The Sweet Spot Suite

The Sweet Spot Suite is a new set of features included in the BrainMaster 3.0.2 software. They are designed to facilitate "sweet spot" training. This approach to training takes full advantage of subtle adjustments in training parameters, as well as the ability to finely adjust frequency parameters during training. The new features consist of the ability to adjust and see key parameters both before and during the training session.

The new or newly adjustable parameters are Sustained Reward Criterion, Refractory Period, Autothreshold Epoch and Autoupdate Continuous Mode, On-the-fly Frequency Shifting Increment, Digital Filter Smoothing Window, Text Damping Factor, and Filter Order. In addition, there are improvements to onscreen waveform displays to include average amplitude, current threshold, and percent time over threshold.

These new parameters provide two main benefits. Firstly, the system is much more tunable and adjustable, for a variety of needs. For example, for high-frequency training (beta, gamma), it may be desirable to shorten certain response parameters to provide faster feedback. For low-frequency training (alpha, theta), parameters can be tuned for more selective, stable feedback, requiring improved mental control. The second benefit is the ability to set the system to respond more in accordance with previous systems that may have been used to develop protocols or approaches. For example, the "Neurocybernetic" systems use filters with order 2, and a particular smoothing value for the digital filters, in addition to a particularly tuned autothreshold mechanism. This new suite of features makes it possible to address training protocols that have been developed on this and other systems, and adapt them to the BrainMaster.

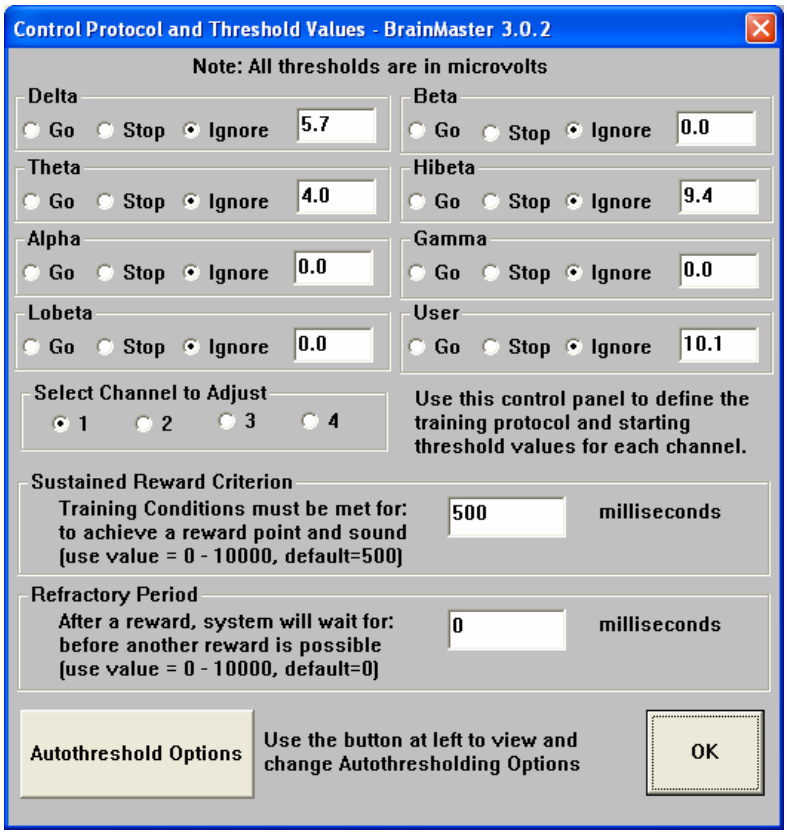
Summary of adjustable tuning parameters, ranges, and default values

Parameter	Units	Usable Range	Default Value
Sustained Reward Criterion	milliseconds	0 – 10000	500
Refractory Period	milliseconds	0 – 10000	0
Autothreshold Epoch	seconds	5-60	60
On-the-fly Frequency Adjust Increment	Seconds	0.1 – 1.0	0.5
Digital Filter Smoothing Window	Milliseconds	0 – 1000	60
Text Damping Factor	Damping units	0 – 1000	100
Digital Filter Order	Integer number	1 – 10	3, 6

These new parameters, their related control panels, and practical use in neurofeedback protocols, are explained below.

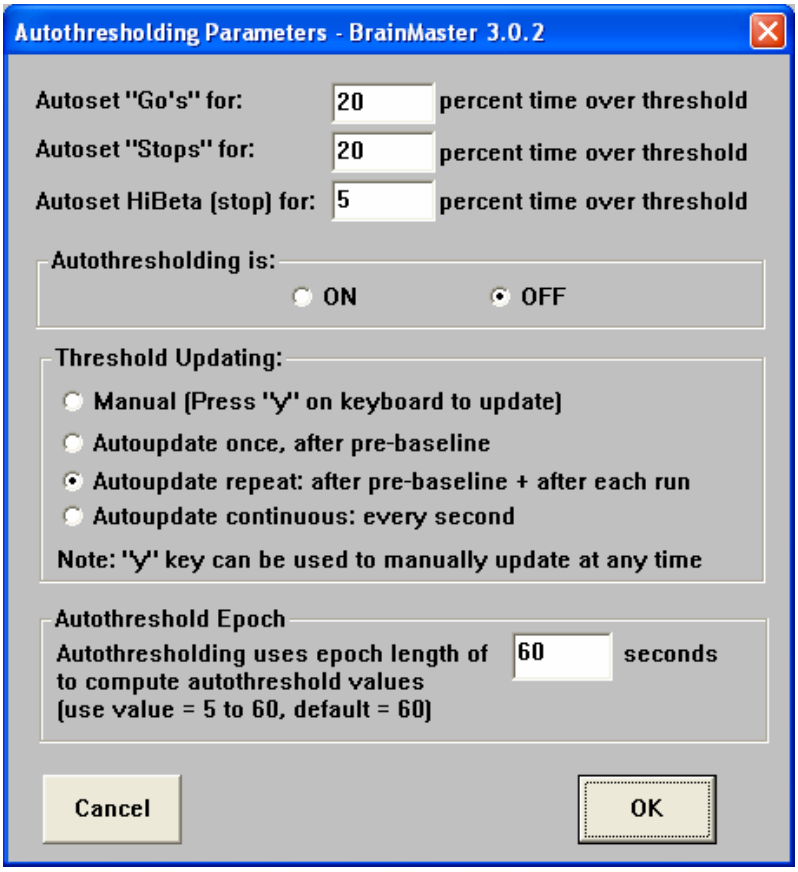
Sustained Reward Criterion – the length of time that the system requires the training conditions to be met before a discrete reward (point and/or sound) is issued. This parameter is used to avoid "spurious" feedback. It ensures that the trainee is sustaining the conditions for a defined time. If it is long, the task becomes more difficult, and will require more skill and sustained ability on the part of the trainee. This parameter also sets a limit on the number of points that can maximally be achieved per unit time. For example, if set to 500 milliseconds, then a maximum of 2 points per second, or 120 points per minute, are possible. If faster response is desired, it could be set lower, typically between 100 and 500 milliseconds. For a more discriminating response, it can be set higher, up to 1 or even 2 seconds.

Refractory Period – the length of time that the system will wait, after a reward is issued, before allowing another reward to be provided. This parameter is used to optimize the operant conditioning, by providing a "consolidation" period after each learning event. It interacts with the Sustained Reward Criterion to limit the maximum number of rewards. For example, if the SRC is set at 500 milliseconds, and the refractory period is also 500 milliseconds, a maximum of 1 point per second or 60 points per minute would be possible.



Autothreshold Epoch – how much time the system takes into consideration when computing automatic thresholds. This parameter will affect how much time is used to compute new thresholds for use when thresholds are updated automatically. If this is set for a short time, e.g. 5 seconds, then the autothreshold will vary more, and will shift based on very recent data. If it is set for a longer time, it will be more stable, but may also be "bogged down" by looking at older data. If the EEG conditions change suddenly, the autothreshold will take longer to adapt. This is also the epoch used to compute the "percent time over threshold" that is displayed in various displays, and is also accessible as a training variable via. the Event Wizard.

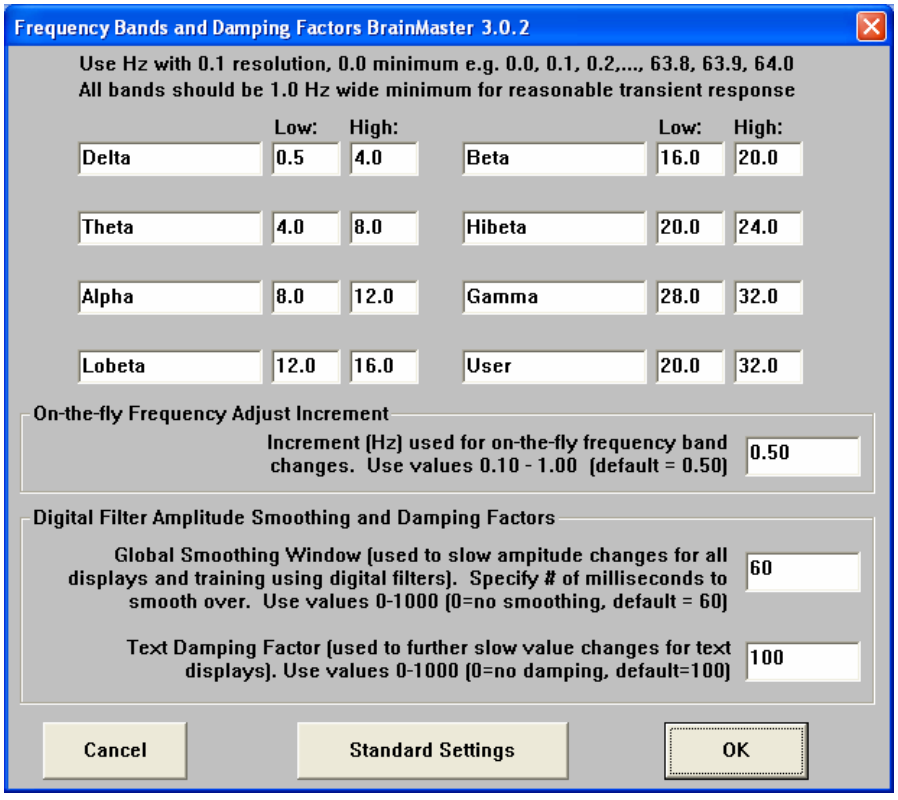
Autoupdate Continuous mode. In addition to "once" and "repeat (each run), a new "continuous" mode is now provided for continual changes in autothresholds for targeting emergent variability. If the thresholds are allowed to change continually, valid feedback continues to be provided, but the total rate of reward tends to be more constant when using rapidly changing thresholds.



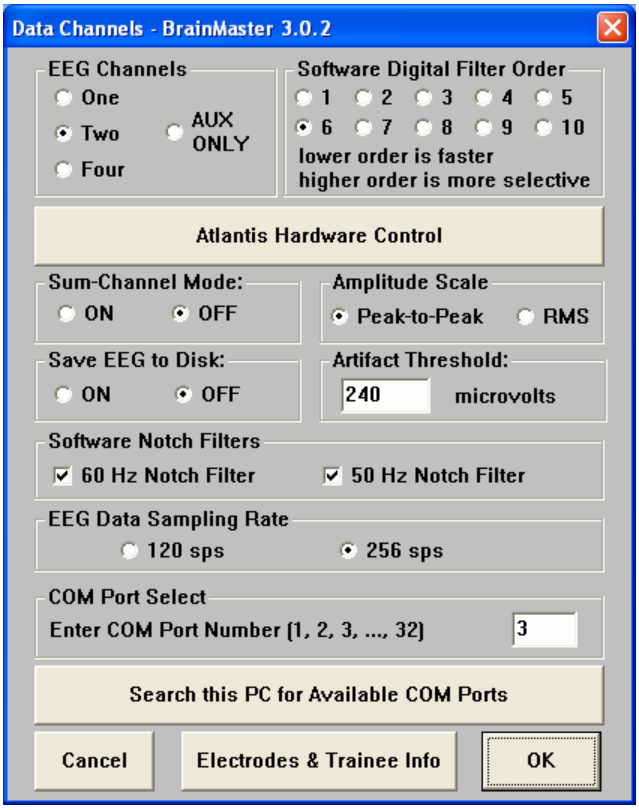
On-the-fly Frequency Adjust Increment – the amount of shift in the frequency bands when changing frequency bands on the fly. This controls the amount of shift that occurs when the operator uses the <Shift> key to access frequency adjust mode, and then usese the keyboard keys “d, t, a, l, b, h, g, u” to adjust the frequency band up (lower case) or down (upper case). For those who want very fine control, for example, this can be set to 0.1 or 0.2 Hz.

Digital Filter Smoothing Window – the interval of time that the system smooths (averages) the filter envelope when computing the amplitude. This will slow down the response of the thermometers, bargraphs, and similar displays. It will slow all displays and sounds that are controlled by the digital filters. For a more smooth display, this can be set for up to a 1 second (1000 millisecond) smoothing interval.

Text Damping Factor – the damping factor used when computing slow changes in amplitudes for purpose of text display. This provides “exponential” damping, and regulates the rate of change of text displays in the Text Stats panel, or in the “Numbers” display window. The damping factor defines the maximum rate of change, and is set so that a value of 100 takes about 10 seconds to fully adapt to a change.



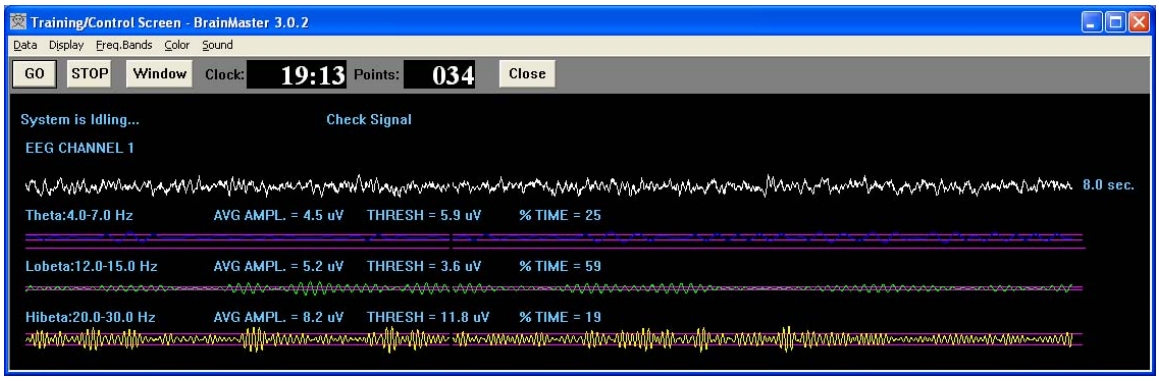
Digital Filter Order – the order (complexity, steepness of cutoff) of the digital filters can now take values of 1, 2, 3, 4 , 5, 6, 7, 8, 9, or 10. Low orders provide shallow cutoff bands, which provides faster response but less accuracy. High order filters provide sharper cutoff, but slower response to changes in wave transients.



The following table provides an estimate of the response of the filters used in typical EEG situations. This should help in choosing filter order for particular needs. In general, children, beginners, or high-frequency training should use lower filter orders to achieve faster response, while advanced, adult, or meditation students may want to use higher order filters to receive more selective feedback.

Filter Order	Approximate % of EEG energy “leaking” in from adjacent band(s)	Approximate # of input cycles required to fully respond to a change in input
1	30-40	1.5
2	20-30	1.8
3	15-20	2.0
4	10-12	2.3
5	5-8	2.7
6	4-5	3.0
7	3-4	3.3
8	2-3	3.7
9	1-2	4.0
10	<1	4.5

Onscreen displays – the filtered waveform displays now show Average Amplitude, Current Threshold, and Percent Time over Threshold for all filtered components.



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