

# **BHSAI**

**Biotechnology HPC Software Applications Institute**

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## **PC-PVT**

Psychomotor Vigilance Task software for PC

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User's Guide

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## Overview

The PC-PVT software was developed at [BHSAI](#) as a PC-based replacement to the [PVT-192®](#). The software currently implements the visual stimulus protocol and provides configuration settings identical to PVT-192 for running Psychomotor Vigilance Task (PVT) studies. A Graphical User Interface (GUI) is provided for managing studies, subjects, and trial data. Existing tools written to work with PVT-192 results, such as the REACT software, may continue to be used when analyzing results generated by PC-PVT. In addition, the software provides its own data analysis facilities, including the individualized PVT prediction algorithms developed at BHSAI.

Due to the performance-sensitive nature of the software, not all PC hardware will provide equally accurate test results. The System Requirements Section goes over the details of the required and recommended system components. A relatively modern PC (by 2012 standards) running Windows 7 with HPET hardware, 1000 Hz mouse polling, a mid- to high-end video card, and a fast (e.g., 2 ms) LCD panel should be able to measure reaction times to within 1-10 ms accuracy. The accuracy of measurements will drop with older and slower components. For example, the default mouse polling rate on Windows is 125 Hz, which immediately introduces an error in response detection of up to 8 ms.

The rest of the User's Guide provides all necessary information for installing and using PC-PVT. Sections at the end contain technical details about the protocol implementation and file formats, which should be useful to anyone attempting to interface directly with the data storage system.

## Prediction Algorithm

The prediction algorithm integrated into PC-PVT is an experimental part of the system. It is designed to predict performance (represented by several metrics) up to 24 hours into the future for each subject within a study. In order for the predictions to be accurate, a number of constraints have to be met:

First, each subject is expected to take PVT trials at regular intervals (e.g., every hour). This interval must be specified as the *Session Rate* parameter for the study. Missing sessions are tolerated, but may degrade the quality of predictions.

Second, the algorithm currently does not handle sleep breaks between trials. Predictions will only be accurate during a single total sleep deprivation period.

Third, predictions for the most recent trial are generated and saved immediately after the end of the trial, using all previous non-practice trials to customize the algorithm parameters for that individual. As a result, the subject must use the same computer during testing to ensure that the full PVT history is available to the algorithm.

## System Requirements

The following software and hardware components are required or recommended to run PC-PVT:

### ***Software***

- Windows XP SP3+, Vista SP2+, or 7 SP1+ (32- or 64-bit). Windows 7 is recommended.
- Windows Installer 4.5+.
- DirectX 9.0c End-User Runtime (installed automatically).
- MATLAB Compiler Runtime R2011b.
- Microsoft Excel 2003+ for export functionality.

### ***Hardware***

- Any Intel or AMD x86 processor supporting SSE2 instruction set.
- 2 GB of free disk space.
- 1 GB of memory (2+ GB recommended).
- USB mouse, preferably supporting 1000 Hz polling (e.g., Razer).
- Video card and drivers supporting Direct3D 9 API.
- CRT or LCD monitor, preferably supporting 8 ms or faster response time. The monitor should report accurate physical size in its EDID block.
- 1024x768 @ 60 Hz or greater progressive scan video mode.
- HPET support on the motherboard is recommended (see BIOS settings). This requires Windows Vista or 7.

## Terminology

### *Absolute Time*

Refers to a time measurement, in seconds, relative to the start of the session (see *Time Zero*). Most time values in the raw output format are absolute.

### *Installation Directory*

Directory that contains the main PVT executable. By default, C:\Program Files\PC-PVT\ or C:\Program Files (x86)\PC-PVT\.

### *Inter-Stimulus Interval, ISI*

The pause between the latest response (mouse click) and the oncoming stimulus. The interval is selected independently before each stimulus from a uniform random distribution in the range  $min \leq ISI < max$  with a granularity of 1 ms. The minimum value may not be less than 1000 ms, which is the *Response Feedback* duration, the maximum value may not be greater than 65,000 ms, which is the *No Response* condition.

### *Practice Session*

A PVT session that is used to familiarize the subject with the testing protocol. Data for practice sessions are stored on the hard drive and may be exported via the PVT Manager. However, these sessions do not appear in the Analysis window and are not used by the prediction algorithm.

### *Prediction*

An estimate of the subject's future performance based on his/her previous sessions.

### *"Ready?" Screen*

The initial image seen by the subject upon launching the PVT session. It consists of white text on black background providing some basic instructions to the subject. The PVT session begins when the subject clicks the primary mouse button after reading the instructions.

### *Relative Time*

Refers to a time measurement, usually in milliseconds, relative to some other recent event during the trial. For example, the relative reaction time (RT) is calculated by taking the absolute time of the response and subtracting the absolute time of the associated stimulus.

### *Response, False Start, No Response*

A mouse click during a PVT session. A response is considered valid if it was preceded by a stimulus. Responding before stimulus presentation (excluding the response feedback period) results in a *False Start* condition. Failing to respond within 65 seconds results in a *No Response* condition.

### *Response Feedback*

A 1-second period after each response during which the result is shown on the screen. If the response is valid, the actual reaction time (RT) in milliseconds will be shown. Otherwise, the letters "FS" or "ET" appear to indicate a false start or no response (elapsed time) condition, respectively. *This 1-second period is considered part of the next ISI, but any*

*mouse input during this period will NOT trigger a false start condition.*

*Root Directory*

Directory that contains the data for all local studies. It is selected on first invocation of the software and may be modified later by editing the `conf.xml` file in the installation directory.

*Session, Trial*

These terms are used interchangeably to refer to a period of time during which a single subject is sitting at the computer and responding to visual stimuli. The duration of a single session/trial is specified by the TTT (Total Trial Time) parameter in the study configuration. This is typically set to 5 or 10 minutes.

*Time Zero,  $T=0$*

The reference point for all absolute time measurements during an active PVT session. Defined as 500 ms after the mouse click at the "Ready?" screen.

*Total Trial Time, TTT*

The duration, specified in seconds, of a single PVT session/trial.

*VBlank*

The period in the monitor's refresh cycle when nothing is being drawn on the screen. The previous frame was drawn from top to bottom, the next frame is about to be drawn. As a rough idea of its duration, if the monitor has a vertical refresh frequency of 60 Hz (16.667 ms), the scan time could be 16 ms, while vblank is 0.667 ms.

## Conventions

The following conventions are used throughout this document:

`File System Path`

Monospaced font is used for file, directory, and program names.

### **Keyboard or Mouse Command**

Bold font is used to indicate a key press or mouse action.

*Emphasis*

Italic font is used to emphasize specific information and technical terms.

`<element>...</element>`

Monospaced font containing XML tags is used to refer to configuration file contents.

Time units are specified either in seconds (s) or milliseconds (ms).



## Installation and Updates

Follow these steps to install PC-PVT for the first time:

1. Verify that the hardware requirements are met.
2. Install MATLAB Compiler Runtime (MCR) by running `MCRInstaller.exe`.
3. Install PC-PVT by running `Setup.msi`.
4. Test the application by double-clicking on the `PVT Manager` icon on the desktop.

### **Updating**

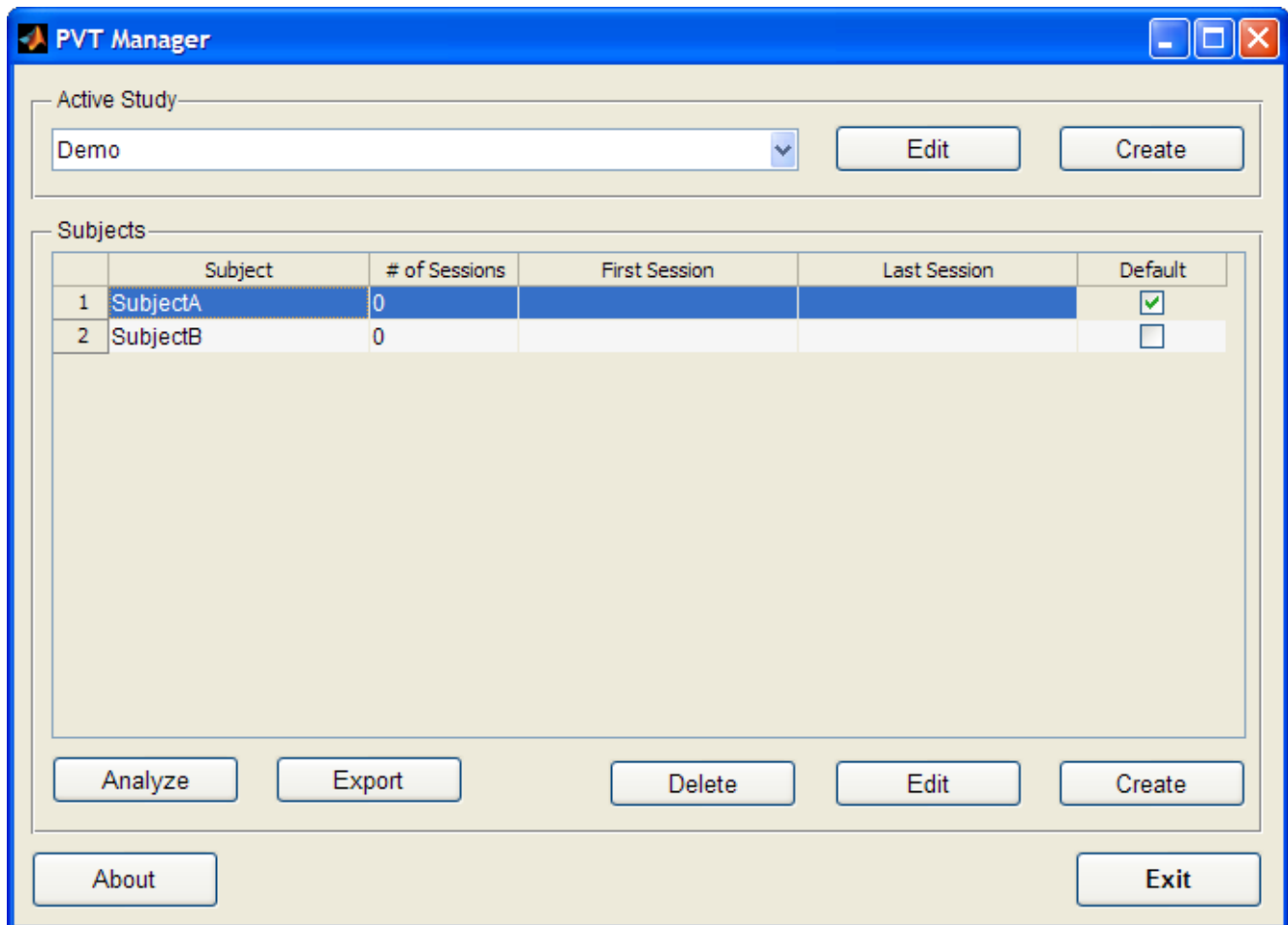
There are two types of updates – those that require a newer version of MCR and those that do not. If the Version History entry for the update does not specify a change in MCR version, then the update may be performed simply by running the new `Setup.msi` package. This will automatically remove the previous PC-PVT version and install the newer one.

If the update requires a new MCR, the previous version should be uninstalled manually via the `Control Panel`, and the new MCR version installed before running `Setup.msi`.

*All settings and data will be preserved across version updates. However, it is always recommended to backup the program and data files in case something goes wrong.*

## Manager

The manager is used to define studies and subjects, configure test parameters, view test results, and export data. It is started by passing the `-a` flag on the command-line to the main executable. If this flag is not specified, the PVT trial component will run, which is described in the next section. Desktop and Start Menu shortcuts for running the trial and manager are created automatically when the software is installed. When starting the manager, the first window provides an overview of the active study:



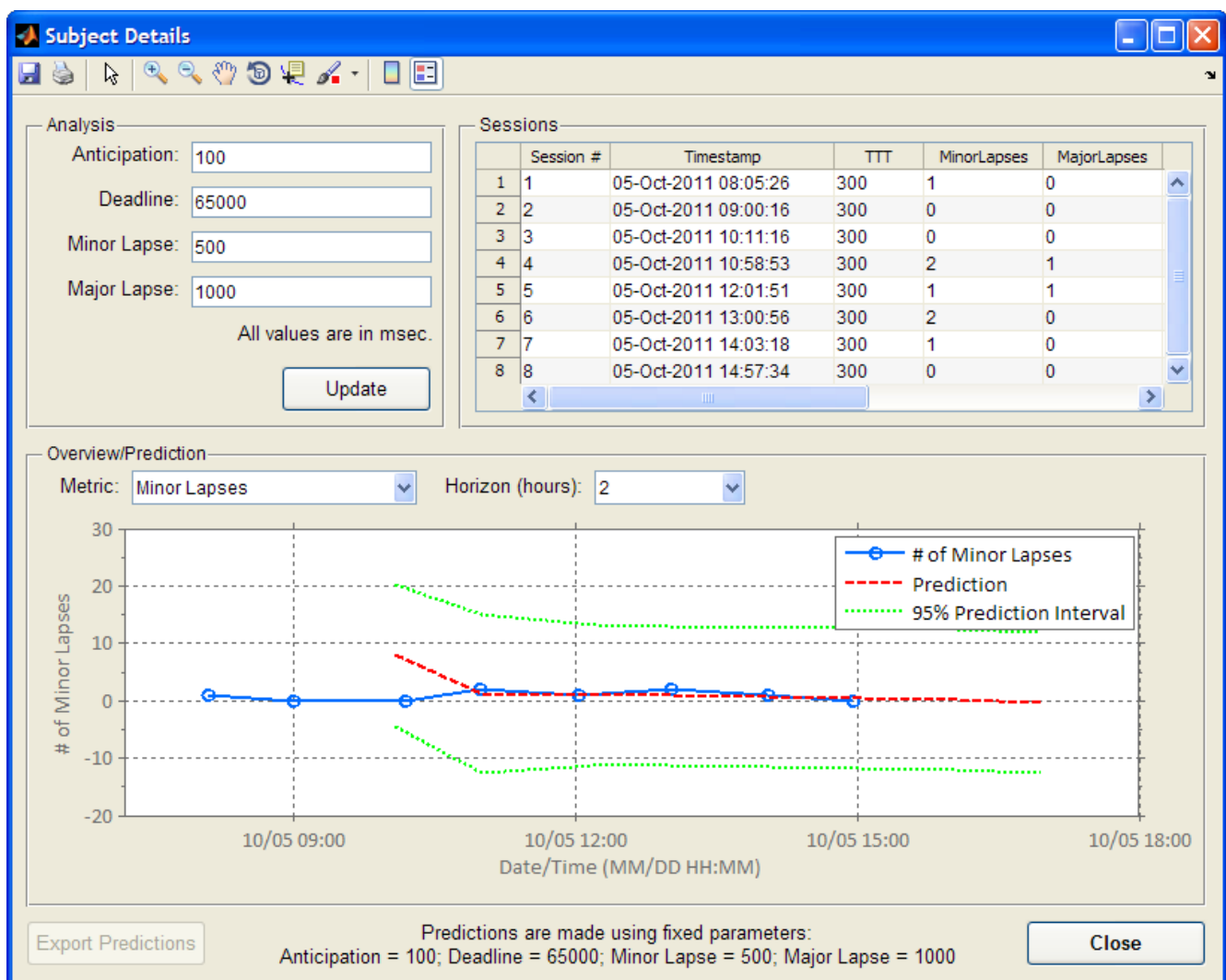
The “Active Study” drop-down menu lists all studies found under the root directory. A study directory that is missing its `study.xml` configuration file will not be listed.

All defined subjects within the current study are shown in the “Subjects” table along with some basic information about the number of sessions they performed, the date/time of the first and last session, and which subject is the “*default*.” Marking a subject as *default* causes that subject to be selected automatically upon starting the next PVT session. It is possible to uncheck the default checkbox, in which case subjects will be required to select their ID before starting the session.

Selecting one or more subjects enables the “Export” function, which exports PVT data for all selected subjects into a Microsoft Excel file. This feature requires Microsoft Office 2003+ to be installed on the local computer. Use **Ctrl** and/or **Shift** keys on the keyboard to select multiple subjects. The exported Excel file will contain a single sheet called “Summary” that provides all basic statistics for each subject/session. All other sheets are named using “<SubjectID>\_<SessionID>” format and contain raw PVT data for that session.

## Data Analysis

Double-clicking on one of the subjects, or selecting the subject and clicking “Analyze,” brings up the analysis window:



This window is used to get a quick overview of all non-practice sessions and to view the output of the prediction algorithm. The “Analysis” box specifies the current parameters that are active for the study. These affect the calculations of several statistics. For example, if the “Major Lapse” is

defined as 1000 ms, then the “MajorLapses” column in the “Sessions” table will count the total number of RTs that are greater than 1000 ms. These parameters also affect the “Export” function on the main Manager window for the current study.

The table below provides a summary of configurable analysis parameters:

Parameter	Default	Description
Anticipation	100 ms	$RTs < X$ are ignored when computing statistics. False starts are not counted in the Anticipations column.
Deadline	65000 ms	$RTs \geq X$ are ignored when computing statistics.
Minor Lapse	500 ms	$RTs \geq X$ are counted in the MinorLapses column. This count also includes Major Lapses.
Major Lapse	1000 ms	$RTs \geq X$ are counted in the MajorLapses column.

*False start and no response conditions are always excluded from calculations.*

## Trial

A PVT trial begins with the Setup window, which permits the selection of subject ID and trial practice status.

The current study is set according to the study that was selected most recently in the manager. As a result, if the study name does not match what was expected, exit out of the trial setup, run the manager, and select the appropriate study. *The two applications will not run at the same time.*

If a default subject is defined for this study, that subject will be automatically selected in the “Subject ID” drop-down menu. Otherwise, the current ID will be blank and subjects will be required to select their ID before proceeding to the pre-trial mood question.

The person administering the trial should verify the information presented in “Study day” and “Date/time” fields. If any value is incorrect, exit the application and adjust the system clock or study settings.

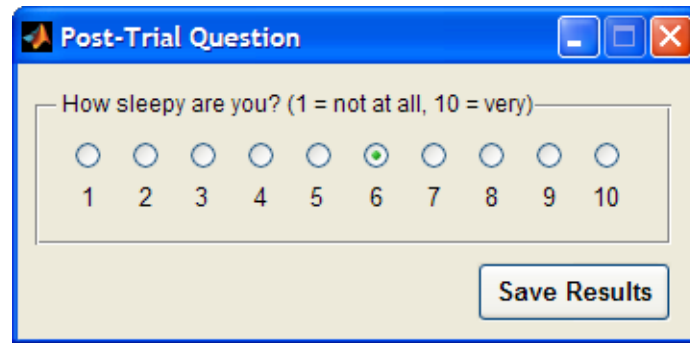
The pre-trial mood question dialog will show up only if the mood question is configured for the current study. If not, then the trial will begin right after the setup window and an answer of -1 will be stored. The subject may use numbers on the keyboard to answer the question (**1-9** and **0** = 10).

Clicking “Exit” at this point will terminate the trial without storing any data. However, once the subject clicks “Begin” (or pushes **Enter** on the keyboard), the configuration and log files will be written to disk in preparation for running the trial.

From this point on, the subject follows instructions on the screen to perform the test, using the mouse button to respond to visual stimuli.



At the end of the test, the mood dialog will appear once again (if the mood question is configured) to obtain the subject's post-trial mood.

A screenshot of a Windows-style dialog box titled "Post-Trial Question". The dialog has a blue title bar with standard minimize, maximize, and close buttons. The main area is light beige and contains the text "How sleepy are you? (1 = not at all, 10 = very)". Below this text is a horizontal row of ten radio buttons, each with a number from 1 to 10 underneath it. The radio button for "6" is selected, indicated by a small green dot in its center. At the bottom right of the dialog is a button labeled "Save Results".

Post-Trial Question

How sleepy are you? (1 = not at all, 10 = very)

1 2 3 4 5 6 7 8 9 10

Save Results

After clicking “Save Results” (or finishing the trial, if a mood question is not configured), the trial configuration file (`trial.xml`) is updated with the post-trial mood response, PVT data are stored to the hard drive in raw and PVT-192 formats, and the prediction algorithm is executed to predict the subject's performance several hours in advance based on the current and all previous non-practice sessions. *Prediction is not executed for practice sessions.*

## PVT-192 Comparison

The PC implementation of the PVT protocol attempts to duplicate the behavior of the PVT-192 device as closely as possible. The following is a list of known differences between the software and PVT-192:

- Error codes 0 (response on wrong button), 2 (false response, wrong button), and 3 (either button held down) are not used. These codes were deemed to be not applicable for input via the PC mouse. For example, a right-handed person may choose to respond by pressing the right mouse button with their thumb, while holding the mouse in their hand and off the table. Another right-handed person may prefer to click the left mouse button in the normal fashion. Therefore, even after taking into account the subject's left/right hand preference, there is no obvious definition of the “wrong” button as long as the input method is consistent.
- Post-false start behavior does not match PVT-192. The PC software handles a false start (FS) like any other response; the letters “FS” are shown on the screen for 1 second and the session then goes into the next ISI period, which obeys the configured minimum and maximum ISI values. The PVT-192 has been observed ignoring the configured minimum ISI parameter after the false start (i.e., it presented the next stimulus before the minimum ISI time has elapsed). It is not obvious what algorithm the PVT-192 uses after a false start to determine when the next stimulus is to be presented. This difference in implementations should not have any tangible impact on the results.
- The first response time is valid. The first RT reported by PVT-192 in each session is smaller (faster) than actual by around 100-200 ms. As a result, when processing PVT-192 output, it is necessary to ignore the first data row. The PC software reports all response times with equal accuracy.
- The millisecond counter on the screen starts by showing five digits (“00000”). PVT-192 starts with the display of a single digit and goes up to four when reaching the 1-second mark. Due to the increased distance of the subject from the screen and the relative size of the stimulus, displaying five digits, including 10's of seconds, was deemed to be the more appropriate design choice.
- The mood field in `data.pvt` does not specify the actual mood question. PVT-192 allows just one word to be used as the mood question. For example, if that word is “TIRED” then the output data file will contain a line such as:

```
"TIRED PRE, POST TRIAL:",6,6
```

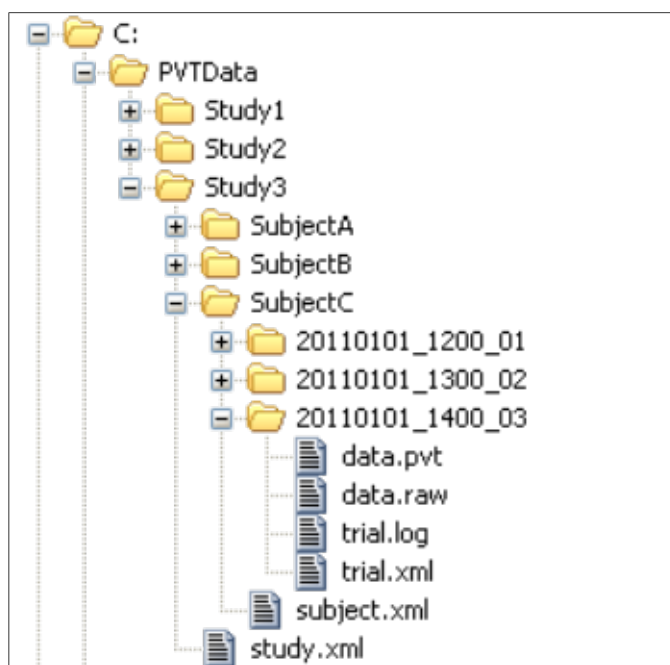
The PC software allows an arbitrary phrase to be used as the mood question. As a result, the first word in the line above will always be “MOOD” for data sessions performed on the PC.

All other behavior of the PC software is identical to PVT-192.



## File System Organization

When running the PVT Manager for the first time, the user is asked to select or create a *root directory*. This directory is used to store all studies, subjects, and sessions in the following hierarchy:



In the above example, `C:\PVTData\` is a root directory that contains three separate studies. Each study has its own set of subjects, and each subject directory contains all PVT sessions/trials performed on this computer. Trials performed on one computer may be moved to another, but this should only be done when the same subject used two different computers in the same study.

The trial directories are named using the format `YYYYMMDD_HHMM_NNN`, where `NNN` is a sequential trial number starting with 001. If trials from two separate computers are later merged together, there will be duplicate sequence numbers. However, since all trials are also timestamped it is always possible to determine the sequence in which the trials were performed.

The following table provides short descriptions of files that may be present in each trial directory. If the trial was terminated abnormally, only `trial.xml` and `trial.log` will be present (`data.raw` may also be present, but will be empty). In this case, `trial.log` will contain an explanation for why the trial was not completed normally. If `trial.log` is also missing, the status element in `trial.xml` should report the error condition that prevented trial execution (see PVT Protocol Implementation Details for information on exit codes).

File Name	Description
<code>data.pvt</code>	Session data in PVT-192 format.
<code>data.raw</code>	Session data in raw format (see Raw Output Format).
<code>trial.xml</code>	Trial configuration.
<code>predict_*.csv</code>	Prediction algorithm output.
<code>*.log</code>	Debugging information recorded during the trial.
<code>*.mat</code>	MATLAB data used for debugging.

The three XML files (`study.xml`, `subject.xml`, and `trial.xml`) contain configuration settings for the study, subject, and trial, respectively. An additional configuration file called `conf.xml` is located in the installation directory and defines global application settings, including the location of the root directory.

### ***Moving Files***

The XML configuration files may be edited by hand and moved from one computer to another. This should only be done when neither the manager nor the trial software is running. The trial configuration file also contains copies of `conf.xml`, `study.xml`, and `subject.xml` files as they were at the time when the trial was taken. As a result, it is always possible to determine and recreate the exact conditions of a previous trial.

### ***Renaming Studies and Subjects***

It is possible to rename studies and subjects. This must be done manually when the manager and trial software are not running. To rename a study, change the directory name, and then edit the “<name>...</name>” element in `study.xml`. The study will not be usable unless both of these items match exactly under case-sensitive comparison. Likewise, to rename a subject, change the subject's directory name, and then edit the “<id>...</id>” element in `subject.xml`.

This renaming protocol was implemented specifically to prevent accidental changes in study or subject directory names.

## Raw Output Format

The PVT results are written to a file called `data.raw` at the end of the session. This file is saved in the session directory as defined in File System Organization. If the session is terminated abnormally, this file could be missing or empty, depending on the cause of termination. The table below provides short descriptions of all columns in the raw output file:

Column Name	Description
<i>id</i>	Response ID counting up from 0
<i>isi</i>	Planned ISI period (excluding feedback time)
<i>it</i>	Absolute ISI period start time
<i>sp</i>	Absolute frame swap (present) time
<i>st</i>	Absolute stimulus time (digits visible on the screen)
<i>rt</i>	Absolute response time
<i>err</i>	Error in polling for mouse input
<i>bp</i>	Bad present flag ( $st - sp > \text{max. expected scantime}$ )
<i>fs</i>	False start flag
<i>nr</i>	No response flag

All time values (*isi*, *it*, *sp*, *st*, *rt*, and *err*) are in seconds. The *id* column simply enumerates all responses. The *isi* column specifies the intended ISI period, which is computed at the start of the session. The next four columns contain absolute times of key protocol events described in the next chapter. The *err* and *bp* columns report diagnostic information that is not likely to be useful for any real analysis. The *fs* column is set to 1 to indicate a false start. The *nr* column is set to 1 to indicate no response.

The following table provides formulas for extracting information from the raw output:

Desired Parameter	Formula
RT (1st column in PVT-192 output)	$RT = \begin{cases} 1 & \text{if } fs = 1 \\ 65000 & \text{if } nr = 1 \\ \text{round}((rt - st) * 1000) & \text{if } fs = 0 \text{ and } nr = 0 \end{cases}$
ET (2nd column in PVT-192 output)	$ET = \text{round}(rt * 10) / 10$
Actual ISI (including feedback)	$ISI = \text{round}((st - it) * 1000)$

## PVT Protocol Implementation Details

This section describes low-level details of how the PVT protocol is implemented by `pvt.exe`. Once started, `pvt.exe` runs until it encounters an error during initialization, the user aborts the trial by pressing **Ctrl-Q**, or the trial time exceeds maximum configured value (TTT). The following table describes all possible exit codes:

Exit Code	Description
0	Normal termination, results saved
1	General error
2	User abort or loss of application focus
3	Video configuration error
4	Initialization error
5	Command-line options error

The program is written in C using Direct3D 9 API for all video functions. It is compiled using Visual Studio 2010 and requires the 2010 C Runtime library. Upon starting, the program initializes the video, input, timer, and logging subsystems, and displays some basic instructions for the subject to read. This is the “Ready?” screen.

The session will begin with the click of the **primary mouse button**. The step sequence below describes what happens after the mouse click. The steps refer to variable names that are described in the Raw Output Format section. Pressing **Esc** at any time during the test (including at the “Ready?” screen) causes the test to terminate with an exit code of 2.

1. The screen is erased, execution is paused for 500 ms. This delay is also present in PVT-192.
2. The test timer is started; this is  $T=0$ . Variables *it*, *sp*, *st*, and *rt* will be recorded as the number of seconds elapsed since this point in time. The phrase *current time* is also relative to this point.
3. Execution is paused for another 1000 ms. This delay is present in all subsequent iterations in the form of the response feedback.
4. Internal parameters are reset in preparation for the next stimulus/response sequence.
5. Time *it* is set to current time minus 1000 ms (will be close, but not quite zero for the first iteration).
6. The next *isi* value is selected from a uniform random distribution in the range  $[ISI_{min} - 1000, ISI_{max} - 1000)$ .
7. The program sleeps for *isi* milliseconds, periodically checking for a false start condition. If a false start is detected, the current time is recorded as time *rt*, times *sp* and *st* are set to 0, and the loop continues with step 15, showing “FS” as the result.
8. The counter “0000” is drawn to the back buffer. The program waits for the start of the next

vblank period and issues the “present” command, swapping the front and back buffers. This is time *sp*. The screen is still blank at this stage, but the counter will be drawn once the scanline reaches the middle of the display.

9. The program monitors the scanline position during the next refresh cycle. When the scanline reaches the bottom of the digits (10% of the screen height below the digits, to be exact), the *st* time is recorded. This time is a best guess as to when the subject is first able to see the stimulus.
10. If  $st - sp > t_{vblank} + \left( \frac{t_{scan}}{mh} * (cb + (mh * 0.1)) \right)$ , where *cb* is counter bottom and *mh* is monitor height, then the *bp* flag is set to 1 to indicate that the digits may have been on the screen already by the time *st* was set. In plain English this means that if time difference *st* – *sp* is longer than it would take to complete a full vblank period and refresh the monitor up to the bottom of the counter plus 10% margin of error, then the OS most likely performed a context switch after step 8, causing the program to miss a few refresh cycles.
11. The program performs a single poll for input. If no input is available, it waits for input for 1 millisecond.
12. The counter is updated and redrawn.
13. The loop continues with step 11 until a response is detected with an upper limit of 65 seconds.
14. A mouse click is detected or 65 seconds have passed since time *st*; current time is recorded as *rt*. If the response is detected while waiting for input, the *err* field is set to 0. If the response is detected by polling, *err* is set to the time between the poll and the last input wait period. This is the uncertainty in the response timestamp and is typically negligible (< 1 ms).
15. The response feedback is shown on the screen for 1000 ms. A false start shows letters “FS,” while no response shows letters “ET.”
16. The screen is erased and input queue is flushed. All mouse responses during the feedback period are ignored and do not trigger a false start.
17. If the current time is less than the configured Total Trial Time (TTT), the next stimulus/response iteration is entered at step 4. Otherwise, results are written to `data.raw` and the process exits with the status 0.

The process of drawing the counter on the screen relies on the Extended Display Identification Data (EDID), which is reported by the monitor to the video card. Among other things, EDID contains the approximate physical height and width of the monitor. The PVT software uses this information to ensure that the text on the screen is using a calibrated 72 point font (i.e., the numbers should be approximately 1 inch in height). If the EDID information is incorrect or missing, the counter will be of incorrect size. A future revision of the software will provide some additional controls to resolve this issue.

## Configuration Files

There are five types of configuration files:

File Name	Location	Description
<code>conf.xml</code>	Installation directory	Global settings affecting all studies
<code>study.xml</code>	Study directory	Study parameters and analysis settings
<code>intro.txt</code>	Study directory	Trial instructions shown to the subject
<code>subject.xml</code>	Subject directory	Subject settings
<code>trial.xml</code>	Trial directory	Trial information and copies of <code>conf.xml</code> , <code>study.xml</code> , and <code>subject.xml</code> contents.

All of these files, except for `intro.txt`, use a very simple XML structure, which is described below. Certain elements expect to contain specific data types. For example, the “`<name>...</name>`” element in `study.xml` must be a string. If the study is assigned a numeric name, the value must be enclosed in single quotes as in the following example:

```
<?xml version="1.0" encoding="utf-8"?>
<study>
  <name>'123'</name>
  ...
</study>
```

The global configuration file is created during the first program invocation. The installation directory must be writable in order to save this file. The table below provides descriptions of all global configuration parameters:

Element	Description
<code>root</code>	Full path to the root directory containing all local studies.
<code>version</code>	Current software version. This value should not be changed.
<code>study</code>	Active study name.
<code>pvt_args</code>	Common arguments passed to <code>pvt.exe</code> .
<code>sn</code>	Device serial number. Defaults to 9999, but may be changed to any other integer to help identify which computer was used for running the trials.
<code>demo</code>	Demo flag. Do not use.
<code>analysis</code>	Global default analysis parameters.

Studies are located by looking into the root directory and identifying all sub-directories that contain a valid `study.xml` configuration file. Study configuration parameters are:

Element	Description
name	Unique study name. Must match directory name.
created	Date/time when the study was created.
owner	Person responsible for the study.
desc	Study description or any other useful information.
day1	Date of the first day according to the study protocol.
ntrials	Number of expected trials per subject. Not used by the software.
rate	Minimum expected session rate in hours. For example, a rate of 1 means that a session should be taken every hour excluding breaks for sleep or other reasons.
mood	Pre/post-trial mood question. Not used if empty.
isi	Min/Max/Step ISI parameters in seconds. Step is currently not used.
ttt	Total trial time in seconds.
subject	Default subject ID.
nextid	Next auto-assigned subject ID.
analysis	Per-study analysis parameters that override global values set in <code>conf.xml</code> .

Similar to studies, subjects are defined by having a valid `subject.xml` file located in a sub-directory under the study:

Element	Description
id	Unique (within the study) subject ID.
created	Date/time when the subject was created.
hand	Either “left” or “right” to indicate hand preference.
info	Additional subject information.
ntrials	Number of finished trials. This field also determines the sequence number of the next trial.

Finally, `trial.xml` file does not contain any configurable settings, but instead stores all relevant information for a single trial. In addition to trial-specific information, this file also stores exact copies of `conf.xml`, `study.xml`, and `subject.xml` file contents as they were when the trial was taken. This is an additional redundancy to ensure that conditions under which a trial was

performed are always known.

Element	Description
id	Trial ID constructed from the timestamp and sequence number.
created	Date/time when the trial was started.
timezone	Timezone that was in effect on the host computer.
num	Trial sequence number.
day	Study day (see <code>day1</code> in <code>study.xml</code> ).
practice	Practice flag.
pre_mood	Answer to pre-trial mood question (1-10, -1 when the mood question is disabled).
post_mood	Answer to post-trial mood question.
status	Program exit code (see PVT Protocol Implementation Details).
app	Copy of <code>conf.xml</code> .
study	Copy of <code>study.xml</code> .
subject	Copy of <code>subject.xml</code> .



## Version History

### 1.1.0 (2013-02-19)

- Added per-minute statistics to the exported Excel file.
- Updated MATLAB Compiler Runtime (MCR) to version R2012a.

### 1.0.4 (2012-02-13)

- Added a fifth digit to the counter.

### 1.0.3 (2012-02-03)

- Added hard-coded “STOP!” text to the ready screen.
- The mouse cursor is now hidden during the trial.
- Fixed a minor bug where **Ctrl-Q** was reported as an “external request” for termination instead of “user command.”

### 1.0.2 (2012-01-05)

- Allowed the use of `intro.txt` file to show per-study trial instructions.

### 1.0.1 (2012-01-04)

- Removed “Exit” and “Begin” buttons from the pre-trial mood dialog.
- Disabled mood dialog’s “Close” button (use **Ctrl-Q** to abort).
- Responding to the mood question is now sufficient for moving on to the next step.
- Changed **Esc** to **Ctrl-Q** as the trial abort command.

### 1.0.0 (2011-12-12)

- First public release.
- Added tool tips for all data-entry fields.
- Removed the “Exit” button from post-trial mood dialog.
- Added StudyDay, Date, and Time columns to export summary.
- Integrated RTD algorithm using individualized reference RT distribution.
- Added Speed, RTD, Fastest 10%, and Slowest 10% metrics to the analysis GUI and export summary.
- Enabled prediction for Major Lapses, Mean RT, Speed, RTD, Fastest 10%, and Slowest 10% metrics.

### 0.7.1 (2011-10-24)

- Created msi-based setup package.
- Extended prediction horizon to 24 hours.
- Allowed the user to exclude practice sessions in exports.
- Data in PVT-192 format are now appended to a per-subject `all_trials.pvt` file.
- The analysis plot now changes dynamically based on trial selection.
- Fixed a number of minor bugs.

0.7.0 (2011-10-14)

- First preview release.