Practical Guide to Synchrony Training with BrainMaster

This document describes ways to train EEG synchrony using the BrainMaster. It provides various options for doing this type of training. The methods shown are examples, and variations are possible. For example, different choices of references and ground are possible, and different sites can be chosen.

Synchrony training requires at least 2 channels of EEG to be monitored. It is not possible to do synchrony training with 1 channel. In particular, it is not possible to train synchrony using a "bipolar" hookup, such as T3 active and T4 reference. A bipolar connection can only downtrain synchrony, and can never uptrain synchrony. Thus, at least 2 channels are required, and each channel is typically recorded in a "monopolar" fashion, with a neutral reference such as an ear, or linked ears. Synchrony training can also be done with more than 2 channels. The BrainMaster Atlantis 4x4 can be used to acquire and train 4 channels of synchrony. Also, the Open Focus Synchrony Trainer can be used to acquire 5 channels of EEG, and combine them in hardware, providing one virtual EEG channel of output for training. This is described in more detail below.

Generally, synchrony training is done involving both hemispheres (left and right) of the brain. Typical active lead locations for two-channel training are, for example, C3 and C4. This would train primarily the motor strip. However, other choices include P3 and P4 (primarily the parietal areas), or O1 and O2 (primarily the occipital areas). When 4 channels are used, training can be both interhemispheric (between the hemispheres) and intrahemispheric (within a hemisphere). An example of a 4-channel inter- and intra-hemispheric connection would be F3, F4, P3, and P4.

Any frequency component band or bands can be trained using synchrony training. The most common frequency band is alpha (8-12 Hz), since it is known that alpha synchrony is accompanied by relaxation, mental clarity, and similar benefits. Training synchronous theta (4-7 Hz) and delta (1-4 Hz) is not recommended, as these components are often associated with drowsiness, distraction, and are often seen in cases of attention deficit and cognitive disorders. Beta (15 – 30 Hz) is also not commonly trained for synchrony, because beta waves are more localized in general, and diffuse beta is associated with such things as anxiety and tension. Gamma (35-45 Hz) can be trained for synchrony, and gamma synchrony is associated with mental clarity, problem solving, and higher cognitive function. Synchrony training of alpha and gamma together is an emerging technique, and is generally found to have beneficial effects. These components can be easily trained with the BrainMaster by using the two bands as enhance ("go") components in a synchrony protocol.

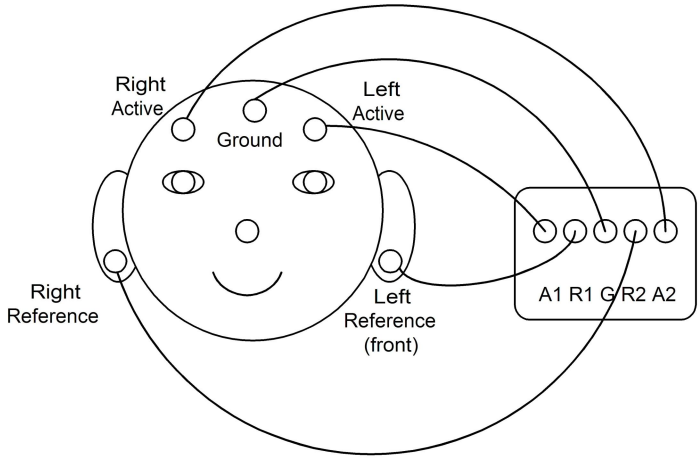
Synchrony can be trained by using various built-in metrics such as coherence, similarity, spectral correlation, and comodulation. This document, however, will focus on synchrony training that uses channel recombination (adding and subtracting raw EEG waveforms) as a simple and easy to learn technique.

One Person

One person can do synchrony training with 2 or more channels. The simplest method is to acquire 2 channels of EEG using a BrainMaster EEG such as the 2E, 2EW, or any model of Atlantis module. It is necessary to acquire each channel in a "monopolar" fashion, and to set up an appropriate protocol for synchrony training.

One Person Two-channel Synchrony Training

One person can do basic synchrony training with two channels by using two monopolar hookups as shown. The exact active leads can be C3 and C4, P3 and P4, or O1 and O2, for example. In this application, frontal leads, e.g. F3 and F4 are not common, and are not recommended.



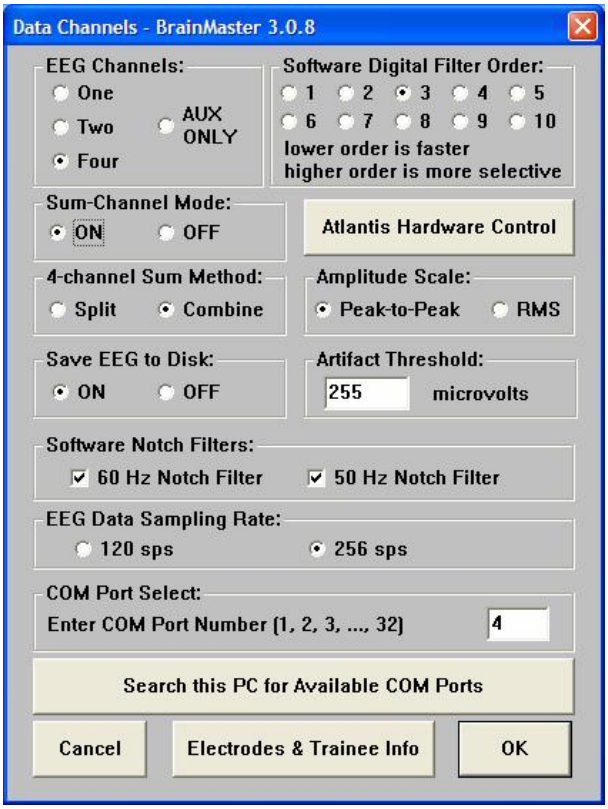
Once the sensors are placed as shown, several protocols can be used to uptrain synchrony. One of them is the built-in protocol called "peak", which trains using a "metric" such as coherence or similarity. The user can start with this protocol and then choose any of the available metrics, such as "Pure coherence," "Training/Similarity," "Spectral Correlation Coefficient (SCC), or "Comodulation". Any of these will train the EEG of the two channels to have similar characteristics, as follows:

Pure coherence – will train for stability of the phase separation between the 2 channels
Training coherence –will train for zero phase separation and similar amplitude
Spectral Correlation – will train for similar spectral energy
Comodulation – will train for similar amplitude variations between the 2 channels.
Phase – when trained down, will train the signals to be in phase.

The "peak" protocol provides sound feedback indicating that the signals are increasingly similar. The coherence threshold should be adjusted for optimal feedback. It is not possible to use "autothresholding" with coherence, as this is not advisable for clinical reasons. Rather, it is best to set the threshold continually, to find the best level for training.

Use of sum-channel mode.

The approach that will be emphasized here is to use the "sum channel" mode. This mode is chosen by simply setting Sum Channel Mode "ON" in the Data Channels control panel. When two channels are used, the choice of Sum-Channel mode to ON is all that is required to enter this mode of operation.



When this option used, set up the protocol as follows:

Data Channels – 2 channels of EEG
Sum Channel mode "on"
Training protocol – channel 1 "go" on the component of interest
Training protocol – channel 2 "stop" on the component of interest

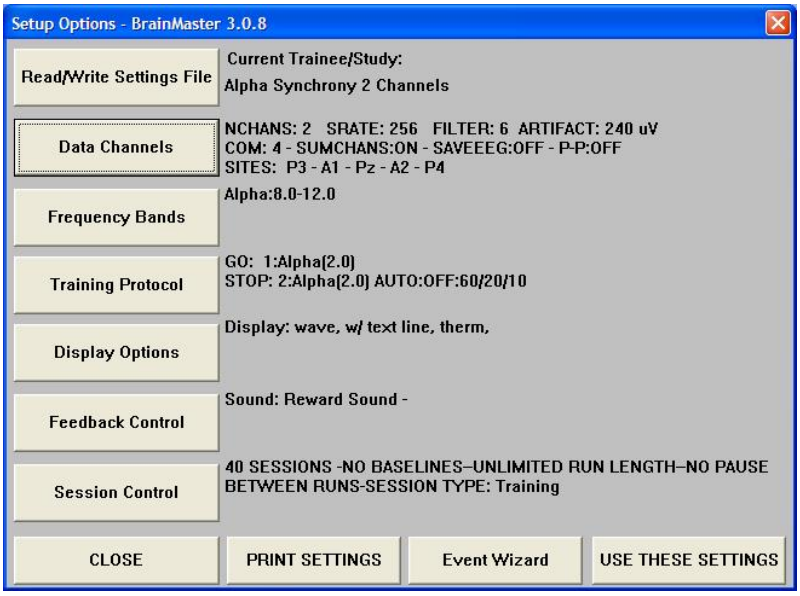
When Sum-Channel mode is turned on, then the EEG channels are recomputed so that channel 1 becomes the sum, and channel 2 becomes the difference.

In other words,

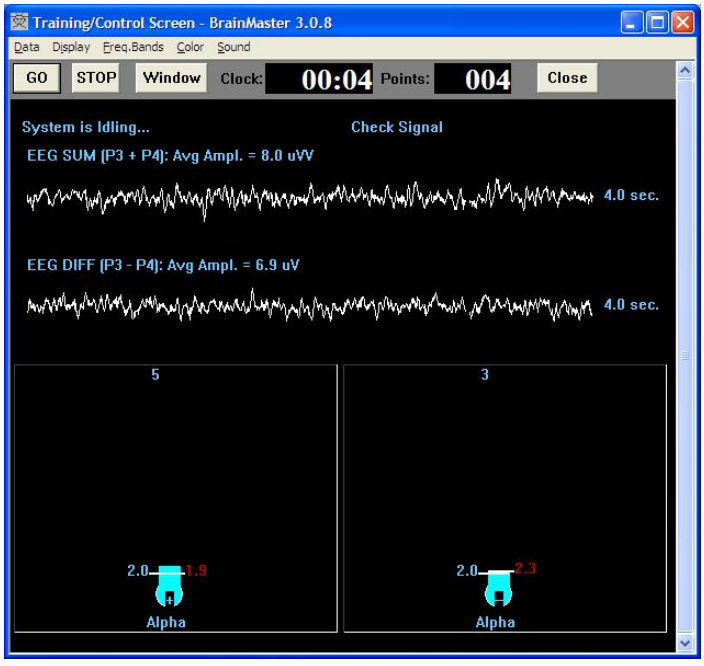
1 + 2 becomes channel 1
1 – 2 becomes channel 2

When the channels are "recombined" in this manner, the displays and computations proceed as normal, except that the waveforms that are used are the algebraic ("arithmetic") sum and difference signals.

The setup screen is shown below:

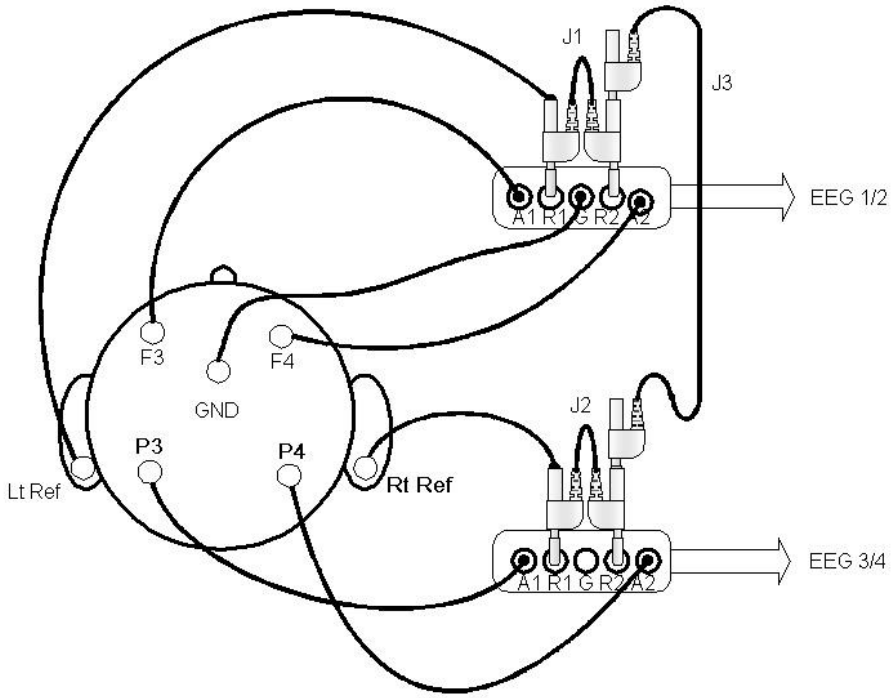


This method will uptrain the sum of the channels, and downtrain the difference. This will reward when the two channels are synchronized, and will tend to train them to be the same in frequency and phase, as well as being maximum amplitude. An example of the training screen is shown below. Note that the waveforms are labeled as the SUM and DIFF respectively, and that channel 1 is being trained up ("+" in the left thermometer) and channel 2 is being trained down ("-" in the right thermometer).



One Person Four-channel Synchrony Training

One person can do advanced synchrony training with 4 channels as shown. Note that this connection uses linked ears as a convenience. Three "jumper" wires are used to combine the ear references into a single "linked ears" reference that is used for each of the 4 channels. The 4 active channels used in this example are F3, F4, P3, and P4. Other choices could be used, for example, C3, C4, Fz, and Pz.



Example Hookup
Single Trainee - 4 Channels
Using 2 2-channel cables
Linked Ears Reference

(uses 3 "linked-ears" jumpers)
for separate ears, omit Jumper J3

When sum channel mode is used with 4 channels, there are two options, called "split" and "combine"

In "Split" mode, the channels are mapped as follows:

1 + 2 becomes channel 1
1 – 2 becomes channel 2
3 + 4 becomes channel 3
3- 4 becomes channel 4

With this mode, one would typically uptrain channels 1 and 3, and downtrain channels 2 and 4**.**

In "combine" mode, the channels are mapped as follows:

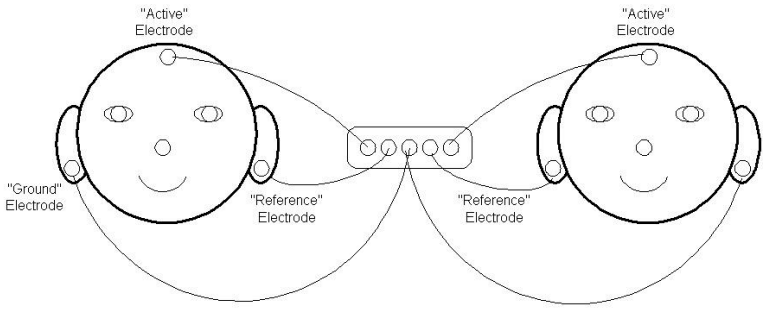
1 + 2 + 3 + 4 becomes channel 1
1 – 2 becomes channel 2
(1 + 2) – (3 + 4) becomes channel 3
3 - 4 becomes channel 4

In this mode, one would typically uptrain channel 1 and downtrain channels 2, 3, and 4.
Two Persons

There are various ways to train two people with synchrony training. The goals are twofold. First, that each individual is doing synchrony training within their own brain. The second is that the two individuals are doing synchrony training between each other. The simplest method, to use two channels for two people, satisfies the second goal, but not the first.

Two Persons Two-channel Synchrony Training

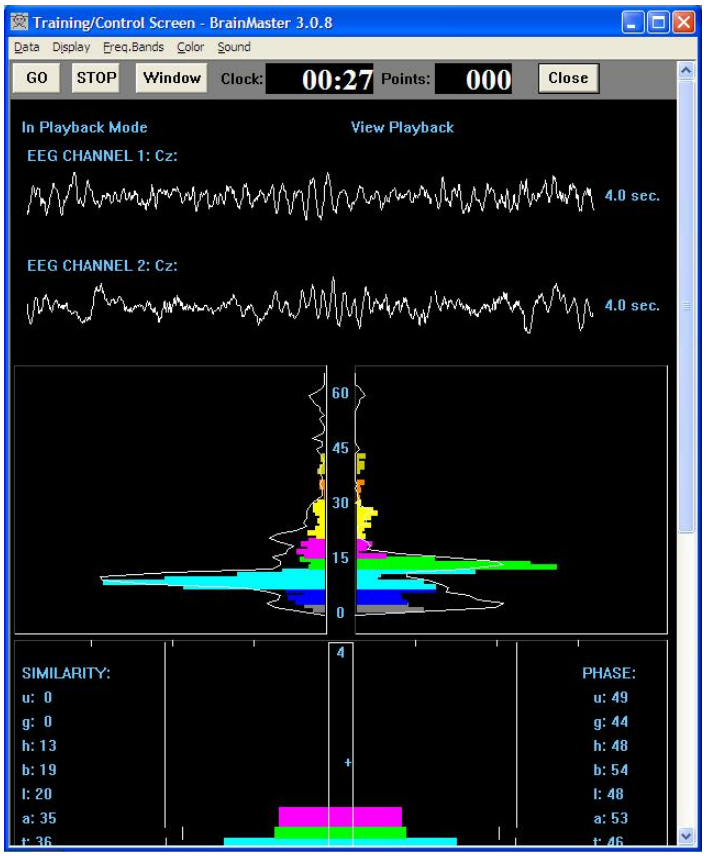
It is possible to do synchrony training between two people with a two-channel EEG. In this case, each individual is not getting synchrony training within themselves. However, they are training synchrony with each other. A possible connection is as shown. Note that a jumper would be used so that each of the grounds is going into the same connection. As an alternative, the two individuals could be connected with a separate lead. Or, they could hold hands or touch in some other way, to be at the same ground potential.



Couples Training - 2 channels

When two people are connected in this way, any of the preceding two-channel synchrony protocols can be used, to train the two EEG signals into synchrony.

The following is an actual screen of a two-person training session using this type of connection. The protocol used was the standard “peak” protocol. Observe that the two EEG waveforms look different in frequency content. The partner on the left has more alpha waves, and the partner on the right has more SMR energy. Note that the BrainMirror shows this difference. By using the “peak” protocol, the trainees get a reward sound when the coherence between their EEG’s is large. This encourages them to have a consistent phase relationship between their EEG waves. An alternative scheme could be to use the “comodulation”, which would encourage their EEG energy to wax and wane together. Comodulation is an easier condition to meet, since it does not require that the waves are phase-locked, only that they rise and fall at the same time.



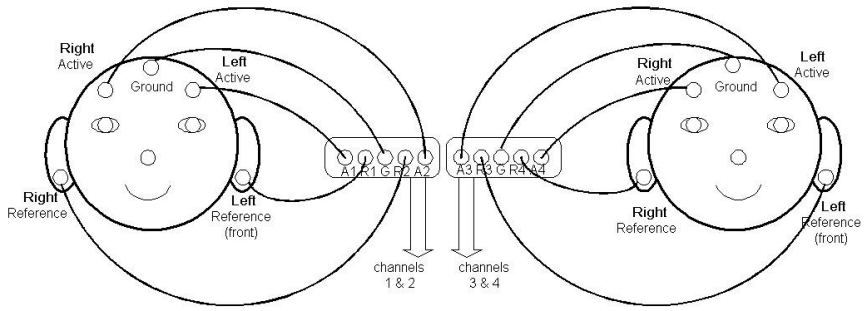
Example screen of two people doing synchrony training, with a total of 2 channels.

One person is using channel 1, and the other person is using channel 2. This trains them to synchronize their EEG waves to each other.

Two Persons Four-channel Synchrony Training

It is also possible to train two people with synchrony training with 4 channels, in which each person is doing synchrony training within themselves, and also with each other. In this use, you could use either the "split" or the "combine" sum-channel mode. If you use "split", then you would uptrain the two sum channels (channels 1 and 3), and downtrain the two difference channels (channels 2 and 4). This emphasizes the individual synchrony, not the combined synchrony.

If you use the "combine" method, you would uptrain channel 1, and downtrain the other 3 channels. This would train the couple to maximize their synchrony together, and also to maximize their individual synchrony.



Couples Training - 4 channels

The 4-channel synchrony methods shown use the Atlantis 4+4 EEG device. Each pair of channels has its own input cable, providing 5 inputs, for a total of 10 inputs.

Note that in the connection shown, it is not necessary to provide a ground between the two people. This is because each of them is grounded to their own input connector. The two input connectors grounds are connected together internal to the Atlantis module.

Synchrony Training with the Open Focus Synchrony Trainer (OFST)

The Open Focus Synchrony Trainer is a special hardware device that combines the EEG signals in an analog circuit external to the EEG device. It produces a single EEG-like output that is the sum of the input channels. The OFST is a 5-channel device. The connections commonly used are FPz, Oz, T3, T4, and Cz, with ears used as reference and as a ground. You will connect the OFST sensors as directed in the OFST documentation, and the plug the OFST outputs into the input receptacles of an EEG device.

One Person

To train one person with the OFST, use the following procedure:

1) Apply the 5 sensors per the Open Focus procedure
2) Connect the output of the OFST to channel 1 of the BrainMaster using the “active,” “reference,” and “ground” outputs provided.
3) Use a standard alpha protocol such as “relax.” You will get rewards when alpha is above threshold. The OFST will provide a signal equal to the combined 5 channels of EEG to the BrainMaster, so when alpha rewards are produced, it means that the individual is producing a combined alpha wave above the threshold.

Two Persons

To train two persons with the OFST, use the following procedures:

“Partner 1/Partner 2” training

(this produces a single EEG signal from both people):

1) Connect each person to the OFST per the Open Focus procedure
2) Connect the output of one person’s OFST into the “Partner 1” input of the other OFST
3) Connect the output of the "Partner 2" OFST to channel 1 of the BrainMaster using the “active,” “reference,” and “ground” outputs provided.

Use a standard alpha protocol such as “relax.” You will get rewards when alpha is above threshold. The OFST will provide a signal equal to the combined 10 (5 from each person) channels of EEG to the BrainMaster, so when alpha rewards are produced, it means that the individuals are producing a combined alpha wave above the threshold.

Two-channel training (this produces an EEG signal from each of the people):

1) Connect each person to the OFST per the Open Focus procedure
2) Connect the output of one OFST to channel 1 of the BrainMaster using the “active,” “reference,” and “ground” outputs provided.
3) Connect the output of the other OFST to channel 2 of the BrainMaster using the “active,” “reference,” and “ground” outputs provided.

Use a two-channel alpha synchrony protocol. This can be either a “peak” type protocol, or a sum-channel protocol. Either will work. You will get rewards when alpha is above threshold. The OFST will provide a signal equal to the combined 10 (5 from each person) channels of EEG to the BrainMaster, so when alpha rewards are produced, it means that the individuals are producing a combined alpha wave above the threshold.

