM.

Updated toolboxes

Matlabbatch (`https://git.code.sf.net/p/matlabbatch/code-git`) and the VBA toolbox (`https://github.com/MBB-team/VBA-toolbox`) were updated to the latest available versions (08.11.2016). The updated VBA version fully supports newer Matlab versions and warning messages in Matlab 2014 and newer do not appear anymore (during PsPM startup). In terms of predictive validity, we noted that there was no consistent benefit of the old or new version of this code (Figure 5.1).

Subsessions in DCM models

Until now, long periods of NaN values (which are just disregarded) could cause problems for inversion of DCMs. These periods are now split (according to threshold value) into subsessions. The subsessions will be evaluated independently, while at the end the results will be stacked together. Therefore the output-format will not change and should be compatible with earlier releases.

Import

New import function for Labchart files

The new import function allows direct import of raw labchart files without exporting them to a suitable format (as was required to date). The function is only available on Windows systems.

General linear modeling (GLM)

New modalities

- Startle eyeblink for EMG (SEB)

Pupil Models

- Blink channels were removed. Periods during blinks and saccades are set to NaN already in the import function. This applies to all channels of the respective eye. Accordingly, blink validation functionality was removed in the function pspm_find_valid_fixations. If needed, blinks and saccades can be imported as custom channels using channel ids 7-10 (two eyes) or 4-5 (one eye), while blinks and left eye come first.
- Importing pupil channels now allows direct specification of a transfer function to convert arbitrary units to mm.
- Importing of eyes which have not been recorded creates channels containing NaN values, so that the same import batches can be used for groups of subjects, even if one eye is missing in some of them.
- Sessions in eyelink files (caused by interruption of recording) will be concatenated according to the timing variable.
- In pspm_find_valid_fixations
  - the use of software aspect ratio was replaced by resolution. This allows to correctly map the gaze coordinates to the shapes mapped by the stimulus software.
  - gaze coordinates can be plotted in order to verify the validation settings.
  - interpolation option was removed and should now be used independently.

Minor changes & Bugfixes

- Version-Check bug during startup is now fixed.
- Markerinfos will now according to marker channels be converted to an event-based format.
- The data editor (pspm_data_editor) now allows to specify an output file using the command line.
- pspm_split_sessions additionally allows to specify marker ids at which the file should split.
- Artefact correction was extended with a further function (Simple SCR quality correction).
- Convert pupil data becomes convert data and currently only allows area to diameter conversion (arbitrary units to mm is integrated in the import function)

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Bugfixes

- Fix not working options in Matlabbatch module 'Preprocess heart data'

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Bugfixes

- Fix error when calling 'Convert data' from GUI
- Fix taking square root if pupil data is recorded in AREA

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New Functions

- pspm_convert_pixel2unit: Allows to transfer gaze data from pixel to units. This facilitates the use of pspm_find_valid_fixations which needs data in unit values.
- pspm_compute_visual_angle: Computes visual angle from gaze data.
- pspm_convert_visangle2sps: Convert visual angles from Eyelink to Scanpath speed.
- pspm_bf_spsrf_box: SPSRF basis function with box car.
- pspm_bf_spsrf_gamma: SPSRF basis function with gamma function.

New Features

- pspm_extract_segments supports DCM files/structures.
- GLM for SPS.
- pspm_find_valid_fixations can now take a bitmap as input.
- A new way to trim data: Start and end times can be chosen according to marker name or value.
- A new function to import SMI iView X EyeTracker files into PsPM.
- A new function to import ViewPoint EyeTracker files into PsPM.

Changes

- pspm_find_valid_fixations now computes a circle around the fixation points when run in fixations mode.

Bugfixes

- Heart period response function (bf_hprf) coefficients are fixed according to the manual
- pspm_extract_segments bugfixes:
  - Fix bugs related to conditions appearing in different sessions.

- pspm_get_eyelink now imports markers between two recording sessions (previously these markers were "lost")
- pspm_compute_visual_angle: Fix bug in range computation.
- pspm_ecg2hb: Fix out of bounds error occurring for highly noisy data with many outliers.
- pspm_get_acq: Fix incorrect linear transformation during ACQ import.
- pspm_convert_unit: Fix incorrect transformations between metric units and inches.
- pspm_resp_pp: Fix out of bounds error during convolution in cushion mode.
- pspm_pp in 'simple_qa' mode now uses the default values specified in pspm_simple_qa.
- Various further bugfixes.

Improvements

- Blink and saccade channels can be imported with PsPM Eyelink import.
- GLM structure holds the missing data percentage of each condition after segment extraction. Further, the decision to exclude conditions can be made depending on the percentage of missing data.
- pspm_extract_segments now works both with GLM files and already loaded structures
- PsPM now checks if SPM is already in MATLAB path. If so, user is asked to remove it from path before initializing PsPM.
- pspm_load1 now returns statistics about conditions with high NaN ratios.
- pspm_extract_segments now is able to use data stored in GLM/DCM structures instead of relying the existence of original data files.
- Multiple new tests to validate the correctness of the functions.

9 PsPM Version 4.1.1

This is a hotfix release that fixes a few issues with 4.1.0 release.

Changes

- pspm_get_eyelink now uses the scaling factor from [4] for area based arbitrary units to milimeters conversion.
- pspm_get_smi does not perform pixel to milimeters conversion for pupil data anymore. Pupil values are returned as is in pixel units.
- pspm_get_smi performs pixel to milimeters conversion for gaze data only if the stimulus resolution in pixels are given as an extra option.

Improvements

- pspm_get_viewpoint is now able to import blink and saccade channels from sample files as well. In order to enable this feature, event files must be stored asynchronously in the datafile. See ViewPoint EyeTracker section in this manual for further information.

10 PsPM Version 4.2.0

New Functions

- A new pupil data preprocessing function
- A new pupil foreshortening error correction function
- A new QRS detection algorithm for fMRI environments

New Features

- Previously, Eyelink import used to discard 50 ms worth of samples from each side of every blink or saccade period. This behaviour is preserved; however, sample discard duration can now be set by the user.
- Channel processing functions now store extensive historical data in PsPM files. This data can be printed in table format using the new utility `function pspm_format_history_from_file`
- Pupil channel is now loaded according to a new precedence order. Refer to GLM documentation in this manual to learn more.

Changes

- Eyelink import now returns times and dates in a slightly different format.
- Newest version of PsPM is now obtained from the version string in pspm.sourceforge.net, not from the download link zip file name
- GLM now uses the **LAST** channel of a specified modality in a PsPM file.
- Nonlinear SCR model (DCM) now does not use the inter-trial interval duration value (ITI) of the last trial when computing session specific minimum ITI values. Previously, using these last ITI values would lead to abnormally small overall min ITI values in some input files, thereby causing the inference and PCA sections to use less data for all trials. Now, we prevent this from happening.
- Eyelink import parameter blink/saccade edge discard factor default value has been set to 0. This means no extra samples are discarded around blinks/saccades.

Bugfixes

- Fix a bug in `pspm_extract_segments` where trial onsets were not assigned to conditions correctly
- Fix a bug in Viewpoint import where files in DOS format were being parsed incorrectly
- Fix a bug in Eyelink import where blink/saccade periods where misaligned, causing the function to discard useful data and return noise instead

Improvements

- New utility functions to make PsPM more compatible across different operating systems
- An optimized Eyelink import function that is significantly faster and more memory efficient than previous versions
- An optimized SMI event import function that is significantly faster than the previous version
- Multiple new tests to validate the correctness of the functions
- API unification: Now all preprocessing functions use `channel_action` variable to choose what to do with the new channel.

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New Functions

- Three new tests (pspm_hb2hp_test.m, pspm_filtfilt_test.m, pspm_butter_test.m)

Changes

- `pspm_display` and `pspm_ecg_editor` do not perform filtering anymore.
- Treatment of missing data in DCM is now the same regardless of whether they are specified as NaN or via model.missing
- Eyelink import parameter blink/saccade edge discard factor default value has been set to 0. This means no extra samples are discarded around blinks/saccades.

Bugfixes

- Fix a bug in `pspm_hb2hp` where the function crashed when there is no heartbeat left after lower and upper bound filtering of the heartbeat periods
- Fix a bug in `import_eyelink` which imported more markers than the number of markers in the actual .asc file

- Fix a bug in `pspm_display` which crashed when trying to plot ECG signal that contains NaN
- Fix a bug in `pspm_prepdata` which returned only NaN when input signal contained some NaN values
- Fix a bug in `pspm_version` which crashed when MATLAB was invoked with `-nojvm`
- Fix a bug in `pspm_get_viewpoint` which returned '+,=,+' lines in the marker list and which crashed when given a viewpoint data file containing multiple sessions separated with '+,=' type of markers
- Fix a bug in `import_viewpoint` which created a new session for every marker containing a '+' somewhere, e.g.: 'CS+'
- Fix a bug in `pspm_get_events` which was not able to locate a marker if it occured on the first or last sample in a given datafile
- Fix a bug in `pspm_filtfilt` which crashed when the filter parameters were of dimension one

12 PsPM Version 4.3.0

New Features

- In `pspm_get_events`, `import.flank` can be now set to `'all'` what would import all markers and data related to them.
- `pspm_display` allows now to display pupil size units and the gaze x & y coordinate units on the y-axis.
- `pspm_extract_segments` can be used now with raw data and thus be called easily within another function.

Changes

- `pspm_version` has a new url and thus do not send any warning about version checks anymore.
- `import_eyelink` do not import markers which are outside the session end time (`END` marker).
- `import_eyelink` sends a warning whenever two markers have the same timestamp.
- In `pspm_get_eyelink`, `import.flank` set to `'all'`.
- The test of `pspm_extract_segments` was adapted to the new feature.
- External functions and libraries were regrouped in one folder called `ext`.

Bugfixes

- Fix a bux in `pspm_bf_lcrf_gm` and `pspm_bf_ldrf_gm` where the offset was wrongly implemented.
- Fix a bug in `pspm_compute_visual_angle` where there was an error in the conversion factor of pixels wrt. to mm.

13 PsPM Version 5.0.0

New Features

- Allow `pspm_data_editor` to load an epoch file.
- Allow `pspm_simple_qa` to suppress classification of discretisation oscillations as artefacts, to expand artefact windows, and to automatically remove small data islands embedded in artefacts.
- Allow `pspm_simple_qa` to store the epochs of data that are filtered out into an output `.mat` file. The accompanying GUI editor is available under 'Artefact removal' in the tools section.
- Allow `pspm_convert_gaze_distance` to convert from distance units to degrees or scanpath speed. The accompanying GUI editor is available under 'Gaze Convert' in the data preprocessing section.
- Add the possibility to select the flank in the `Import` module of the GUI of PsPM.
- Add the possibility to import DSV (delimiter separated values) as well as CSV (comma separated values) data files.

Changes

- Split the data convert functionality in tools into the 'Gaze Convert' and 'Pupil Size convert' in the data preprocessing section.
- Factor out blink/saccade edge filtering logic out of `pspm_get_eyelink` to `pspm_blink_saccade_filt`.
- Deprecate edge filtering functionality in `pspm_get_eyelink`.
- Make `pspm_pupil_correct_eyelink` use the last gaze channel when there are multiple gaze x (similarly y) channels in the file.
- Make `pspm_extract_segments` return NaN percentages and not ratios.

Bugfixes

- Scale DCM plot XTick by sample rate.
- Correct index offset when dealing with the descending flank for continuous markers.
- Allow `pspm_display` to plot any type of marker channels.
- Fix `pspm_display` behaviour when user tries to load data with less channels than the data he/she is currently displaying.
- Fix `pspm_split_sessions` behaviour when the intertrial interval in the data is random. Add an option `randomITI` (0 or 1) which in the latter case it forces the function to evaluate the mean marker distance using all the markers and not per session. Default value: 0.
- Remove `startsWith` and `endsWith` from all functions for a better backward compatibility.
- Fix bug in `pspm_trim` which was wrongly defining the starting trimming point index.

14 PsPM Version 5.1.0

New Features

- PsPM now has an improved GUI with a more eye-friendly colour and typeface.
- PsPM now has an alternative GUI built by using .mlapp, which shows consistent a more modern appearance across different platforms.

New Functions

- pspm_scr_pp
  - `pspm_scr_pp` replaces the classic `pspm_simple_qa`.
  - `pspm_scr_pp` now allows users to detect clipping, where the results can be exported together with the original outcome.
  - `pspm_scr_pp` now allows users to just write artefact epochs and leave data unchanged.

Changes

- General
  - Dialogs have been rewritten for avoiding endless loops.
  - *Pre-processing* menu has been reconstructed, where *pupil size convert* and *gaze convert* are now under *pupil and eye tracking*.

  - PsPM now always generates test data inside the PsPM folder.

- pspm_interpolate
  - `pspm_interpolate` now process data ending with `NaN` well without throwing warnings.
- pspm_find_sounds
  - `pspm_find_sounds` now throws warning when some data was excluded due to the strict parameter setting.
- pspm_split_sessions
  - `pspm_split_sessions` is now using `pspm_trim` for processing data.

Bugfixes

- pspm_glm
  - A bug that leads to the failure of selecting left/right eye has been fixed.
- pspm_load1 and pspm_dcm
  - A bug that leads to the failure of exporting statistics has been fixed.
- pspm_resp_pp
  - A bug that leads to the failure of opening batch for respiration data processing has been fixed.
- pspm_scr_pp
  - A bug that leads to incorrect matrix construction has been fixed.

References

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[3] Daunizeau, J, Adam, V, & Rigoux, L. (2014) VBA: a probabilistic treatment of nonlinear models for neurobiological and behavioural data. *PLoS Comput. Biol.* **10**, e1003441.

[4] Hayes, T. R & Petrov, A. A. (2015) Mapping and correcting the influence of gaze position on pupil size measurements. *Behav. Res. Methods* **48**, 510–527.