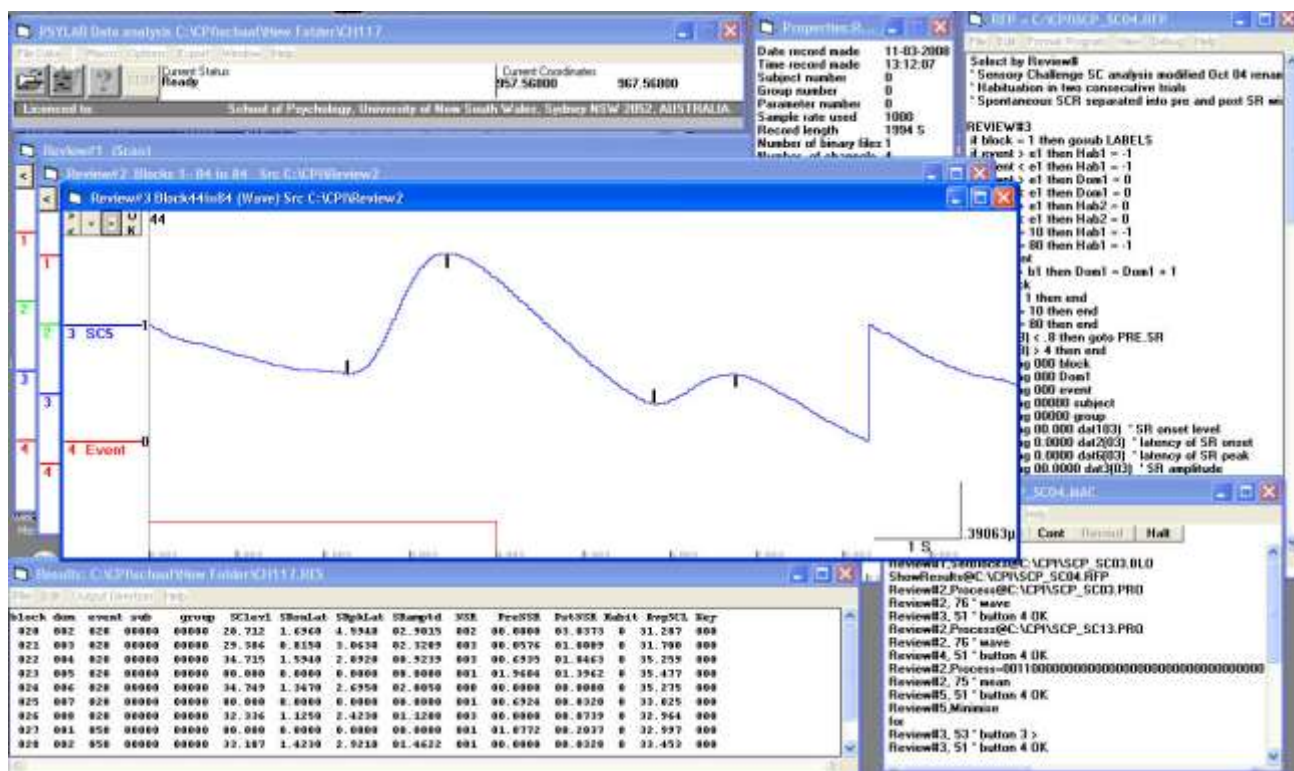


# PSYCHLAB 8

## Analysis for recordings in psychophysiology: Software manual.

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This manual was originally written for an older version of the software dating back to 2003, and some menus and examples may differ slightly from those in the current program, however general function in the present version is similar, with certain additions and improvements to the latest version. For more information please contact CPI. June 2009.

## Description

PSYCHLAB windows off-line analysis system allows reduction and modification of data recorded with a PSYCHLAB measuring system. The analysis system provides conversion of volume physiology waveform data into numeric lists that allow comparison of performance during the experiment or interview (in addition to raw waveform filtering and export). It is capable of working with multiple channels of different data types simultaneously.

A number of unique software tools are provided; the ability to section records into relevant time epochs (blocks), evaluate average, standard deviation, max/min, absolute deviation, removal of Heart Rate artefacts, automatic detection and quantification of a 'WAVE' shape, and signal averaging (mainly used with EEG evoked potential). Additionally there is facility to rectify and smooth raw waveform data (such as EMG), and the analysis system allows full automation of any sequence of functions using 'macro' record and playback mode.

## Summary of use

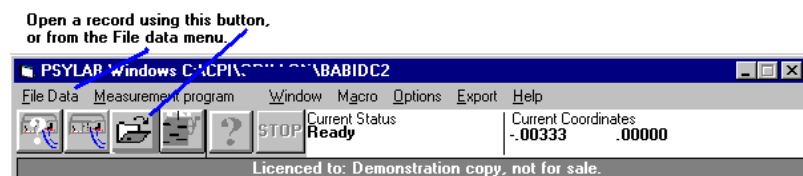
Recorded data are shown in a series of Review windows, at each stage of the analysis process starting with Review#1 which appears when previously recorded data are opened using the third button on the toolbar. Each time a new process is evoked, a new Review appears. Each Review is independent and has its own menu, obtained by double clicking within the body of the Review. Any process chosen from the menu will relate to the data represented in the Review from which it appeared. When first opened data are shown in Scan mode. No process (including Export) can be performed until data have been sectioned into blocks; sections of the record of equal length at chosen time points in the whole record. The block creation process opens a multi-block Review. From this, any number of processes may be evoked. More than one multi-block Review can be created from the original scan Review. Process Reviews show one block at a time, and results are obtained by clicking the OK button, then moving on to the next block using the forward button. Results are written into the Results window under control of the Results Format Program (RFP), which runs when the OK button in the Process Review is clicked. The RFP may be designed to collate results produced by several process Reviews, when the OK buttons on these Reviews are clicked in a given sequence. All of the above actions may be recorded in the Macro window, such that once initially performed, an analysis can be effortlessly repeated on other similar recordings, creating a table of results for each record. A sequence of records may be opened and analyzed using the batch facility, the results for each record being gathered in the Results window or automatically stored in files with the base name of each original recording. PSYCHLAB8 uses short file names throughout, up to 8 characters and extension. FIR filtering and Spectral analysis, although shown on the Process menu, have not been properly tested and are not recommended for use.



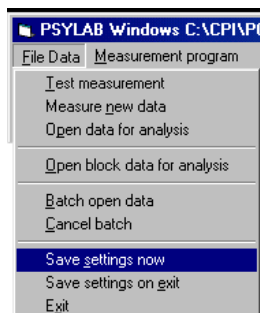
**Multi-block  
Review menu**

## Opening stored data.

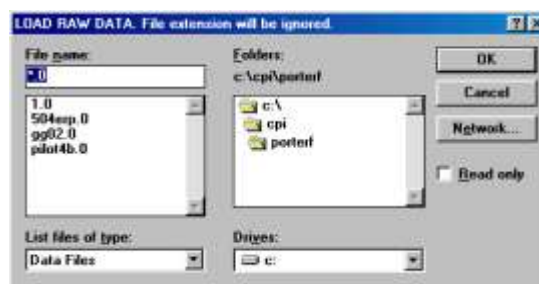
PSYCHLAB 8 analysis system is designed to accept multi-channel data from mixed instrument sources at variable sample rates recorded with the PSYCHLAB measuring system. It permits data conversion into standard ASCII or binary files, and a variety of data reduction methods designed specifically for physiological waveforms. It is primarily operated from the Toolbar menu. Data are shown in 'Review' windows, for which a 'Review menu' may be obtained. Data are opened using the 3<sup>rd</sup> button on the toolbar or Toolbar menu, File data, Open data for analysis. The



**Toolbar menu**



default folder shown in the Load raw data panel may be changed by opening data from the required folder, then using Toolbar menu, File data, Save settings now.

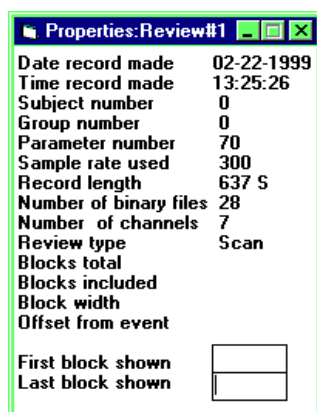
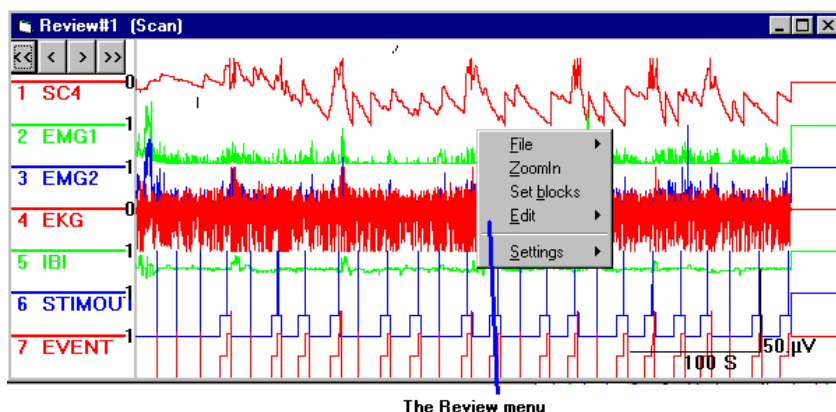


Measured data are stored continuously so that at any time during the experiment valid data for analysis exist in the record.

When a record is opened, the entire

record is shown in Review#1. PSYCHLAB analysis system produces a new Review for each stage of the analysis; a menu is obtained for any Review by double clicking the left mouse button in the body of the particular Review. Functions in the Review menu relate to that particular Review, whereas functions in the Toolbar menu have global effect.

The Review menu found in Review#1 (scan) does not show any analysis options. That is because analysis functions cannot operate unless they are presented with even length sections of data, called blocks. Before data can be analyzed or exported, the record must be sectioned up into blocks, even if these blocks contain exactly the same information as is shown in the Scan Review#1. Review menu, Set blocks, is used to produce a Multi-block Review.

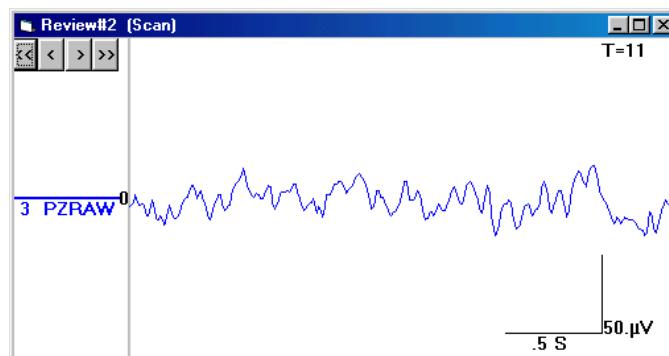
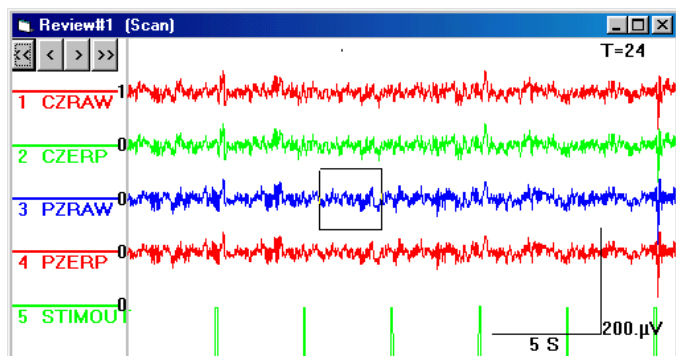


## Properties Window.

The properties window shows details of data shown in the particular Review in focus. To see the properties of a Review, simply click once in the body of the Review and its properties will be shown. If it is a Multi-block Review, not all the blocks need to be shown. The particular blocks displayed in a Multi-block Review may be selected by changing the numbers shown for 'First block shown' and 'Last block shown' in the properties window. Click in the Review so that its Properties are shown, then change the numbers in the First and Last block shown panels, then click back on the Review, and it will change to show the selected blocks. The same method can be used to change the block shown in a Process Review, which show one block at a time.

## ZoomIn.

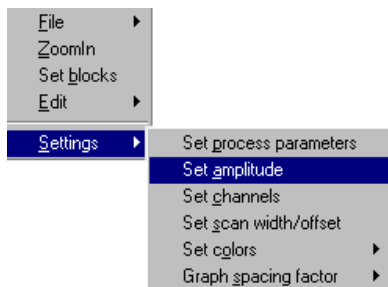
It is possible to look in more detail at sections of the scan Review#1 by Zooming in. To do this, position the cursor to the top left of the area to be viewed, then hold down the right mouse button and drag a rectangle round the area of interest. The rectangle must cross the axis of each channel for it to be included. Then double click the left mouse button to get the Review menu, and select Zoom in. When zooming in on a single channel, if the rectangle is small in height, the zoomin Review will have increased magnification. With the ZoomIn window, or any scan window which shows less than the whole recording, the <<, <, >, >> buttons may be used to move back or forward



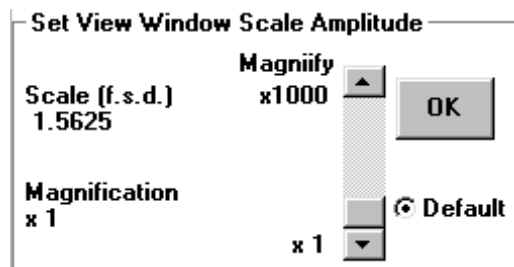
within the record.

## Review settings.

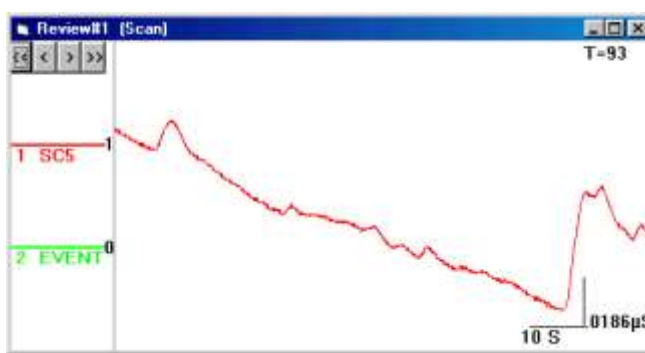
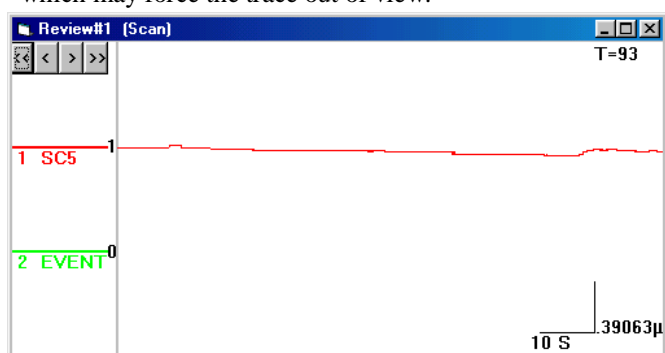
Settings is found at the bottom of the Review menu for every type of Review and may be used to adjust traces within that Review. Settings are transferred to any new Reviews that may be created from that Review.



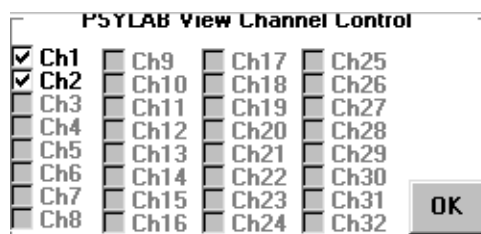
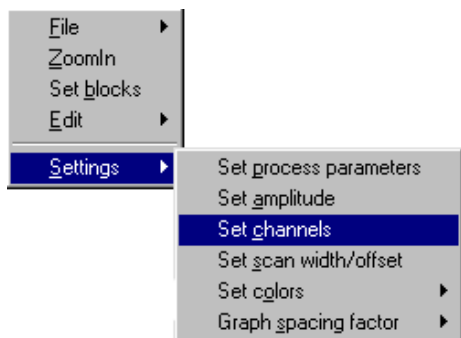
**Settings, Set amplitude.** A magnification adjustment panel appears in the top left corner of the Review. Magnification is adjusted using the vertical slider, then click the OK button.



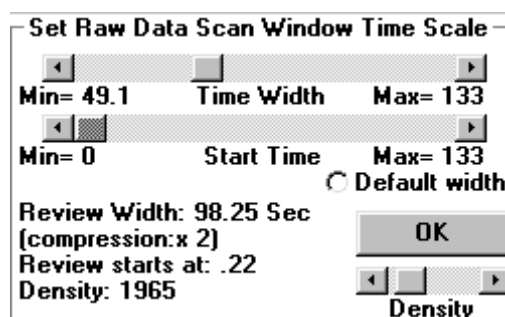
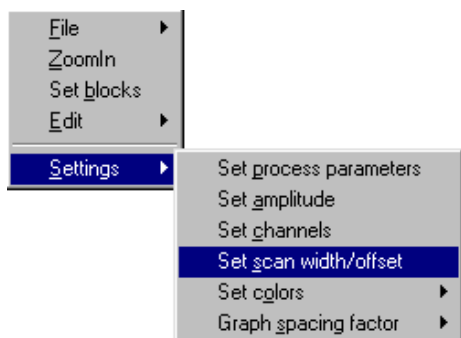
The example shows an SCR trace recorded with SC5, seen unmagnified first, then with magnification set to x 21. Notice the change in the vertical scale marker. The SC5 trace automatically centers itself within the Review, however other traces do not do this, such that if there is significant offset from center, this offset can be amplified when magnification is used, which may force the trace out of view.



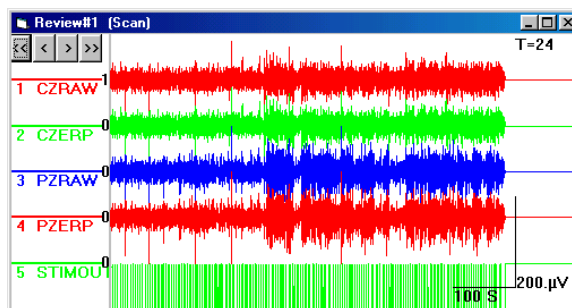
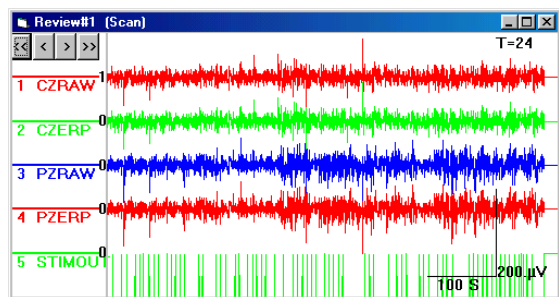
**Settings, Set Channels.** The View channel control allows selection of whichever channels are wished to be viewed. Channels are turned on or off by clicking the appropriate check box. Then click OK.



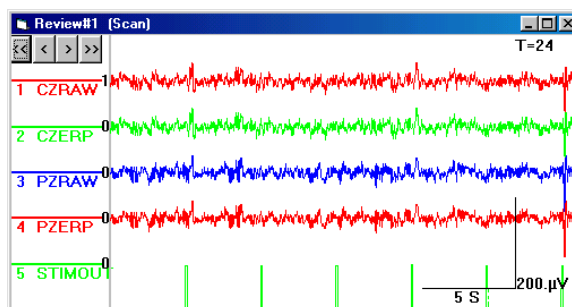
**Settings, Set scan time width/offset.** This panel only applies to Scan type Reviews (not block or process Reviews). It allows adjustment of the time section seen in a scan Review. Review#1 opens showing the full duration of the recording. The 'density' of the trace relates to the number of actual points from the record traced out in the Review. The higher the density, the more detail will be seen, up to the limit where all points recorded are traced.



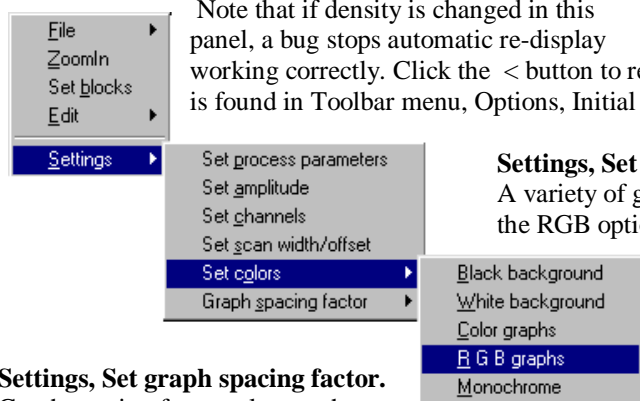




The first example shows a 630 second record sampled at 100Hz with density set at 2500. Notice particularly the event channel, which shows various randomly interspersed stimuli. The next example is the same record but with density increased to 25000. Much greater detail is seen, particularly noticeable in the event channel where in the first example not all the brief events showed up. In the last example, density is 2500, but 'default width' is selected, so that only a short section (25 seconds) of data is seen, but every point is shown.



Note that if density is changed in this panel, a bug stops automatic re-display working correctly. Click the < button to replenish the display. An alternative control for setting density is found in Toolbar menu, Options, Initial display density setting.



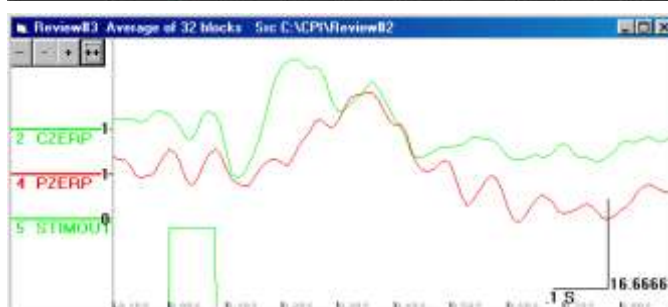
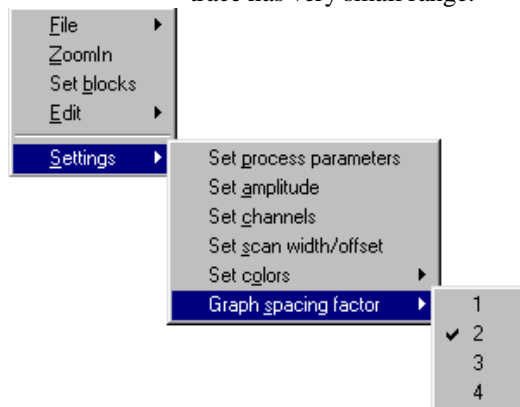
### Settings, Set colors.

A variety of graphic modes are available. All examples shown here use the RGB option, meaning that primary colors red, green and blue are used to draw graphs, and the White background option. Graph color option selected for a Review will be carried to any further Reviews created from that Review.

### Settings, Set graph spacing factor.

Graph spacing factor relates to how Multiple traces are spaced. Factor 1 allows each trace a completely separate area in the Review space, so that it is impossible for traces to overlap. Factor 2 allows each trace to overlap the next by 50%. This is the setting used in every example in this manual, except the two Reviews shown here to demonstrate other graph spacing. The result of factor 2 setting is that the range of each trace extends from the axis of the trace above (or Review top if it is the top trace) to the axis of the trace below (or Review bottom if it is the lowest trace). The examples below show ERP traces, first using graph spacing factor 1, then with graph spacing factor 3. Scale range for each trace is determined by looking at the distance between the top of the Review and the first trace axis, which is half full scale range. The higher factors can be useful when there are a lot of channels which tend to move in somewhat the same direction, as with ERPs. Allowing higher overlap

increases magnification where large numbers of traces means that each trace has very small range.



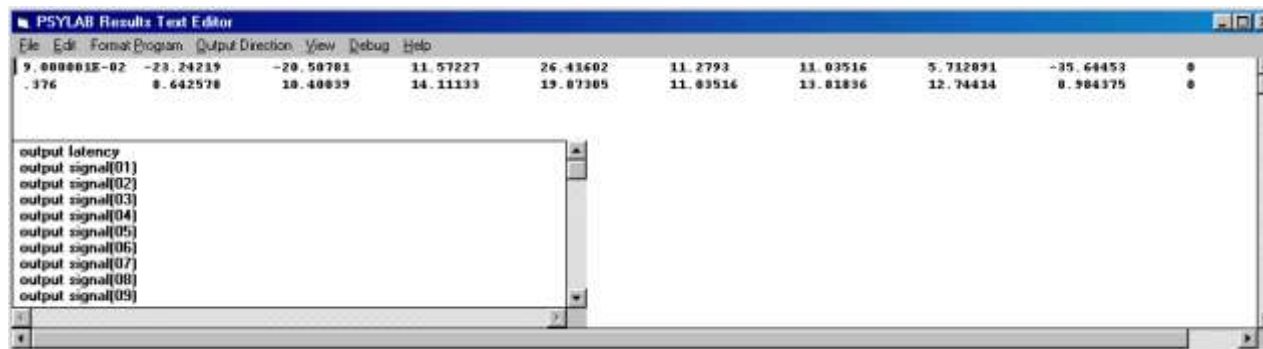
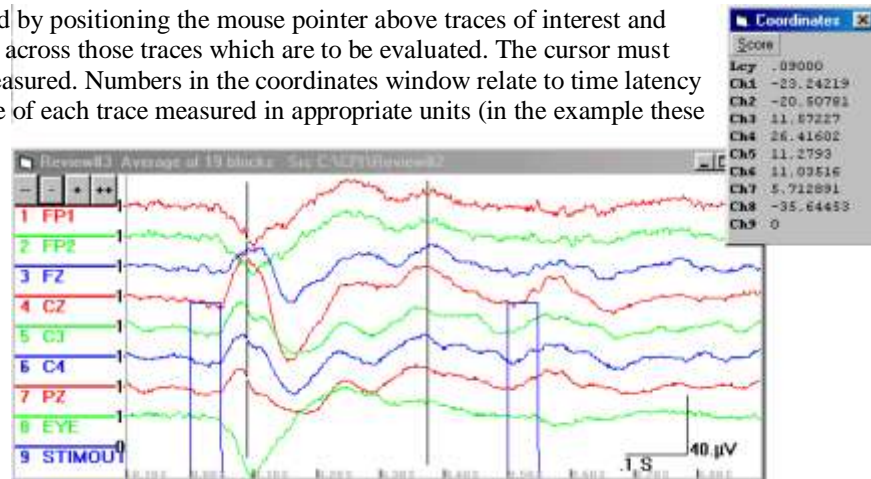
## Coordinates window.

The coordinates window is produced by positioning the mouse pointer above traces of interest and dragging with the left mouse button across those traces which are to be evaluated. The cursor must cross the axis of each trace to be measured. Numbers in the coordinates window relate to time latency of the cursor and absolute amplitude of each trace measured in appropriate units (in the example these are micro Volts).

This method may be used on any type of Review to evaluate traces within it. The latency measure will be time from the start of the record in a scan Review, or time from onset of event in a block or process Review where blocks are produced relative to some event.

**The score button** has the effect of transferring values

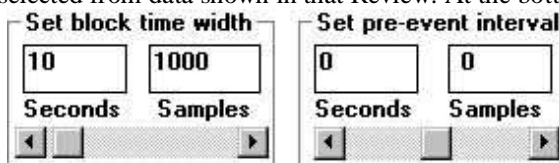
seen in the coordinates window to the Results text editor. This allows any number of trace values within any Review to be measured and stored. Regardless of however many channels are selected to show in the coordinates window, the system will by default format the Results text editor to produce data for all channels, and include the latency value. This format may be changed by removing lines from the list seen in the Results format program panel 'output latency', 'output signal(01)', etc.



output signal(01)', etc. Note that each line starts with a space. The results text editor is discussed more fully later in this manual.

## Sectioning data into blocks.

When Set blocks is selected from the scan Review, the Block selection window appears. Normally this will be done from Review#1, which shows the entire recording, however if Set blocks should be selected from a scan Review obtained by Zooming in to show part of the entire record, blocks will only be selected from data shown in that Review. At the bottom of the Block selection window there are two horizontal slider panels. The first is labeled 'Set block time width'. This is a crucial setting, whichever method is used to determine when blocks will be selected. The time width for blocks must be defined. The setting of time width in seconds is directly related to the number of samples, as sample rate is constant for each recording. Move the slider to obtain the desired time width. A minor bug is that if very short time width (<.02S) or pre-event interval is used, the Seconds panel may give a misleading display. The samples panel is always reliable, time width = (number of samples \* sample rate). If the block selection window is closed and re-opened, most settings do not change except pre-event interval, which returns to its default setting. These types of control can be moved in three ways; by holding the left mouse button down and dragging the square slider, which causes large changes; by clicking within the gray area between the slider and the left or right ends of the range, which normally causes changes of ten of one hundred units; or by clicking on the arrow at each end of the range which causes single unit changes. In the case of these block width and pre-event interval sliders, the number of Samples is changed by moving the slider, and the Seconds display is calculated by (number of samples) / (sample rate).



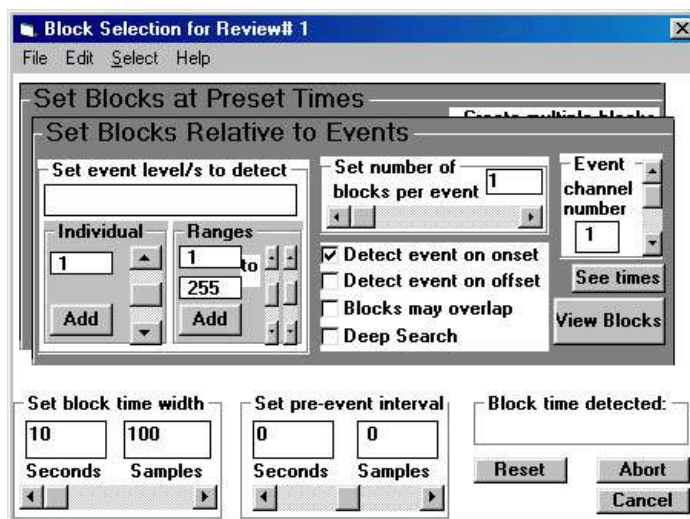
'Pre-event interval' is only relevant if blocks are generated relative to events. It allows the block start time to be offset from the time of an event. A positive pre-event interval means that the block will start before the event; a negative setting means the block will start after the event.

The block selection panel provides two ways of sectioning data; on the basis of absolute time into the record, or by locating events in an event channel and using these to determine the start time of each block. Two panels are provided in the block selection window. The primary mode of block selection is 'Set blocks relative to events', as most experiments involve some type of events marked into the recording, even if these are just buttons pressed by an operator to indicate the beginning of different phases. However, if there are no events in a record, or if it is required to section up the record into consecutive blocks so that data can be exported, 'Set blocks at preset times' may be used. To find this panel, click on the edge which can be seen..

### Export of raw data.

This requires data to be first sectioned into blocks. Usually the entire data is sectioned into blocks using the Preset Times panel.

**Set blocks at preset times.** To use this panel, a block time width must first have been chosen. The panel may be used to select blocks at particular discrete times, by setting a start time and number of blocks, then clicking 'Add'. This may be repeated at different start times if required. It may also be used to section up the entire record, by setting a start time of 1 and number of blocks 1000, in which case the number of blocks will be limited to the length of the record. Factors affecting block width are the type of analysis that is to be performed, e.g. for skin conductance at least 10 seconds is required to see a complete response, or it may be required to use 60 second or 300 second blocks, etc.

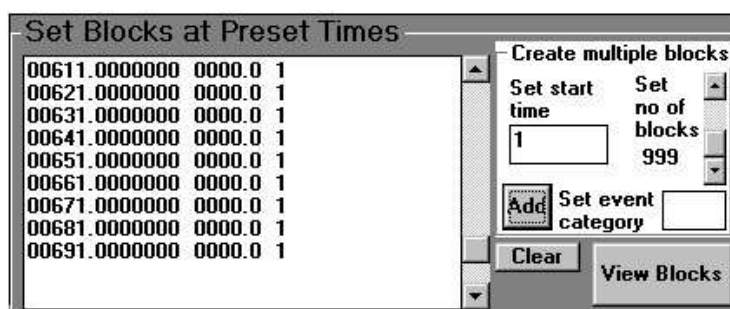


When blocking the record for export, block width may be thought irrelevant, but certain criteria must be considered:

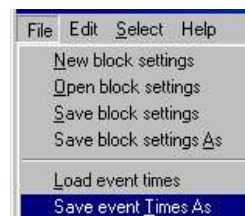
- 1) The last block is unlikely to end exactly at the end of the record and the part of the last block that goes past the end of the record will contain erroneous information (which may be easily recognizable), but the shorter the block size chosen, the less such erroneous data there will be;
- 2) There is a limit of 999 blocks maximum, and the system works slightly more slowly with more blocks.

To recap on how to use this panel:

- Choose a block width.
- Choose a start time; if sectioning up the whole record, set this time to 1.
- Select the number of blocks required; if sectioning up the entire record, move the slider to the bottom to select 999 blocks. The system will only create as many blocks as it takes to contain the whole data.
- Click the add button. If more blocks were selected than it takes to contain the whole data, a warning message is displayed - cancel it by clicking OK.
- Click the View Blocks button.



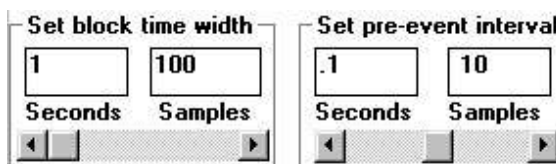
The start time of each block is seen in the large panel. If wished, this start time information can be saved to disk from the File menu, and re-loaded for use on another similar recording (also for use under macro control). To save start times, use the File menu in the block selection panel, Save preset times.



The last step is to create a multi-block Review with blocks beginning at the designated start times. Click View blocks to close the block selection window and create a multi-block Review showing blocs of the chosen width beginning at the designated start times. At this stage, if it is wished to retain the selected block width setting, use Toolbar menu, File data, Save settings now (it is not recommended to use Toolbar menu, File data, Save settings on exit).

**Set blocks relative to events.** This panel is designed to allow events marked in an event channel to be used to determine when blocks are picked out from the recording. Parameters are set so that the event channel can be scanned and blocks selectively created from the entire recording

**Set block time width.** As with the previous method, block time width must first be chosen. Factors affecting block width will relate to the type of analysis that is to be performed, e.g. for skin conductance at least 10 seconds is required to see a





complete response, or to observe non-specific response activity or changes in different phases of a procedure, it may be required to use 60 second, 300 second or some other block time width. To view specific response to discrete events, much shorter block width is likely to be used, e.g. for EEG ERP around one second is typical and for startle analysis 0.16 seconds is common.

**Set pre-event interval.** This control is provided to make it possible to offset the start time of the block from the time of an event. For a typically EEG ERP analysis, for example, block width of 1 second might be chosen and pre-event interval set to 0.1 seconds so that 0.1 seconds of pre-event data and 0.9 seconds of post event data is seen. This control may be used to offset the blocks from events for other reasons. It must be remembered that the time shown is the pre-event interval, not the offset, so that a positive value means the block starts before the event and a negative value means it starts after the event.

**Set event levels to detect** allows specific numbers that should be found in the event channel to be specified so that particular events may be picked. The level prescribed may be one discrete number (e.g. '100'), several discrete comma separated numbers (e.g. '100, 110, 120,' etc.), ranges (e.g. '100 to 120' to include all integer numbers from 100 to 120 inclusive) or any comma separated combinations of these. The square panels

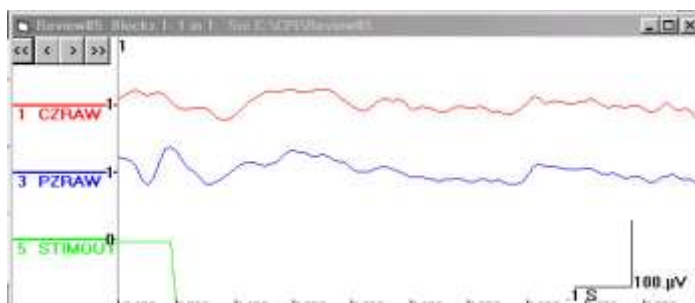
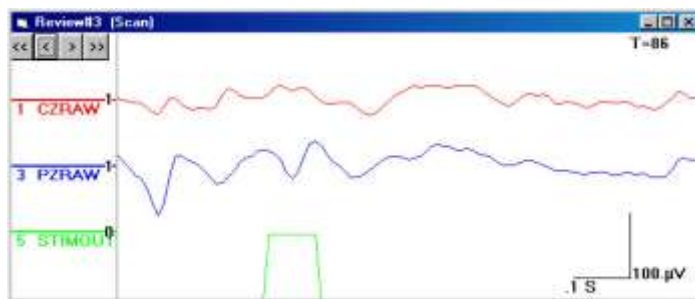
'Individual' and 'Ranges' are provided to make sure that the format (comma separation and spacing) of numbers put into this box is correct. Move the vertical slider to get the number or range of numbers required, the click add, then repeat as required. The box may also be manually edited. Further examples of setting event levels are given at the end of this section.

**Event channel number.** This slider is provided to allow the channel that is to be used for event detection to be selected. However, PSYCHLAB will automatically set the event channel appropriately in most cases. It is possible in exceptional cases to use waveform channels for event detection, but it can be tricky to set the system to detect the particular aspect of the wave that is required. Normally a stimulus type event channel will be one generated during measurement with commands such as '\$measure event stimin' or '\$measure event stimout' and these are automatically detected by the system.

**See times.** In the same way as discussed in the previous section for 'Set Events at Preset Times', a list of the times of each event detected may be seen by clicking this button, after all, the event detection parameters have been correctly set.

**Deep search.** This check box must be checked if the event is of short duration. Specifically, if the event is shorter than 20 samples (e.g. 200ms at 100 samples per second) then it should be checked. The event detection system works more slowly when this box is checked.

For simplicity, the next examples use only short sections of data from which to create blocks. Normally, blocks are created from the entire record as seen in Review#1 when data first open.



**Set Blocks Relative to Events**

Set event level/s to detect: 1 to 255

Individual: 1 Add

Ranges: 1 to 255 Add

Set number of blocks per event: 1

Event channel number: 2

☒ Detect event on onset

☐ Detect event on offset

☐ Blocks may overlap

☐ Deep Search

See times

View Blocks

**Block Selection for Review# 2**

File Edit Select Help

**Set Blocks at Preset Times**

**Set Blocks Relative to Events**

Set event level/s to detect: 1 to 255

Individual: 1 Add

Ranges: 1 to 255 Add

Set number of blocks per event: 10

Event channel number: 8

☒ Detect event on onset

☐ Detect event on offset

☐ Blocks may overlap

☐ Deep Search

See times

View Blocks

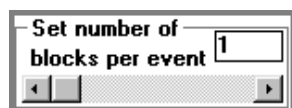
Set block time width: 1 Seconds 100 Samples

Set pre-event interval: 5 Seconds 500 Samples

Block time detected:

Reset Abort Cancel





**Detect event on onset** and **Detect event on offset** are provided to modify the way the events are detected. The following

three Reviews illustrate how they work:

**Review#3** (as shown in the blue title bar) shows a random section of raw data with an event recorded in the lower channel.

**Review#5** shows what happens when a block is selected from this data with block width set to 1 second, pre-event interval set to 0 and Detect event on onset checked. The block begins at the point where the event channel changes to the prescribed level to be detected.

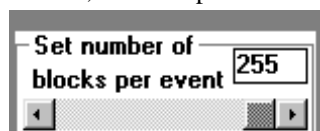
**Review#6** is the result when Detect event on offset is checked. The block begins at the point where the event channel ceases to be at the prescribed level to be detected, so the event is not seen. In this case it is the falling edge of the event, but it does not necessarily need to be so, if the event changed to some other value than zero it would still be the end of the level that was prescribed to be detected. The position of the block in data can be noted in this example by observing the EEG.

### Blocks may overlap.

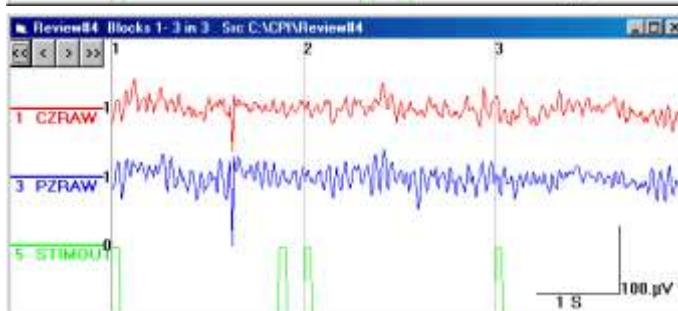
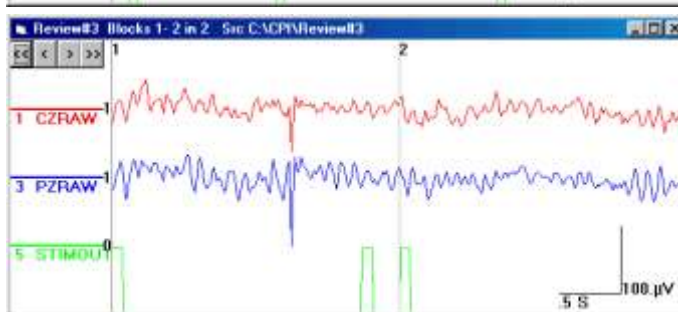
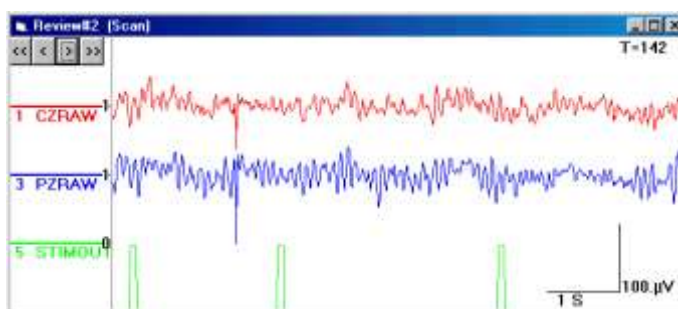
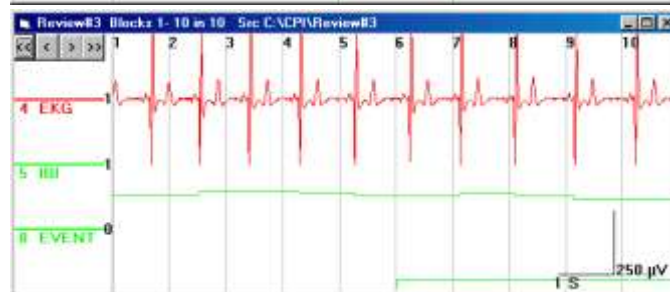
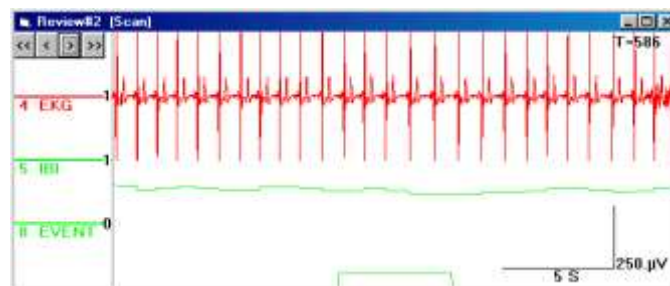
This control is provided to deal with a situation where marks in the event channel may be closer together in time than the chosen block width. If Blocks may overlap is not checked, if an event occurs less than a block width from the time of the previous event, the second event will be ignored. This can be useful, as it is often not desirable to score data relative to an event if there was a previous event too close to it that might still be having an effect. Ideally the measurement program should be designed to ensure that stimulus events are far enough apart to allow suitable block width to be chosen when scoring data that will avoid

overlapping events. Review#2 shows a scan section of data with 3 events which was obtained by zooming in on part of a much longer record. The first two events are 2 seconds apart, the 2<sup>nd</sup> and 3<sup>rd</sup> event are 3 seconds apart and there is 2.5 seconds between the 3<sup>rd</sup> event and the end of the scan data section. When blocks are selected using 2.3 seconds block width and with Blocks may overlap unchecked, the result is seen in Review#3 showing two blocks created, because the 2<sup>nd</sup> event is too close to the first. The second event is therefore seen within block 1. When the same thing is done with Blocks may overlap checked, 3 blocks are created in Review#4, one for each event. The first block still includes the 2<sup>nd</sup> event, so part of the data is duplicated in the second block, which also shows this same event.

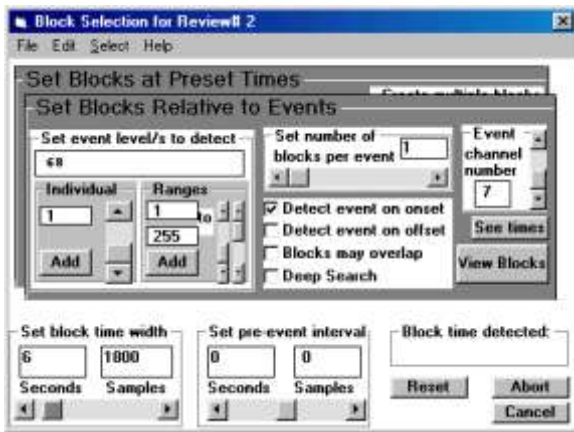
**Set number of blocks per event.** This slider is set to 1 for most purposes. However it can be useful to generate more than one block for each event detected, for example when wishing to compare



second by second heart rate from before a stimulus with after the stimulus. By using this control in combination with Set block width and Set pre-event interval controls, it can be arranged to produce blocks either side of an event. The scan Review#2 shows a short section of heart rate data zoomed in from a longer recording. Blocks are selected using 1



second block width, 5 second pre-event interval and 10

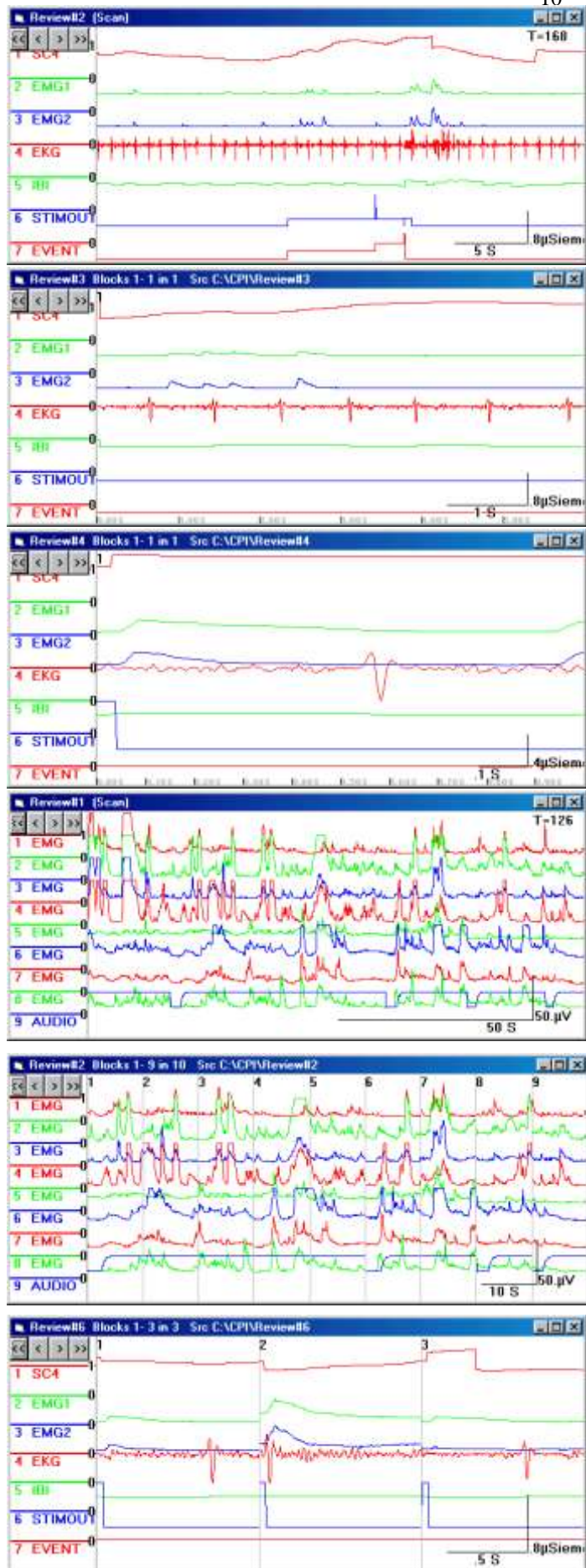


blocks per event as shown in the block selection panel.

Review#3 shows the contiguous blocks that are created, 5 before the event and 5 after it. If these block settings were used on a complete recording scan, as seen in Review#1 when data are first opened, instead of a short section seen in a Zoom in Review, it would produce ten blocks for each selected event in the record. Data produced from these blocks could be sorted knowing that data from the first ten blocks related to the first stimulus event, the next ten belong to the second stimulus, etc. Heart rate data would typically be analyzed using the MEAN function to produce an average IBI for each one second block, which can easily be converted to heart rate

in the Results Format Program (RFP) using the reciprocal ( $HR = 60000 / IBI$ ) where IBI is in mS. These functions are explained in later sections of this manual.

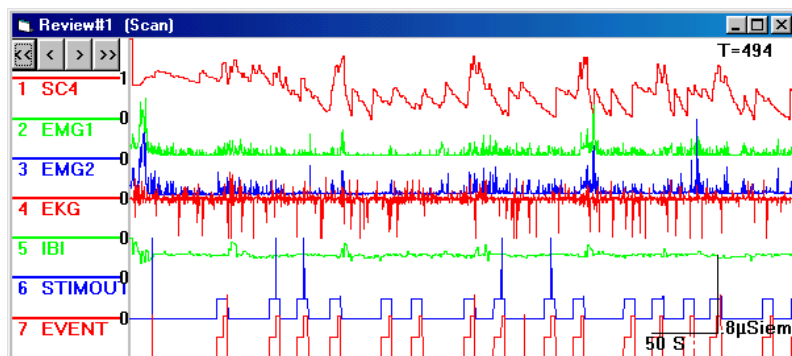
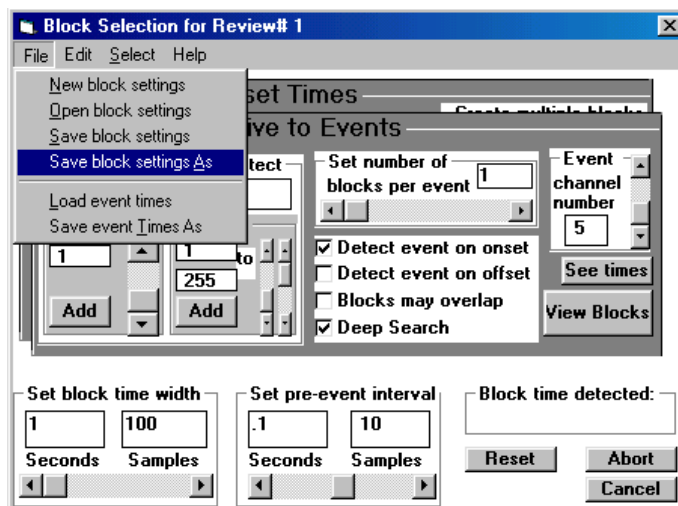
Another use for this control is in a typical emotion experiment where there are general 'stages' in the recording indicated by the operator pressing keys during the procedure. In this instance (and in various other designs) it may be required to get information for the entire time after each key was pressed, which could be any duration. For example, in an interview the operator presses different keys when the subject is asked various questions, and waits for a variable period after each question. Useful data must be produced in even length time periods. It would be no use comparing the number of skin conductance responses to each question, for example, if one question took three times longer than another. By setting 'Number of blocks per event to a large number, the system will fit as many set width blocks as it can into the period between each event. The last block for each event will end less than one block time width from the onset of the next event (this needs to be considered when selecting block time width, the longer the block, the more data is likely to be lost between the end of the last block and the onset of the next stimulus). In the example shown, the 'AUDIO' channel is used to select blocks, with number of blocks per event set to 255. Review#1 shows a scan of the entire record, Review#2 shows 10 second blocks created to fill (as closely as possible) the time between stimuli. When analyzed, there will be a variable number of blocks for each stimulus, but because the blocks are of like duration, data can be compared between blocks. An event code can be included in data for each block, so that it can be easily related to the particular stimulus to which it belongs. The first, second, etc. blocks for each stimulus can be compared, or data for all blocks for each particular stimulus can be averaged.



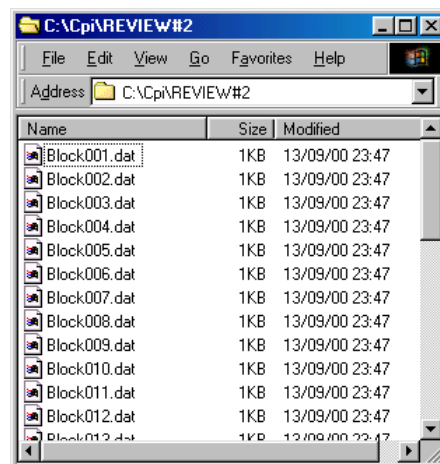


### Set event levels to detect: Examples.

Review#2 is a scan section of a startle experiment showing a complex event pattern in the bottom channel 7. The measurement program to produce this pattern was designed so that there is first a rise to level 68, which designates a particular type of pre-stimulus in the startle paradigm, then after approximately 6 seconds, the level increases to 132 indicating the onset of the startle probe, then two seconds after that the level increases to 204 marking a brief shock stimulus. The actual experiment produced a series of these stimulus trials, with slightly varying event levels so that particular trial types could be differentiated (e.g. different types of pre-stimulus might be designated by levels 69, 70, 71, etc., and probes in these trials would be marked by corresponding levels 133, 134, 135, etc.). Thus, if event level 68 is put into the Set event levels to detect. Box,



blocks are generated synchronized at the onset of the pre-stimulus only for that category of trial, but also blocks can be generated synchronized with the onset of the probe, again only for that particular category of trial. This allows maximum flexibility when comparing different aspects of data in different trial types (e.g. skin conductance response to the pre-stimulus can be obtained, and also blink response to the probe). Review#3 shows a 6 second block created with event level 68 from the single trial shown in scan Review#2, and Review#4 shows a 1 second block created with event level 132 (the traces have been magnified using Review menu, Settings, Set amplitude. to show the blink in channels 2 & 3 more clearly). Review#6 shows 3 blocks obtained when level 132 is used to select blocks from the whole record (shown in Review#1).



### Save and Load block settings.

The setting of all controls in the Block selection panel, including the values entered into Set event levels to detect, can be saved and re-loaded using the File menu. Block settings are stored in a file which has extension .BLO. This file can be automatically called up when PSYCHLAB analysis system is operated under macro control. If the block selection panel is used when a macro is being recorded, the system will automatically ask for block settings to be saved in a file. Any number of block settings files can exist, allowing great flexibility when using the system to analyze data from different experiments. If block settings are loaded for inappropriate data, e.g. block settings which specify channel 10 for the event channel when the inappropriate data only has 5 channels, an error will occur. It is inadvisable to try to use block settings saved when analyzing one particular experiment to analyze a different experiment, unless they are very similar, particularly where sample rate and channel definitions are concerned.

### View Blocks.

When all settings are correct, click view blocks to produce a multi-block Review. Data from the relevant parts of the entire record are re-written (duplicated) into files stored in a folder with the name of the multi-block Review, which become the source for all process functions evoked from that Review.

## ZoomIn (multi-block Review)

There are two ways that ZoomIn works on Multi-block data.

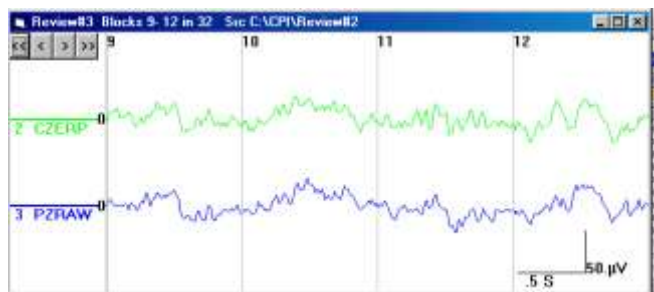
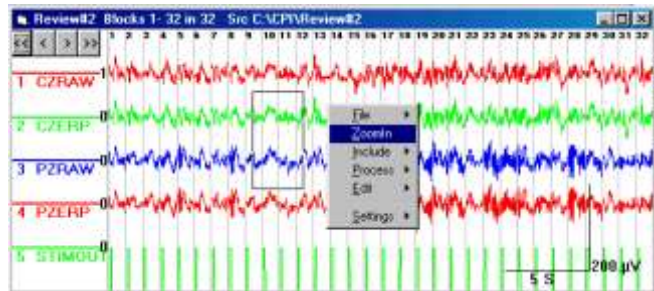
- 1) Point to a particular block, then double click the left mouse button and select ZoomIn from the Review menu. The particular single block will be shown in a new Multi-block Review.
- 2) Use the right mouse button to draw a rectangle around some particular blocks and channels, then select ZoomIn to see only those channels in a new multi-block Review.

The >, >>, <, and << buttons may be used in multi-block Reviews that show less than all blocks, to move the selection within the total blocks, moving one block at a time (>), or by the number of blocks shown (>>). It is not possible to zoom in on data within a discrete block. The Properties window displays which blocks are shown in a multi-block Review. The two boxes at the bottom of the Properties window may also be used to change which blocks the Review shows. These two boxes may be edited by typing in them. When the Review is brought back into focus by clicking on it, blocks shown will change to those described in the Properties window.

This way, an original multi-block Review may be changed to show only a range of the total number of blocks, without the need to use ZoomIn, which creates a new Review.

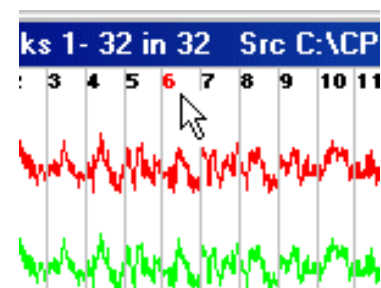
Properties: Review#3	
Date record made	05-03-1995
Time record made	14:23:03
Subject number	504
Group number	0
Parameter number	42
Sample rate used	100
Record length	630 S
Number of binary files	16
Number of channels	5
Review type	Blocks
Blocks total	32
Blocks included	32
Block width	1.
Offset from event	0.1
First block shown	9
Last block shown	12

However many blocks are shown in a multi-block Review, Process functions operate on the total number of blocks, not the number shown. Zooming in or showing only a range of blocks is used so that blocks may be viewed more clearly, for example to allow manual screening of blocks.





## Include.



data – one line of data relates to each trial. In these circumstances it is undesirable to alter the number of blocks that are processed by excluding, as it affects the number of lines of data in the results file which normally needs to remain constant to suit further cross subject analysis.

**Include all blocks** and **Exclude all blocks** may be used to set all blocks included or excluded.

**Include, Manually select blocks** is a redundant feature from an earlier PSYCHLAB version. Block include status is most easily set by pointing and clicking as described above.

**Include, Screen out-of-range blocks.** This may be used to automatically exclude blocks that have values which fall outside a given range. It is most frequently used with EEG ERP data, to exclude blocks which have artifact or blink. Only channels which are selected will be screened. A channel is selected if the black number which shows on its left axis is 1.

Screening range is set in the Process settings panel, which is obtained in Review menu, Process, Set parameters. With EEG data, screening range would often be set to just within the maximum range for particular channels. An indication of channel range is given with the scale marker to the bottom right of each Review. In this case the range is 200uV, so settings of + 90 uV and – 90 uV are appropriate. The scale marker shows the range of the first channel that is selected. EEG recorded with EEG8 amplifiers has scale for all channels set the same. If an eye channel is recorded, this would be the channel to use for screening. If no eye channel is recorded, all channels could be included for screening, with the range set just within maximum (e.g. +/-99 uV). Note that the EEG8 amplifier has a manual attenuator on eye channels which means that actual eye voltages may be double (50% setting) or 5 times (20% setting) scale voltage shown, but the screening range should still be set with respect to the scale voltage

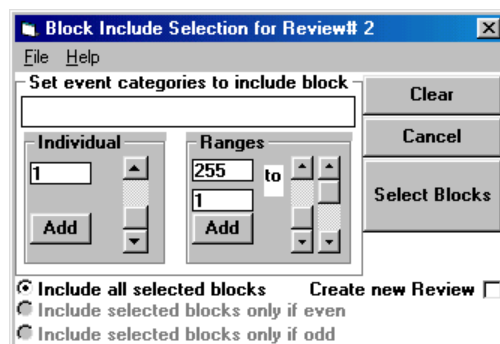
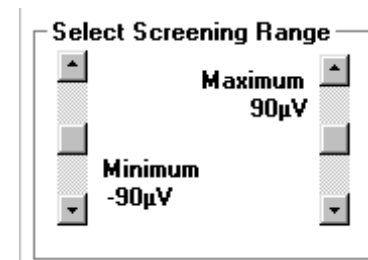
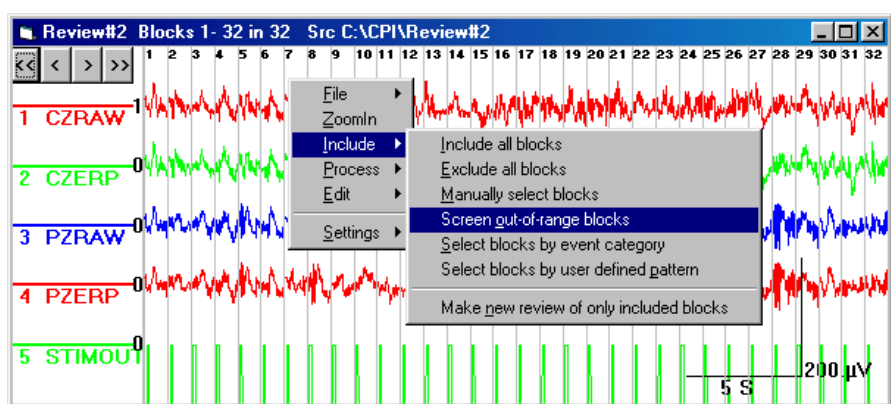
shown.

When the screening range has been correctly set, Review menu, Include, Screen out-of-range blocks may be used. Blocks will be screened in turn, and the block number at the top of the Review will change color for excluded blocks. If no blocks appear excluded after screening, check that the screening range is in fact within the maximum range; try reducing screening range until some blocks do change color just as a check. Make sure that relevant channels are selected. If all blocks are unexpectedly excluded, check that the event channel is not selected. Use Review menu, Include, Include all blocks. to reset all blocks before re-testing screening.

## Include, Select blocks by event category.

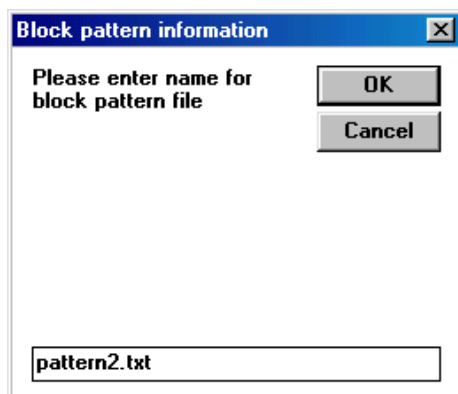
The main purpose for this function is for a future development in which the measuring system might generate data already in blocks, instead of the continuous recordings that are the present mode (October 2000).

Otherwise, one or more multi-block Reviews using any event selection can be created from the normal Block selection window. Review menu, Include, Select blocks by event category. may be used to exclude particular blocks where an original multi-block Review contains blocks with various event categories. Blocks should be reset using Review menu, Include, Include all blocks. before using this method for excluding particular blocks (it excludes only blocks that are already selected, it does not re-

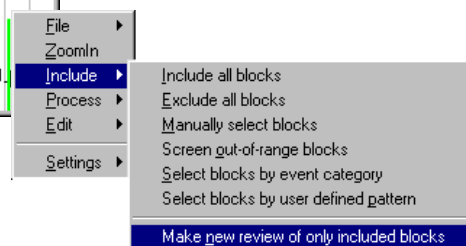
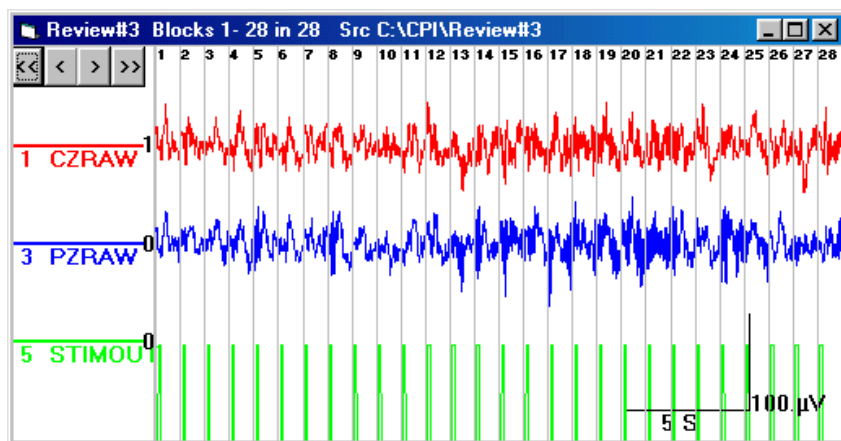
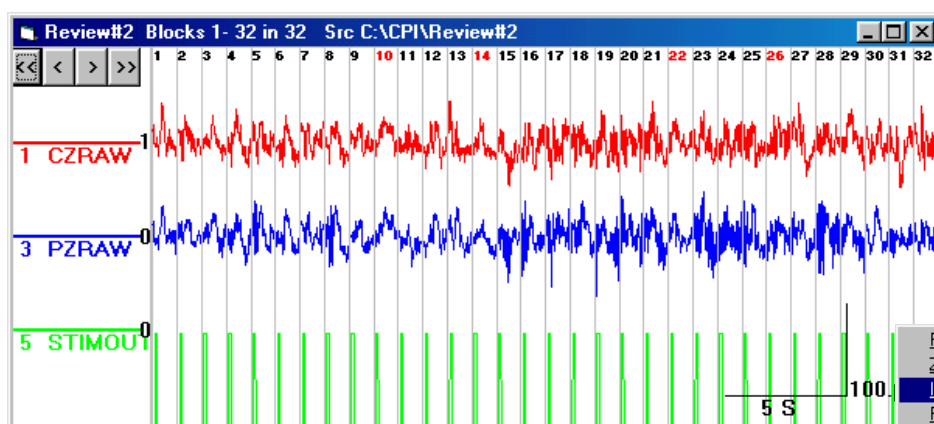
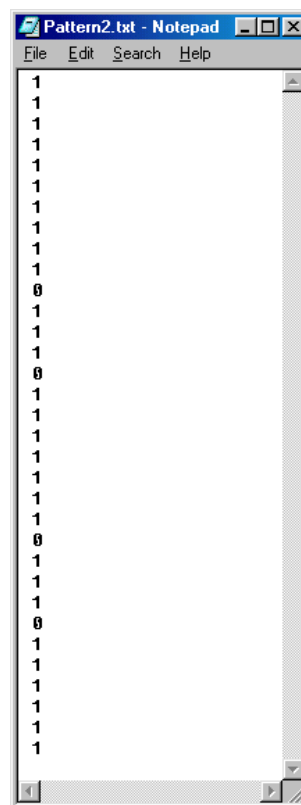


include blocks that are already excluded). If Create new Review. is checked, a new multi-block Review appears containing only the subset of blocks.

**Include, Select block by user defined pattern.** This may be used to include particular blocks to a pattern described in a text file. It can be useful when recorded event codes do not discriminate necessary blocks, but trial patterns are known. Necessary blocks may be included or excluded



from all by loading in the appropriate pattern from disk file. If the file does not contain as many lines as there are blocks, remaining blocks will be deselected. If it contains too many lines, the last lines of the file are ignored. Review#2 shows blocks selected using the file shown in Notepad editor to the right. Each line contains just one character, 1 or 0 for include or exclude. Certain process functions may not obey Include status. Average, used for EEG ERP analysis, only averages included blocks and leaves out excluded blocks, but other functions may process all blocks regardless



of include status. If only included blocks are required to be processed by other functions, a new multi-block Review may first be created containing only the required included blocks.

**Include, Make new Review of only included blocks.** This may be used to create a multi-block Review from an original one, containing only the blocks that were included in the original. The

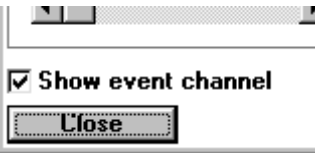
example Review#3 is a new multi-block Review created using the Pattern example above. Note that blocks in the new Review do not retain the same block numbers used in the original Review.

## Processing data.

Processing operations are designed only to work on data in blocks, which provides processing algorithms with uniform length data on which to operate. This has the advantage that like information is produced for each block, allowing valid statistical comparison.

### Channel Selection.

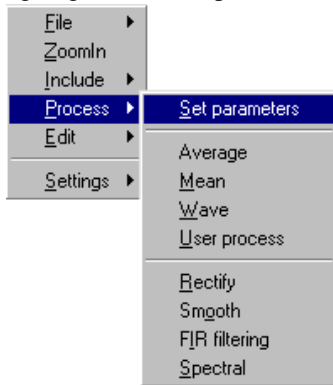
Process functions operate only on channels that are *selected*. Selected channels are shown with 1 on the axis just to the left of the waveform area. Unselected channels are shown with 0. To change a channel's selection status, click on the selection indicator (i.e. click on the 1 to change it to a 0, and vice-versa).



Almost invariably, the event channel should not be selected when processing data, as it contains a different type of data to physiology waveforms. However, the event channel can be made to show in process Reviews by checking a box in the Process settings window.

### Set parameters.

It is important to select channels before going into the Set parameters panel, as



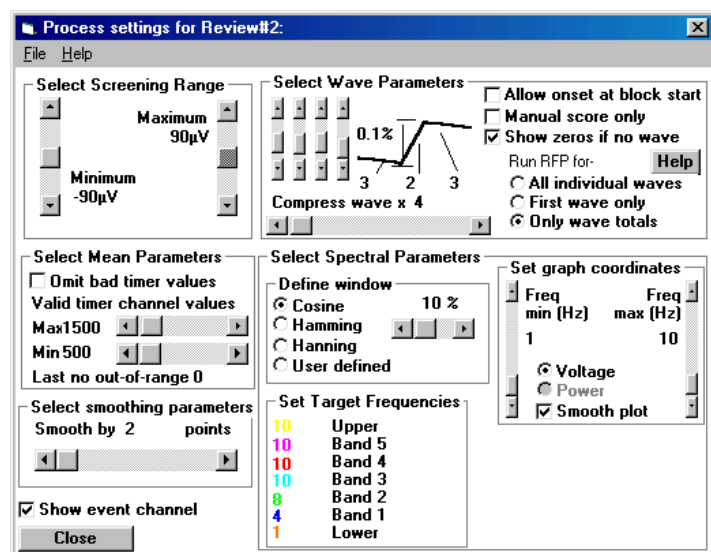
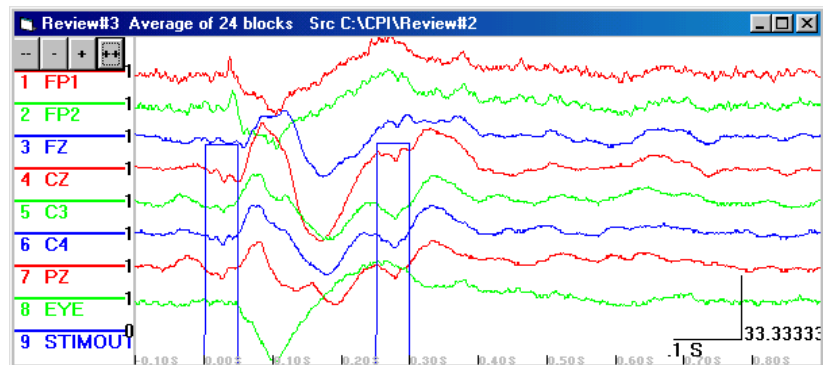
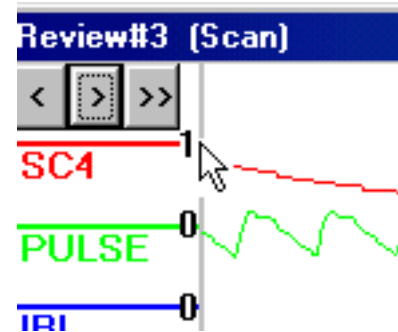
when a Process settings file is stored, it includes the current channel selection.

The Process settings window is opened using Review menu, Process, Set

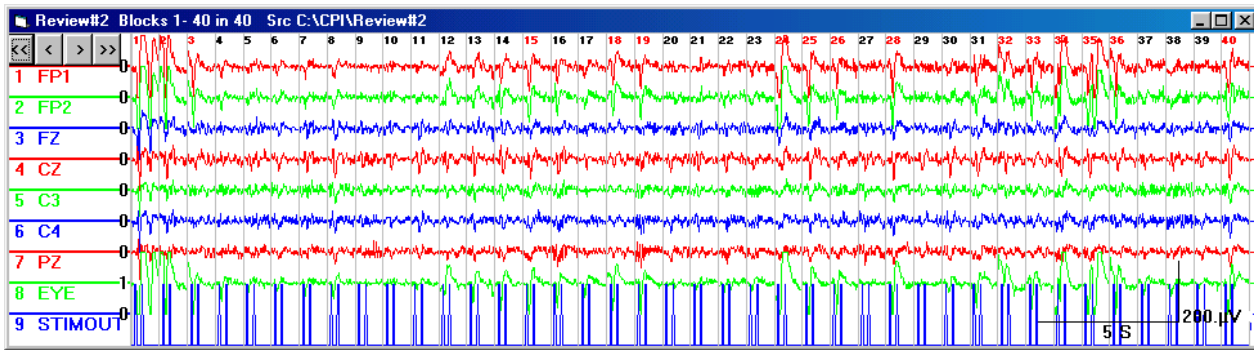
parameters. The settings in the Process settings window relate to the particular Review from which it was opened. PSYCHLAB allows different Process settings to be used in different Reviews. If the Review is a multi-block Review, the settings for that Review will be used for any process functions used on that multi-block data. The settings that show when the window is first opened are the default settings. These default settings may be permanently changed by altering process settings, then closing the Process settings window and then selecting Toolbar menu, Save settings now. However, there is an alternative way to change settings to a stored pattern, by using Process settings window menu, File, Load process settings. This way of loading in

process settings allows different settings to be loaded from various files, whereas there can only be one set of default settings stored using Toolbar menu, Save settings now. If inappropriate settings are loaded, it may result in an error. If this occurs repeatedly, cancel the error, then use Toolbar menu, Save settings now, so that default setting suit the data.

The Process settings window is divided into sections relating to particular processing algorithms. These are discussed within descriptions of each particular process function.



## Process, Average.

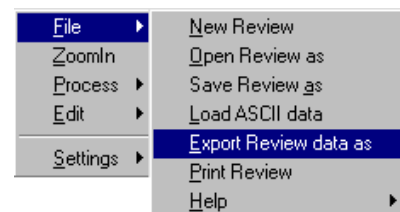


This function performs signal averaging of the type used with EEG evoked potential. Like points of each block are averaged together, so that random aspects of data tend to cancel out, whereas effects relating to a stimulus synchronized with all blocks will be amplified. Only selected channels are included in the resulting Average Review. Note that before opening raw data, it is possible to invert data in Toolbar menu, Options, Invert data. This can be used to orient the ERP wave positive or negative up, as preferred. Blocks are then created, and before EEG data are averaged, normally they are screened using Include, Screen out-of-range blocks. The panel in the **Process settings** window which has bearing on the Average function is, therefore, Select screening range. The channel/s to be used for screening should be selected, then the Process settings window opened from the multi-block Review using Review menu, Process, Set parameters. The Screening range panel should be appropriately adjusted, Process settings window closed, before using Review menu, Include, **Screen out-of-range blocks**. Review#2 is an example EEG Multi-block Review with screened blocks using the eye channel with screening range set to  $\pm 90\mu\text{V}$ . Channel selection must now be changed to select all EEG channels (but not the event channel). Then, Review menu, Process, Average can be used, the result seen here in Review#3. Notice that while the Multi-block Review shows 40 blocks, the Average Review is Average of 24 blocks, only the blocks that were included.

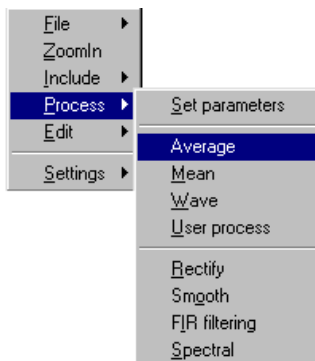
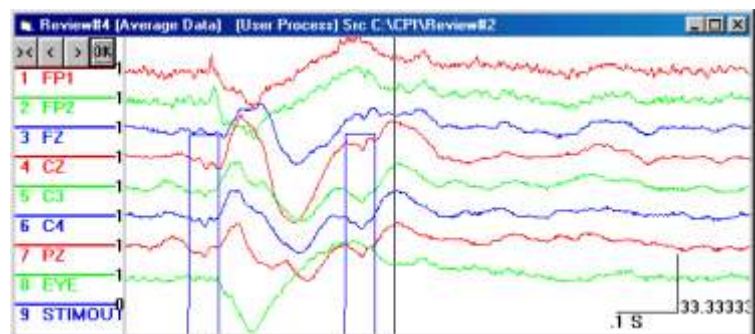
The four buttons in the top left corner of the Average Review have different uses now; they are a convenient way to change magnification, which can also be done using Review menu, Settings, Set amplitude.

ZoomIn cannot be used on average traces.

At this stage the following options exist for use on the average traces:



- 1) **Export** average data using Review menu, File, Export Review data as. Before using this function, settings in Toolbar menu, Export, should be checked.
- 2) **Score** the traces using the coordinates window, using the same method described near the beginning of this manual.
- 3) **Wave** process the average data, using Review menu, Process Wave. Normal rules for the wave function apply, however ERP traces are



generally too complex for the wave function to be able to reliably detect desired aspects.

File	Edit	Format	Program	Output	Direction	View	Debug	Help
-.002	-1.318359	1.611328	-78125	.6835938	-2.392578	-.6835938	-.7324219	
-.001	-1.367188	1.886641	-1.074219	.2441486	-2.685547	-.3277344	-1.318359	
0	-1.025391	1.757813	-1.123847	9.765625E-02	-2.781203	-.78125	-1.611328	
-.001	-.8789863	1.788984	-.9277344	9.765625E-02	-2.734375	-.5853375	-1.757813	
-.002	-1.886641	1.886641	-1.318359	-.2441486	-2.325688	-.8789863	-2.197266	
output latency								
output signal[01]								
output signal[02]								
output signal[03]								
output signal[04]								
output signal[05]								
output signal[06]								

4) **User Process** the average data. Review menu, Process, User process. provides a wide range of possibilities using the Results Format Program (RFP) language to automatically manipulate ERP data. In its simplest mode, the OK button can be clicked in the User process Review, Cancel button clicked in the Open RFP panel, and numerical information for each trace flows into the Results window. **Pre-stimulus**

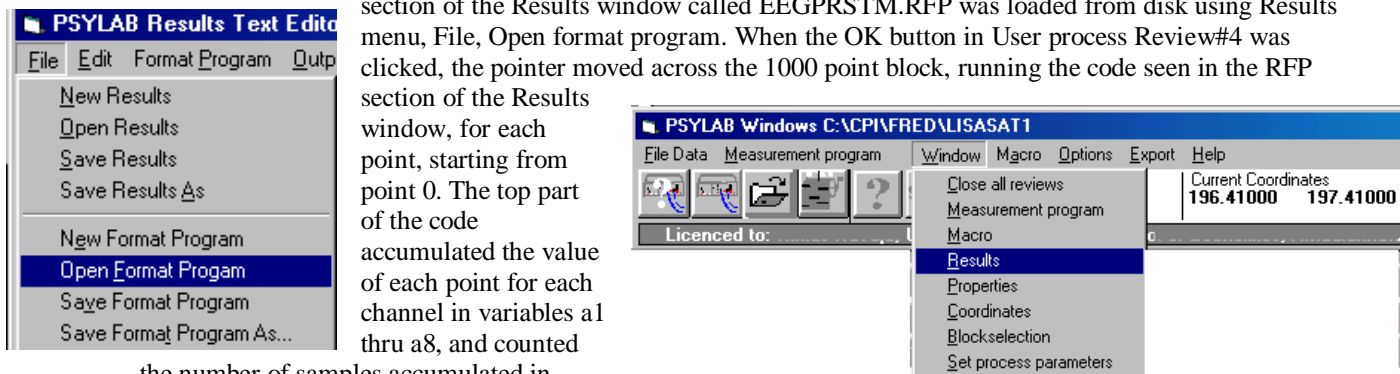


**Mean** can be produced by more complex RFP programming and even automatic scoring of traces may be possible.

User Process was employed to produce **ERP pre-stimulus mean** for the data shown in the above example as follows:

The Results window was opened from Toolbar menu, Window, Results. The RFP seen in the RFP program section of the Results window called EEGPRSTM.RFP was loaded from disk using Results menu, File, Open format program. When the OK button in User process Review#4 was clicked, the pointer moved across the 1000 point block, running the code seen in the RFP section of the Results window, for each point, starting from point 0. The top part of the code accumulated the value of each point for each channel in variables a1 thru a8, and counted

the number of samples accumulated in variable n1. After 100 points the top line in the RFP caused a jump to the FINISH subroutine. Data in this recording was sampled at 1000Hz, so 100 points is 0.1 seconds, which was the pre-stimulus period arranged when blocks were originally created. The FINISH subroutine first sets function 'pointer' to 'sblo'. RFP function 'sblo' returns the size of the block in points (i.e. 1000). Function 'pointer' relates to the position of the pointer that is seen to run across the Review as the RFP runs for each point. A full list of commands and functions for the RFP language is given in the Results Format Program section of this manual. 'Pointer = sblo' has the effect of jumping the pointer to the end of the block, so that no more points are processed. The rest of this subroutine calculates average for each channel, outputs that information into the Results area, terminates the line in the results area so that next output will be on a new line, and resets the variables to zero in case the OK button should again be clicked.



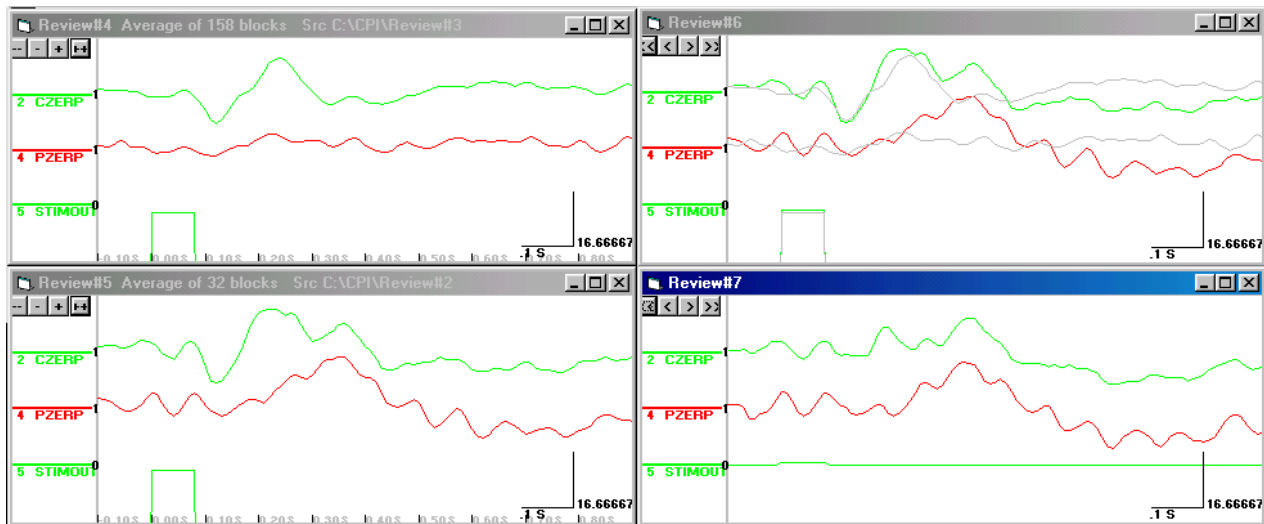
```

PSYLAB Results Text Editor C:\CPI\EEGPRSTM.RFP
File Edit Format Program Output Direction View Debug Help
-2.918457 -3.557129 -3.01123 -1.185059 -8.935547E-02 -1.304688 -4.541016E-02 -2.885742

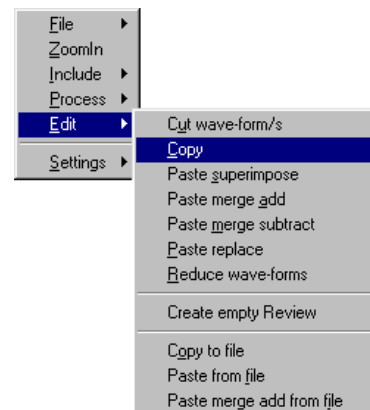
if pointer = 100 then goto FINISH ' define point where pre-stim data ends
a1 = a1 + signal(01)
a2 = a2 + signal(02)
a3 = a3 + signal(03)
a4 = a4 + signal(04) ' accumulate values
a5 = a5 + signal(05)
a6 = a6 + signal(06)
a7 = a7 + signal(07)
a8 = a8 + signal(08)
n1 = n1 + 1 ' count points
end

FINISH
pointer = sblo ' skip pointer to last sample in block
a1 = a1 / n1
a2 = a2 / n1
a3 = a3 / n1
a4 = a4 / n1
a5 = a5 / n1
a6 = a6 / n1
a7 = a7 / n1
a8 = a8 / n1 ' calculate average data
output a1
output a2
output a3
output a4
output a5
output a6
output a7
output a8 ' print prestim average values in results window
output ' terminate line in results file
a1 = 0
a2 = 0
a3 = 0
a4 = 0
a5 = 0
a6 = 0
a7 = 0
a8 = 0
n1 = 0 ' reset variables for next use.
end

```



- 5) **Compare or Subtract** Average traces with other Average traces. This is performed by generating more than one Multi-block Review and ERP Reviews from original data. Review menu, Edit, Copy. may be used to put traces into the clipboard; then the various paste options used to Superimpose, Add, Subtract, or Replace. The example shows two ERPs generated in an oddball paradigm, rare (Review#5) and frequent (Review#4), then the two superimposed (Review#6), and finally the frequent subtracted from the rare (Review#7).
- 6) **Grand Average.** This is performed with Review menu, Edit, Copy to File. ERP traces for each subject are generated and copied to file. When the last subject is done, Review menu, Edit, Paste merge add from file. is used to add the ERPs from all subjects to the last subject's ERP. The total number of subjects added must be counted. Finally, Review menu, Edit, Reduce waveforms is used to divide accumulated values by the number of subjects, producing a Grand Average which is correctly scaled. This may then be Copied to file in the Edit menu, or the Grand Average can be processed in any of the other ways mentioned here.

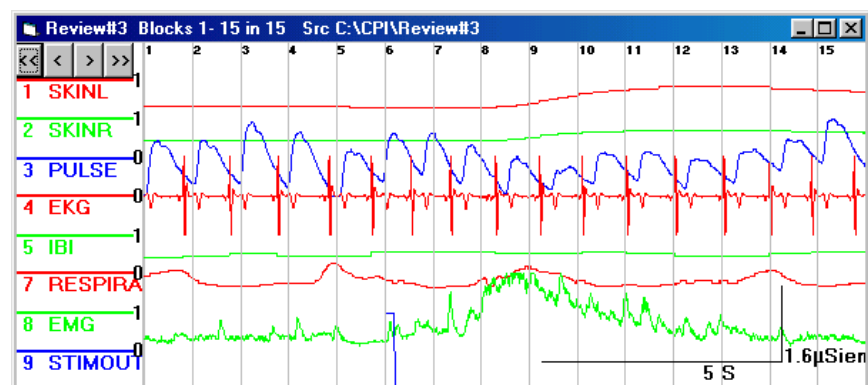


## Process, Mean.

Review menu, Process, Mean. may be used to produce:

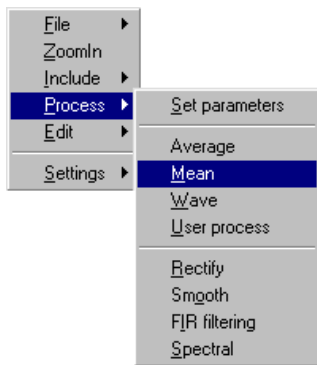
- 1 Average of all points in one block (referred to as Mean to avoid confusion with signal Averaging discussed above).
- 2 Standard deviation of all points in one block.
- 3 Confidence measure for Heart Rate data in that block, based on out-of-range value detection and correction.
- 4 Maximum value encountered in that block.
- 5 Minimum value encountered in that block.
- 6 Absolute deviation of all points in that block.

Typical uses include average SCL, average, standard deviation and absolute deviation of heart rate over long time epochs, average and maximum pre-probe EMG in startle trials, average and maximum facial EMG in longer time epochs of emotion data. The example Review#3 has SC, Heart rate (HR) derived from the EKG in hardware using an Interval Timer (which measures IBI in milliseconds), Respiration and EMG



traces. Fifteen contiguous one second blocks are produced with 5 before the stimulus and 10 after it. Appropriate measures for use with the Mean algorithm are SC (SCL), HR (IBI) and hardware rectified/integrated EMG. If raw EMG is recorded, Process, Rectify and Process, Smooth may be used before the Mean function is applied. Other measures such as pulse and EKG are AC waves that alternate about zero. Mean of these measures would tend to zero and have no usefulness.

Before selecting Review menu, Process, Mean. within the Multi-block Review, appropriate channels must be selected. The Mean Review produced shows the first block. Most traces seem flat in the one second block, as SC and IBI are slow changing variables.



The **Process settings** window has one panel for use with the Mean function; adjustment relating to IBI, from which Heart Rate is derived.

#### IBI artifact rejection.

The maximum and minimum settings in this panel determine a range within which IBI values are acceptable. Outside that range, IBI values are omitted from the Mean calculation.



**Select Mean Parameters**

☒ **Omit bad timer values**

**Valid timer channel values**

Max1500

Min 500

Last no out-of-range 0

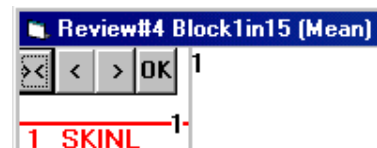
The example recoding was made at 100 samples block will contain 100 samples. Let us suppose quarter of the time in one block. This would be within range, i.e. between 500mS and 1500mS movement artifact occurred causing the Interval quarters of the way through the block causing a low, i.e. below 500mS. If Omit bad timer values.

Parameters panel, the Mean function would calculate average IBI by adding together the value of 75 samples and dividing the result by 75. A number of 25 would show as Last no. out-of-range. All other Mean function data (Standard deviation, max, min, absolute deviation) would also be based on 75 points. If the box were not checked, the Mean function would use all 100 points, including the bad ones, to make the calculation.

per second, so each one second that IBI were out of range for a happen if IBI were originally (120BPM and 45BPM) but a Timer to mis-trigger three new IBI reading that was too was checked in the Select Mean

The last no. out-of-range. value is one of the items produced by the Mean algorithm that is available as result data (Dat3), to be used as a confidence value, where zero is 100% confidence, higher values indicate less confidence up to the number of points in a block (in this case 100), indicating that IBI data is completely unreliable.

To get numerical result data from the Mean Review, click the OK button. This opens the Results window, and shows a panel for selecting data. A panel appears in the Results window which may be used to select data produced by the Mean algorithm. The panel has italicized headings numbered 1 thru 7; these should be followed in turn. 1, *Select header information for line*. Check the boxes underneath



this heading for information that will be headed to the beginning of each line of data produced. Block number is useful to help identify each line in the results file. Event value will help identify which trial results data belongs to. It returns the value of the event that triggered the block selection process to generate the block/s. Next, click on the button labeled 2, *Add*. This will generate the first section of code in the Code generated panel. Next, 3, *Select channel number*. Moving this slider up and down changes the big number seen next to it. To start with, no number may appear. Mover the slider up one and back down one, and the number of the first channel will appear. 4, *Select required output per channel*. For the selected channel, select items of data required. If it is the last channel, also select Terminate line after this channel. This will have the effect of creating a line break in the Results file after data for each particular block. When correct items are selected, click 5, *Add*.

**PSYLAB Results Text Editor**

File Edit Format Program Output Direction View Debug Help

**Set up Output for MEAN function**

*To generate a line of result data, follow the numbered instructions in italics...*

1 *Select Header Information for line*

☒ Block number ☐ Time ☐ Subject number ☐ Day ☐ Group number ☐ Month ☐ Year ☒ Event value

2 *Add*

3 *Select channel number*

8

4 *Select required output per channel*

☒ Average ☐ Standard Deviation ☐ Bad value count (timer channel) ☒ Maximum ☐ Minimum ☐ Absolute Deviation ☒ Terminate line after this channel

5 *Add*

6 *Go to 3...*

7 *Close (transfer code to RFP)* Cancel

**Code Generated** Clear

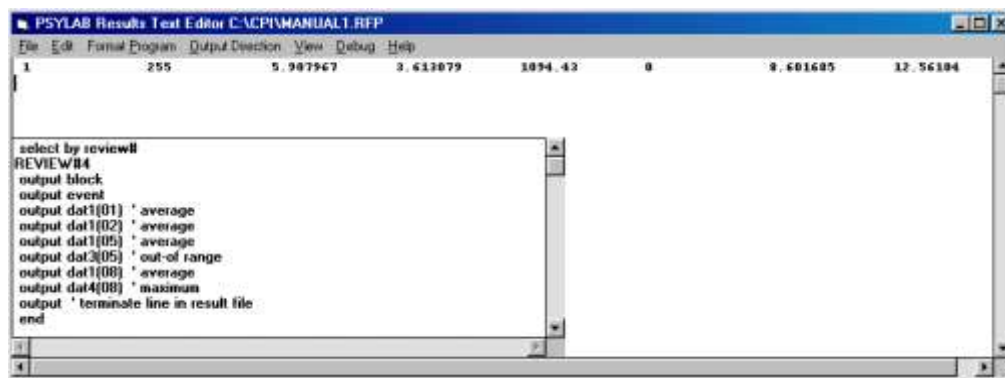
```

REVIEW#4
output block
output event
output dat1(01) 'avera
output dat1(02) 'avera
output dat1(05) 'avera
output dat1(08) 'avera
output dat3(08) 'avera
output 'terminate line
  
```

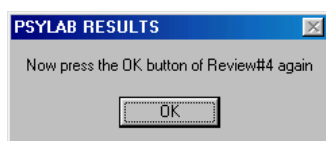
Repeat stages 3 thru 5 for each channel, with consideration for the type of data that is appropriate for each channel. For the IBI channel, include Bad value count, if this is activated in the Process settings panel. For EMG, maximum is often considered useful. Bear in mind when selecting data that the more information included for each channel, the more tedious it can be to decipher results data.

Finally, click on the button labeled 7, *Close (transfer code to RFP)*. This pastes the code from the code window into the RFP program area. If code already existed there, the new code would be amended to it in such a way that both sections of code would operate at appropriate times. This is done by the lines 'select by Review#', and 'REVIEW#4'. The top line causes program execution to jump to the section of code that relates to the Review for which the code is intended. When the code in the RFP area is amended, a prompt asks whether to save the program. Generally it is advisable to do so, so that it may be used again.

After that, another prompt appears 'Now press the OK button again'. The reason for this is that originally, the OK button of Review#4 was clicked, with the purpose of putting data into the Results window. But, because no RFP existed, instead of being able to run the



RFP to output data in the desired format the system produced the Set up panel to allow a program to be created. Now the program has been created, this prompt reminds to click the OK button again so that this time data will actually arrive in the Results window. The alternative to using the Set up panel is, before initially clicking the OK button in the Mean Review, open the Results window from Toolbar menu, Window, Results. then either type a program directly into the RFP area, or load one from disk.



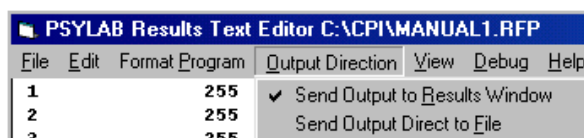
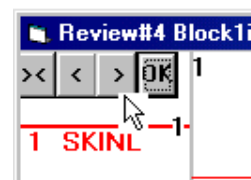
Clicking the OK button produces the first line of data in the Results window as seen in the example above. The next stage is to move Review#4 on to the next block. This is done using the > button. Block 2 appears, and the OK button can be clicked again to put

data from block 2 into the Results window. This is repeated for 15 blocks, producing 15 lines of data in the Results window as shown below.

The meaning of numbers in each line relates to the order of 'output' statements in the RFP, i.e. block no, event value, average of channel 1 (SCL), average of channel 2 (SCL), average of channel 5 (IBI), number of out-of-range timer values for channel 5, average of channel 8 (EMG), maximum of channel 8. Data in the Results area can be saved to disk using Results menu, File, Save results. The setting of Results menu, Output direction is important. If it is not set to Send Output to Results Window, each line of data will go automatically into a disk file named as the Raw data file but with .RES extension. Only one line of data will appear in the Results window. The RFP is described in more detail later in this manual.

The example demonstrates analysis of 15 one second blocks around a stimulus. The data used in the example showed just one stimulus – blocks were created from a zoomIn on a short section of a whole recording. In the long record with many trials, there would be 15 blocks produced around each

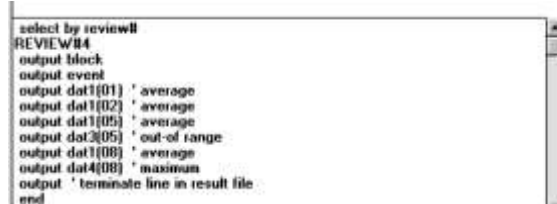
occurrence of specified stimuli. The same method can be used to analyze the whole record; data in the results window can be translated knowing that each stimulus produces 15 lines. Stimulus event values used when setting blocks may have a range of values as specified in the Block selection window, Set event levels to detect. box. The value of each stimulus will be seen in the Event column of the results file, which may be helpful when translating the table of results.



1	255	5.907967	3.613079	1094.43	0	8.601685	12.56104
2	255	5.900603	3.606997	991.25	0	9.962158	20.76416
3	255	5.894599	3.606997	969.5	0	9.771851	16.30859
4	255	5.887159	3.600759	1012.88	0	11.59631	22.90039
5	255	5.881002	3.598999	1014.51	0	6.769897	16.18652
6	255	5.877236	3.596761	854.98	0	13.89722	21.3501
7	255	5.870998	3.591003	820.65	0	18.37891	38.48877
8	255	5.908917	3.629719	904.07	0	44.67639	50
9	255	6.100837	3.757159	922.8	0	38.83545	50
10	255	6.292043	3.841643	888.06	0	26.23596	39.08691
11	255	6.396597	3.888601	923.61	0	20.89441	36.82861
12	255	6.443161	3.910443	1002.4	0	14.0365	23.41309
13	255	6.432195	3.896279	1009.65	0	11.97473	19.6167
14	255	6.384681	3.864763	941.25	0	9.012573	16.24756
15	255	6.325317	3.832358	873.68	0	8.718872	11.12061



It is laborious to have to click the OK and > buttons for a large number of blocks, and the Macro feature can be used to automate this, so that all blocks are processed automatically. Macro is discussed further on in this manual.



```
select by review#1
REVIEW#4
output block
output event
output dat1(01) 'average
output dat1(02) 'average
output dat1(05) 'average
output dat3(05) 'out-of range
output dat1(08) 'average
output dat4(08) 'maximum
output 'terminate line in result file
end
```

In the RFP, remarks are automatically placed at the end of certain lines to help with understanding of how the RFP operates, e.g. ' average seen at the end of line

output dat1(01)

Any characters after the single inverted comma on a line is a remark; it is ignored by the RFP interpreter and has no effect. Remarks generated by the Set up. panel for Mean may not be the same as those shown in the example. This is a bug with the program (October 2000).

## Full list of RFP language commands:

GOTO  
GOSUB  
RETURN  
IF... THEN...  
OUTPUT [value] Send value to the results window or output file as text with 13 character format.  
OUTBIN [value], [format] Send value to binary file. Two byte integer format is used if format is not specified.  
BEEP Make a brief sound using the default warning noise.  
BREAK Used in debug mode to halt RFP file execution.  
END Used to exit execution at the end of a file, or to exit at any point.  
MARK Draw a line at current pointer position in a User Process Review.  
PRINT USING [format] [value] Send value to results window or output file as text using defined format.  
DISPLAY [value],[vertical],[horizontal] Print value in body of User Process at vertical and horizontal position.  
SELECT BY REVIEW# Jump to the specified REVIEW# label (e.g. REVIEW#3). Label must be upper case.  
SELECT BY CHANNEL# Jump to the specified CHANNEL# label (e.g. CHANNEL#2), upper case.

The above commands are used in the direct context, e.g. if  $x = y$  then BEEP, or just BEEP.

LATENCY Function that increases in time increments of data sample interval.  
KEY Change value produced when function key pressed in User Process Review.  
INCLUDE Change include/exclude status of the current block in a User Process Review  
HOUR Change the hour value produced as record time.  
MINUTE When absolute time is selected, the minute of the record time at present position in data.  
POINTER Position in data in a User Process Review. Scans from 0 to number of samples in block.  
DAT1 thru DAT6 Data produced by processing algorithms WAVE and MEAN.  
ABSTIME Used as [value] in the OUTPUT command; presents absolute time in results text.

The above commands are used in the context that they may be set, e.g. LATENCY = x.

TIME Returns the time of the start of a block in User Process Review. Cannot be changed.  
KEY Returns the last function key value pressed in User Process Review.  
LATENCY Returns current time value resolved to sample interval. Latency can be changed.  
RANDOM Returns a random value in range 0 to 255.  
SUBJECT Returns the subject number specified in Subject Details panel when data record was made.  
GROUP Returns the group number specified in Subject Details panel when data record was made.  
PARAMETER Returns the parameter value specified in Subject Details panel when data record made.  
NCHAN Returns the number of channels in the record.  
NBLOCK Returns the total number of blocks.  
SBLOCK Returns the blockwidth as number of samples.  
WIDTH Returns the blockwidth as time in seconds.  
RATE Returns the sample rate used when the record was made.  
BLOCK Returns the number of the block currently being processed.  
INCLUDE Returns the include/exclude status of the block currently being processed.  
REVIEW Returns the number of the Review currently being processed.  
OFFSET Returns the time offset as set when blocks were created  
MONTH Returns the month when the record was made.  
DAY Returns the day when the record was made.

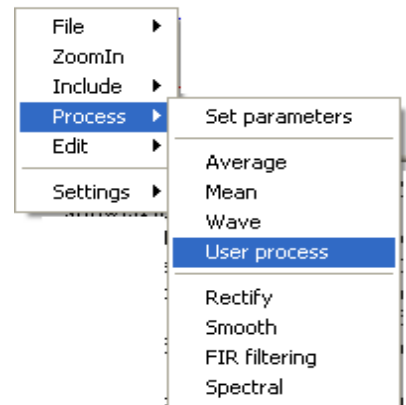
YEAR	Returns the year when the record was made.
EVENT	Returns the event value used to find the particular block.
CHANNEL	Returns the channel number of data being produced by the WAVE algorithm.
POINTER	Returns the current point position when block data are scanned in User Process Review.
SQR [value]	Returns the square root of value, e.g. $x = \text{sqr } y$ Parentheses are not required.
SIGNAL(nn)	Returns the value of channel nn at current pointer position in User Process Review.
DAT1(nn) thru DAT6(nn)	Returns output from WAVE or MEAN algorithm. nn must be two characters, e.g. x1, 03.
GAIN(nn)	Returns range setting of channel nn set on the amplifier when record was made.

Note that in all cases, where a subscript is used in parentheses shown as nn, two characters are required. This can be either a constant, e.g. 01, 02, etc. or a variable e.g. a1, z9, etc. In all other cases, however, leading zeros are not to be used when specifying values as constants, e.g. use .1 not 0.1.

## Process, User Process.

Review menu, Process, User Process may be used to allow processing of data using logical commands in the RFP area. When the OK button in the User Process Review is clicked, it causes the RFP file to run once for every data point in the Review, starting at the beginning of the Review.

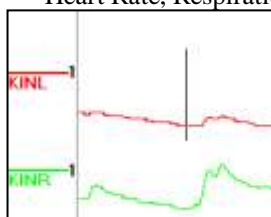
The above list of commands may be used in the RFP.



## Process, Wave.

Results menu, Process, Wave. is a very useful tool. It was originally designed for detecting Skin Conductance responses, but by making use of the adjustable parameters provided in the Process settings panel, it adapts to uses such as R wave detection for calculating

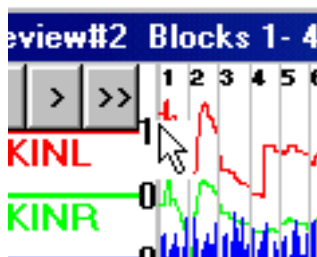
Heart Rate, Respiration wave counting for calculation of respiration rate, Pulse amplitude measurement, quantification of blink amplitude in startle trials, etc.



The Wave detection system works by applying the following test at each point along selected traces:

- 1) A positive slope is detected if a given number of consecutive data points have progressively increasing value, without any instances of intermediate points being of lower or equal value to their predecessor.
- 2) When slope is detected, peak is established when a given number of consecutive data points have value equal to or less than their predecessor.
- 3) When the slope and peak are detected, onset is recognized by tracking back from the first point of the slope to establish the position where a given number of data points have value equal to or less than their predecessor (i.e. the trace is flat or descending).
- 4) The difference in level between the onset and peak is compared with a minimum criterion and if less, the wave is not detected.

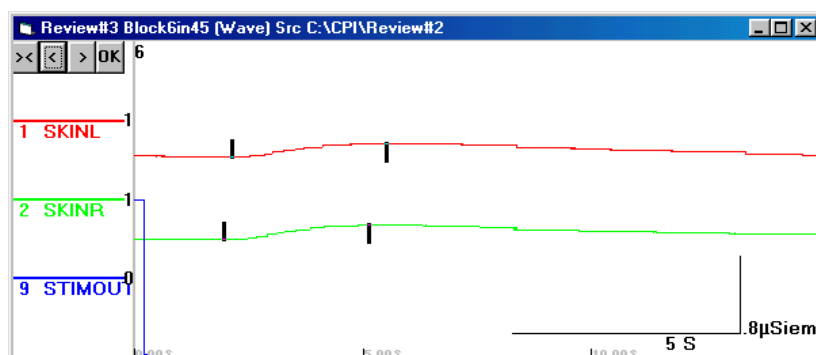
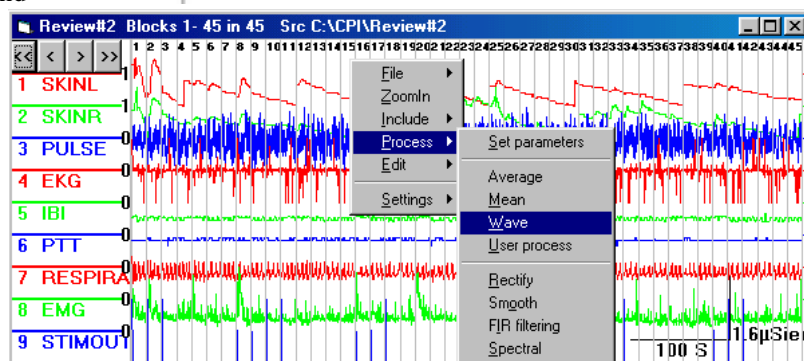
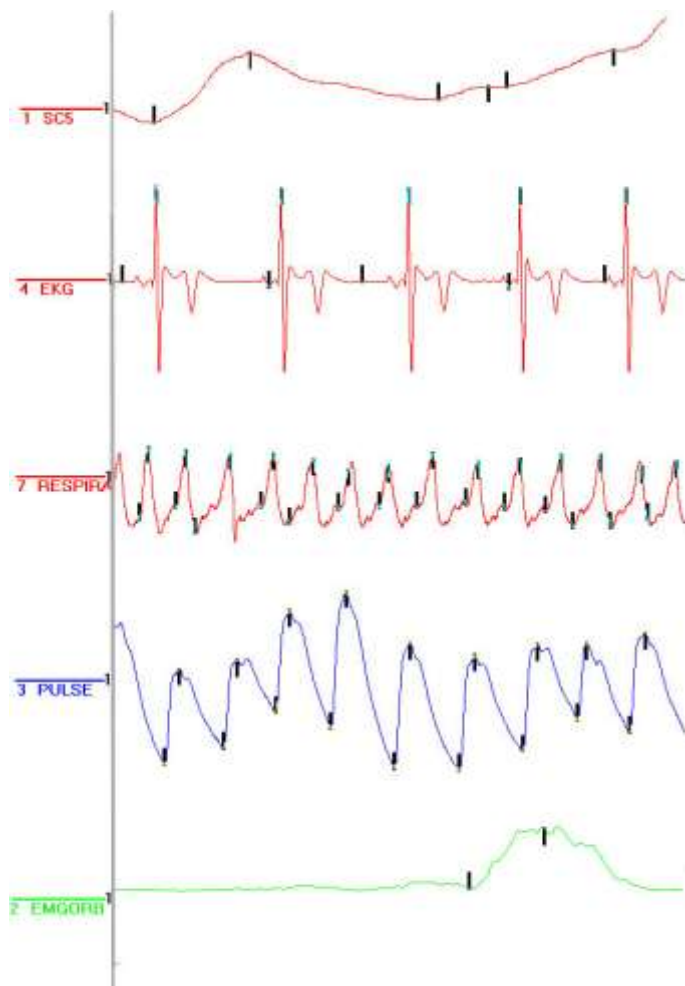
Channels for wave processing must first be selected in the multi block Review before Review menu, Process, Wave is used. A single block is



displayed in the Wave Review, with markers placed above and below the trace, showing the onset and peak of any waves detected. Generally, a Wave Review will

only be used to process one type of data at a time. In a recording with several different traces, one Wave Review would be used to process Skin Conductance, a separate Wave Review would be used to process pulse amplitude, etc. The reason for this is that Process Settings for the Wave Review would almost certainly need to be different for various types of trace. Process settings may be set in the multi block Review

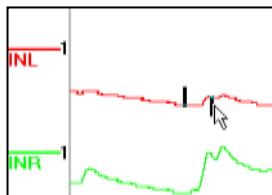
before the Wave Review is created, and settings will be carried forward to the Wave Review. They can also be adjusted after the Wave Review is created by selecting Review menu, Process, Set parameters. from within the Wave Review. When changed this way, the Wave algorithm is re-applied to data seen in the Wave Review immediately the Process settings window is closed.



## Effect of Wave settings.

**Manual score only** ☒ **Manual score only** check box disables

the automatic scoring algorithm. In this mode, the record can be manually scored: Place the mouse pointer above a trace and drag the left mouse button across the axis of the trace, then release. Then grab the score marks and move them to the desired position. This may be repeated as often as necessary. To delete any unwanted score markers, click the



right mouse button on the onset marker. When the block is scored satisfactorily, click OK and proceed in the same way as described for automatically scored blocks.

**Allow onset at block start** check box allows a wave to be scored if the onset marker cannot be correctly positioned

because the wave is too close to the beginning of the block. The box would be checked in cases where the purpose is simply to detect waves, e.g. for counting in HR or RR analysis, or counting spontaneous SC fluctuations. It would not be checked in cases when the time of onset of the wave is important, such as for specific time windowed SCR or perhaps analysis of startle blink data, where the response should not be scored unless the onset meets a latency criterion.

**Compress wave** slider relates to:

- 1) Slope of the wave, i.e. rate of change.
- 2) Sample rate used to collect data.
- 3) Frequency of the wave to be detected.

These three parameters are all linked. The slope will be steeper if the frequency is higher, or if the sample rate is slower. The Compress wave slider allows the number of points that the algorithm sees for its four step wave detection to

**Compress wave x 20**

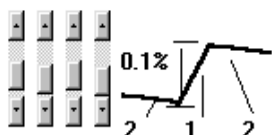


be changed. If it is set to 1, Wave detection uses every data point in the block. At 20, it looks at the first point in the block, and ignores the next 19 points, using the 20<sup>th</sup> point as the next for determining integrity of onset slope etc. The reason for using compression is

that if there is a very gradual slope, the slope detection algorithm will cancel if it finds any point that is not greater than the previous one. This is highly likely to occur in a very shallow slope. Ideal settings for the Wave detection system (WDS) are shown in the table. For SCR detection in a record recorded at 100 samples per second, set compression to 20,

SCR	5 samples per second
Peripheral Pulse	20 samples per second
EKG	100 samples per second
Respiration	5 samples per second
Startle blink	200 samples per second

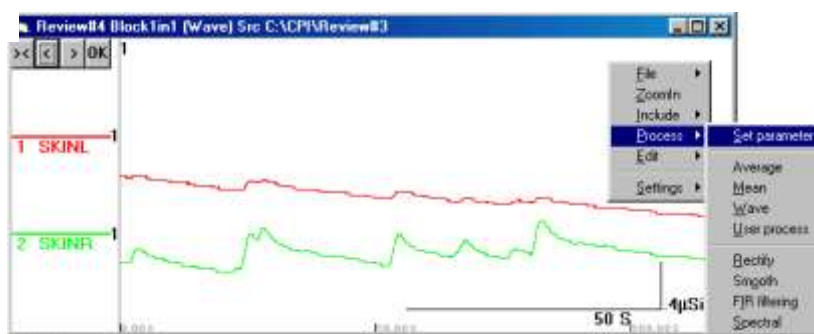
**Four vertical sliders** adjust each of the four stages of the WDS algorithm. The **first slider** determines the



number of points used in detecting onset. A relatively low setting for this usually works well. The **second slider** adjusts the number of

points used to determine the slope. The slope is the first aspect of the wave to be detected, so this slider has profound effect on sensitivity. In the first example, this slider is set to 0, which means that any place where there is an increase in the trace, WDS will pass the slope test. In the second example, this slider is set to 3, which gets a more sensible result with these SCR traces. There has to be a degree of compromise in

setting these sliders, best found by trial and error on the particular data. Run through the blocks to see how many Waves are missed out, or how many undesired score marks appear. When a block is found which is scored incorrectly, change slider settings to get the desired result then go back to see how it affects other blocks. The **third slider** determines the number of points that must comply for the peak to be established. The **fourth slider** determines **minimum response**



**Select Wave Parameters**

☐ Allow onset at block start

☐ Manual score only

☒ Show zeros if no wave

Run RFP for-

☐ All individual waves

☐ First wave only

☒ Only wave totals

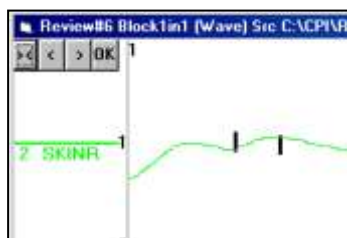
Compress wave x 20

0.1%

3 3 3

Help

☐ Allow onset at block start ☒ Allow onset at block start

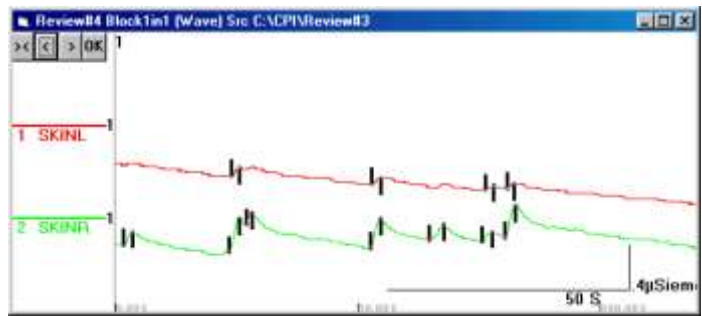


etc.





**amplitude**, i.e. level at peak minus level at onset. This is calculated as a percentage of full scale range. In the examples, the scale marker in the bottom right of the Wave Review shows a vertical scale of 0.4 microSiemen. The height of this scale marker is  $\frac{1}{4}$  of the full scale height available for each channel (e.g. the red channel has a scale range from the top of the Review to the axis of the green channel). Thus, the full scale range is 4 times the value given for the scale marker, 1.6 microSiemen. If the fourth slider is set to 0.1%, the minimum allowable wave amplitude will be 0.0016 microSiemen. SCR analysis often requires a given minimum amplitude to be used, for example 0.02 is commonly used. To achieve 0.02 with the example recording, the calculation would be  $(0.02/1.6) * 100 = 1.25\%$ . A compromise of 1.2% or 1.3% would have to be used as the slider only resolves to one decimal place.



**Data produced by the Wave Review.** Other controls in the Wave process settings panel relate to how data appear in the Results window. These controls are duplicated for view in the Results set-up panel, but cannot be changed there. The Process settings window must be opened from the Wave Review to change these settings.

The Wave Review can produce the following information.

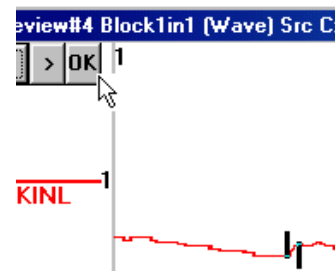
- 1) Onset level of each wave.
- 2) Onset latency (from block stimulus event) for each wave.
- 3) Amplitude of each wave.
- 4) Total amplitude of all waves in each channel.
- 5) Count of waves in each channel.
- 6) Peak latency of each wave.

**Show zeros if no wave** ensures that if no wave at all is detected in a particular channel, WDS will put zero numbers into the Results area, rather than leaving fields blank.

☒ **Show zeros if no wave**  
 Run RFP for- **Help**  
☐ All individual waves  
☐ First wave only  
☒ Only wave totals

When satisfied with WDS settings, click the OK button in the Wave Review. Set up Output for Wave function. Panel appears in the Results window. Resize the results window if necessary to clearly see the panel. Follow the numbered italicized headings in order. 1) *Header information* is data that will appear at the beginning of every line of results. 2) *Add* must be clicked when satisfied with the header selection.

3) *Select required wave information* allows selection of the 6 pieces of information produced by WDS. Normally, either individual information will be required or summation information (total of all waves and total wave count), but not both. Summation information is generally used when non-specific information is collected, such as SC NSR in an emotion study, Pulse amplitude, Respiration rate, EKG for HR. Individual information is likely to be required when a specific response to a stimulus is measured, such as SC SR or startle blink. The channel number field may be helpful to help identify which field in the



**Set up Output for WAVE function**

To generate a line of result data...

Present data for:

☒ All individual waves  
☐ First wave only  
☐ Only wave totals

☒ Show zeros if no wave

To access these controls, open the Process settings panel from the Review menu

1 Select Header Information for line

☒ Block number ☐ Time  
☐ Subject number ☐ Day  
☐ Group number ☐ Month ☒ Year **2 Add >**  
☒ Event value

3 Select required wave information

☒ Channel number  
☒ Individual Wave Onset Level  
☒ Individual Wave Onset Latency  
☒ Individual Wave Amplitude  
☐ Total of All Wave Amplitudes  
☐ Total Count of all Waves  
☒ Individual Wave Peak Latency

4 select format **5 Add >**

6 Close (add code to RFP)

Code Generated

```

HEADER
output ' terminate last
output block
output event
return
REVIEW#4
if channel > c1 then gos
if block > b1 then gosul
c1 = channel ' put cha
b1 = block ' put block
output channel
output dat1(c1) ' onset
output dat2(c1) ' latenc
output dat3(c1) ' amplit
output dat6(c1) ' latenc
  
```

results data relates to which channel, particularly if a separate line is used for each channel.

4) *Select format* determines how information will flow into the results window. It controls the positioning of CR LF (new line) characters in the results text, dividing data into separate lines. Normally, if **only wave totals** is selected (in which case only the two summation fields would be checked), one line would be used for each block, because there will always be the same number of fields produced, regardless of how many waves are detected. The same is true if individual information is required, as in a specific response study, when **First wave only** is selected which means that although wave markers will be seen for all waves, only the first one will be sent to the Results area. If **All individual waves** is selected, it would be normal to terminate the line after each wave. In this case the size of the results file will vary depending on how many waves are detected. This mode is seldom used.

5) *Add* is clicked when the above information and format are correctly set, then 6) *Close (add code to RFP)* must be clicked. At this point a prompt may appear asking to save the RFP. Generally it is useful to do this, so that the settings just produced can be more easily loaded directly from disk for a future analysis. If a suitable RFP has already been opened in the Results window, the Set-up panel will not appear when the OK button is clicked in the wave Review.

Now, when the OK button in the Wave Review is clicked again, the RFP runs once for each wave in the first channel, and then once for each in the second, producing lines of data for each wave in the Results window:

Fields (columns) of each line in the results window have meaning as shown in the list:

Block number.  
Event code for that block.  
Channel number.  
Wave onset level.  
Wave onset latency from event.  
Wave amplitude.  
Wave peak latency.

The RFP that was generated by the set-up panel is also shown; the way the RFP works begins to be revealed. The RFP can be directly edited to adjust the format of output data.

With the Process settings panel changed for First wave only., as shown below, and the set-up panel changed to put a new line between each channel rather than

Line	Block	Event	Channel	Onset Level	Onset Latency	Amplitude	Peak Latency
1	255	1	2.823	24.01	8.800006E-02	25.59	
1	255	1	2.727	52.79	7.200003E-02	54.77	
1	255	1	2.671	76.3	.0400001	70.88	
1	255	1	2.487	80.89	5.599999E-02	82.27	
1	255	2	3.079	1.53	.152	3.51	
1	255	2	3.007	23.39	.348	25.57	
1	255	2	3.319	26.88	.1199999	28.26	
1	255	2	3.063	52.5	.1040001	54.68	
1	255	2	3.135	64.74	.168	67.72	
1	255	2	3.119	75.66	.112	77.64	
1	255	2	3.167	80.34	.352	82.52	

each wave, when the OK button is clicked the results window appears thus:

The field list is the same as before, but only two lines are produced for each block, one for channel 1 and one for channel 2. The RFP generated by the set-up panel is slightly imperfect as it generates a first line which has only header information in it. This short line could just be ignored, or the program could be edited to improve its operation.

```
select by review#
HEADER
output ' terminate last line
output block
output event
return
REVIEW#4
gosub HEADER ' new line between each wave
c1 = channel ' put channel no into variable c1
b1 = block ' put block no into variable b1
output channel
output dat1(c1) ' onset level
output dat2(c1) ' latency of onset
output dat3(c1) ' amplitude
output dat6(c1) ' latency of peak
end
```

**Set up Output for WAVE function**

To generate a line of result data...

Present data for:

☐ All individual waves

☐ First wave only

☐ Only wave totals

☒ Show zeros if no wave

To access these controls, open the Process settings panel from the Review menu

1 Select Header Information for line

☒ Block number

☐ Time

☐ Subject number

☐ Day

☐ Group number

☐ Month

☒ Event value

☐ Year

2 Add >

3 Select required wave information

☒ Channel number

☒ Individual Wave Onset Level

☒ Individual Wave Onset Latency

☒ Individual Wave Amplitude

☐ Total of All Wave Amplitudes

☐ Total Count of all Waves

☒ Individual Wave Peak Latency

Terminate line after each wave ☐

Terminate line between channels ☒ <4 select format 5 Add >

Terminate line between blocks ☐

Cancel

6 Close (add code to RFP)

Code Generated

Clear

PSYLAB Results Test Editor

File Edit Format Program Output/Direction View Debug Help

Line	Block	Event	Channel	Onset Level	Onset Latency	Amplitude	Peak Latency
1	255	1	2.823	24.01	8.800006E-02	25.59	
1	255	1	2.727	52.79	7.200003E-02	54.77	
1	255	1	2.671	76.3	.0400001	70.88	
1	255	1	2.487	80.89	5.599999E-02	82.27	
1	255	2	3.079	1.53	.152	3.51	
1	255	2	3.007	23.39	.348	25.57	
1	255	2	3.319	26.88	.1199999	28.26	
1	255	2	3.063	52.5	.1040001	54.68	
1	255	2	3.135	64.74	.168	67.72	
1	255	2	3.119	75.66	.112	77.64	
1	255	2	3.167	80.34	.352	82.52	

```
select by review#
HEADER
output ' terminate last line
output block
output event
return
REVIEW#4
if channel > c1 then gosub HEADER ' new line between channels
if block > b1 then gosub HEADER ' and between blocks
c1 = channel ' put channel no into variable c1
b1 = block ' put block no into variable b1
output channel
output dat1(c1) ' onset level
output dat2(c1) ' latency of onset
output dat3(c1) ' amplitude
output dat6(c1) ' latency of peak
end
```