BRAIN PRODUCTS
Solutions for neurophysiological research

Press Release

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Dear Customers, Dear Friends of Brain Products,

We are very excited to celebrate 15 years of providing the international neurophysiology research community with our service and solutions.

Over the past 15 years we have expanded from a family business to an international enterprise, which is now counting more than 40 employees and an outstanding worldwide sales network.

We realize every day that our success is dependent on yours. Our goal is to provide you always with high quality products and support.

"We can hear you" is not just the title of the company song written some years ago by Alex Svojanovsky, Brain Products co-founder, CEO and a quite talented hobby composer. These 4 words encapsulate the philosophy of our company.

It is by listening to you that we developed the BrainVision Analyzer software and the BrainAmp DC amplifier. It is by listening to your inputs that we designed the BrainAmp MR system for EEG/fMRI co-registration, our active systems actiCAP and actiCHamp, our wireless MOVE system, our TMS stimulator PowerMAG research (in a joint venture with the company MAG and More) and thus most of our soft- and hardware solutions.

The enthusiastic feedback about our company that we have been receiving from you throughout all these years and the many hundreds of scientific articles based on our products that you have been publishing (more than 300 in the field of EEG/fMRI co-registration alone) make us very proud of our work.

I would like to say thank you very much to all the Brain Products employees and business partners for their competent and passionate work and - of course - to you, our customers for having placed so much trust in us.

We look forward to a long and fruitful collaboration in the years to come.

Pierluigi Castellone
Brain Products' CEO

IN THE FOCUS

EEG-based Brain-Computer Interface (BCI) applications during acquisition of functional MR imaging

*by Surjo R Soekadar, MD**

** University Hospital Tübingen, Department of Psychiatry and Psychotherapy / Institute of Medical Psychology and Behavioral Neurobiology*

Surjo R Soekadar

Online analysis of brain oscillatory activity and measures of brain metabolism, e.g. functional magnetic resonance imaging (fMRI), offer two attractive applications in the context of brain-computer interface (BCI) applications. Firstly, to identify the neural substrates of operant brain control used in various BCI paradigms, and secondly, to integrate brain signals, e.g. neuroelectric and metabolic activity, for novel BCI applications.

However, the significant artifacts generated by the MR magnets make it challenging to record electric brain oscillations during MRI. With RecView, Brain Products offers an advanced software solution that allows real-time analysis of electroencephalographic (EEG) recordings, removing both the gradient artifact and cardioballistic artifact (CBA). In close collaboration with Brain Products' software development team, we have successfully combined and implemented online EEG-based BCI control during acquisition of functional MR imaging.

Participants were comfortably placed in an MRI scanner (Siemens Magnetom Trio® 3T) and motor imagery was used to desynchronize rolandic alpha oscillations (8-12Hz) (Soekadar et al. 2011). A 32-channel BrainCap MR (connected to a BrainAmp MR plus amplifier) was used to record neuroelectric brain activity translated into visual feedback by BCI2000 (www.bci2000.org). Each trial lasted 4.5 seconds. While artifact correction resulted in a feedback delay of 700-1500ms (depending on the filters used), detection of alpha desynchronization during the task was reliable and robust.

This new implementation of EEG-BCI during fMRI acquisition will not only improve our understanding of the neural substrates of operant brain control, e.g. of rolandic alpha oscillations, but also enhance our knowledge about BCI-training related changes of brain activity and functional improvements e.g. after stroke. Implementation of this new module in real-time fMRI-BCI applications is planned to improve specificity and reliability of the BCI systems enhancing communication between distant brain areas, e.g. in patients suffering from schizophrenia (Ruiz et al. 2011) or Alzheimer's disease. ●

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Ruiz S, Lee S, Soekadar SR, Caria A, Veit R, Kircher T, Birbaumer N, Sitaram R. Acquired self-control of insula cortex modulates emotion recognition and brain network connectivity in schizophrenia. Hum. Brain Mapp. 2011 (in press).

Brain Products Inside

Who is who..? - Tomasz Kucinski

Tomasz Kucinski

I'd like to introduce myself as a new Software Developer for Brain Products GmbH. After obtaining a degree in physics at the Technical University in Warsaw (PL), I worked for Elmiko GmbH, the leading Polish EEG device developer and producer. More than a decade at Elmiko's offered me an opportunity to gain experience in the "art of programming" and to familiarize myself with EEG technologies of all sorts (from classic EEG, ECG, to Video-EEG, EMG, EP, biofeedback, and more). I also got a position of Team Manager and led the Digitrack Software project for 5 years.

An important step in my life was the decision to move to Germany. After the first two years, during which I worked for Scopset GmbH (Developer of UML Systems), I returned to the field of medical devices and started to work as software developer for Natus GmbH, which develops, produces and sells medical devices for clinical neurophysiology, accompanied by a software called 'topas'. Developing and maintaining 'topas' was my primary task during the next two years.

Now, I am pleased to become a member of the innovative team of Brain Products GmbH and to contribute with my knowledge and experience to the development of the BrainVision Analyzer. ●

User Research

High-frequency neural activity modulated by crossmodal haptic-to-auditory priming

by Till R. Schneider[1]

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Till R. Schneider

Synopsis

Multisensory processing can be beneficial for the perception of objects, especially if the input of one modality alone is not sufficient for the perception process. In this case, information from different sensory modalities is combined to improve object perception. In our study published in the Journal of Neuroscience we investigated the influence of a haptically explored cue on auditory perception of objects in a crossmodal semantic priming paradigm (Schneider et al., 2011). Crossmodal semantic priming allows information transfer between sensory modalities. On the behavioral level it describes facilitated processing of a stimulus in one sensory modality when preceded by related input from another modality. Haptic cues served as primes and complex sounds of objects as targets. Haptic and auditory stimuli were either semantically congruent or incongruent. We recorded high-density EEG while participants were performing the priming task and observed enhanced neural activity in the gamma-band (60-80 Hz) in response to complex auditory stimuli preceded by semantically congruent haptic cues. Source analysis of this effect revealed enhanced activity in classic multisensory regions in lateral temporal cortex. These findings imply a special role for high frequency neuronal activity for multisensory processing in high-level cortical areas.

Object perception in everyday situations is usually a multisensory process. Imagine a thunderstorm at night. If you are outside, you will first see the lightning and then hear the thunder. The perception of the auditory event (the thunder) is likely to be influenced by the preceding visual event (the lightning). Without the prior visual information, the identification of the auditory event as thunder could be completely different. Thunder and lightning have been previously associated by experience and thus both activate the semantic concept 'thunderstorm'. In behavioral studies it has been demonstrated that semantic congruency serves as one important factor for multisensory integrative processing (Laurienti et al., 2004; Schneider et al., 2008b). However, the integration of multiple sensory inputs requires large-scale interactions between distant cortical areas. The neural mechanisms underlying these large-scale interactions are as yet unknown. The traditional model of multisensory processing postulates that incoming stimuli are first processed in unisensory regions and modalities only converge at later stages within the cortical hierarchy. However, recent research has demonstrated a modulation of neural activity in primary sensory areas by inputs from other modalities (Lakatos et al., 2007; Kayser et al., 2008). Recent models explicitly propose a dynamic view in which synchronized oscillatory activity plays a critical role for multisensory interactions (Senkowski et al., 2008; Kayser and Logothetis, 2009).

The major goal of our study was to investigate the modulation of oscillatory neural activity reflecting the influence of active haptic object exploration on the perception of subsequently presented sounds. High-density EEG recordings in combination with linear beamforming were applied to estimate the cortical sources of oscillatory neural activity. We expected enhanced neural activity due to semantically congruent inputs in the two sensory modalities.

Methods

Fourteen healthy participants (aged 20-29 years) were presented with a crossmodal haptic-to-auditory priming paradigm. Participants were blindfolded throughout the experiment. The stimulus set consisted of 28 objects belonging to one of the two categories household or leisure. Participants' were trained to identify the objects in each modality separately before the main experiment. Haptic objects were presented in a custom-made plastic box and participants were allowed to explore objects with their right hand for 2 seconds within a defined exploration interval. The start and end of the exploration interval was marked by acoustic stimuli and during the exploration interval possible sounds elicited by the objects were masked by pink noise via headphones. In the priming paradigm haptic stimuli were always presented first, followed by either a semantically congruent or incongruent auditory stimulus. The participants' task on the haptic stimulus was to detect rare 'control' objects ensuring active processing of the haptic stimulus. Following an inter-stimulus interval of 2 - 2.4 s, complex auditory stimuli lasting 400 ms were presented binaurally. The participants' task on the auditory stimulus was to assign the perceived object to one of the categories (household or leisure). The EEG was recorded using BrainAmp amplifiers (Brain Products, Munich, Germany) with 124 active electrodes mounted in an EasyCap (EASYCAP GmbH, Herrsching, Germany). EEG data were recorded against nose tip reference but re-referenced to common average prior to subsequent analysis steps. The EEG data were analysed using MATLAB® 7.3 (MathWorks, Natick, MA), EEGLAB 5.03 [http://sccn.ucsd.edu/eeglab; (Delorme and Makeig, 2004)], and FieldTrip [http://fieldtrip.fcdonders.nl/; (Oostenveld et al., 2011)].

Data analysis

We performed spectral analyses to characterize frequency specific responses in the EEG using the multi-taper method (Mitra and Pesaran, 1999). Epochs were extracted around the auditory stimulus (-300 to 1000 ms). For the multi-taper analysis, a fixed time window (ΔT = 200 ms) and a fixed frequency smoothing (Δf = ± 10 Hz, 20-100 Hz) was applied, resulting in three tapers being applied to the sliding time window. Frequency transformations were performed before averaging on the single-trial level for the calculation of total power. Therefore the resulting total power contains signal components phase-locked and non phase-locked to the stimulus onset. To calculate the relative signal change of total power a baseline correction was applied (interval -300 to -100 ms prior to stimulus onset). Total power was averaged in seven regions of interest (ROI) and a cluster-based permutation test was applied to correct for multiple comparisons (Maris and Oostenveld, 2007). Morlet wavelets were used for the analysis of evoked power on the averaged trials.

A linear beamforming approach was applied to reconstruct the cortical sources of the oscillatory neural activity (Van Veen et al., 1997; Gross et al., 2001). This source reconstruction technique uses an adaptive spatial filter, which passes activity from one specific location of interest with unit gain and maximally suppresses activity from other locations. Since linear beamforming is based on the calculation of the co-variance matrix between single channels over trials, this approach is in particular suitable for the analysis of total power. For the source reconstructions a volume conduction model was derived from a Montreal Neurological Institute (MNI; http://www.mni.mcgill.ca) template brain resulting in an anatomically realistic 3-shell model. The lead field matrix was calculated using the boundary element method (BEM) for each grid point in the brain on a regular 6 mm grid.

Behavioral results

Analysis of reaction times to the auditory stimuli revealed a crossmodal priming effect as reflected in shorter reaction times for congruent (mean=452ms) compared to incongruent stimulus pairs (mean=486ms), $t(13)=-5.33$, $p<0.001$. Additionally, error rates differed significantly between the congruent (mean=5.1%) and the incongruent condition (mean=8.38%), $t(13)=-4.47$, $p<0.001$. These findings demonstrate a crossmodal priming effect for semantically congruent haptic and auditory inputs.

Evoked power results

Analysis of evoked power revealed a strong increase in gamma power (25-60 Hz) between 50 and 100 ms. The topographical distribution shows a fronto-central maximum, which is typical

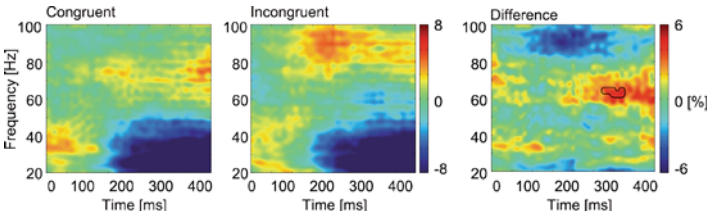

Fig. 1: Group averaged time-frequency representation of the total power at the middle central region in response to the auditory targets in the congruent and incongruent conditions and the statistical difference between the conditions.

for the auditory evoked gamma response. Differences between semantically congruent and incongruent conditions revealed enhanced gamma-band activity for the congruent compared to the incongruent condition ($F(1,13)=5.67$, $p<0.05$).

Total power results

Spectral analyses revealed a power enhancement of neural activity in the gamma-band (60-70 Hz) between 200 and 400ms (Figure 1). The cluster-based randomization statistic revealed a significant cluster at the fronto-central and middle central regions of interest (60-70Hz, 250-350ms). Gamma power in this time window was enhanced for the congruent compared to the incongruent condition. For this specific time window the source reconstruction using linear beamforming was applied. The analysis of lower frequency responses revealed a significant cluster at the middle central and middle frontal ROI in the alpha/beta band (8-16Hz). Alpha/beta band suppression (200-450 ms, 8-16Hz) was

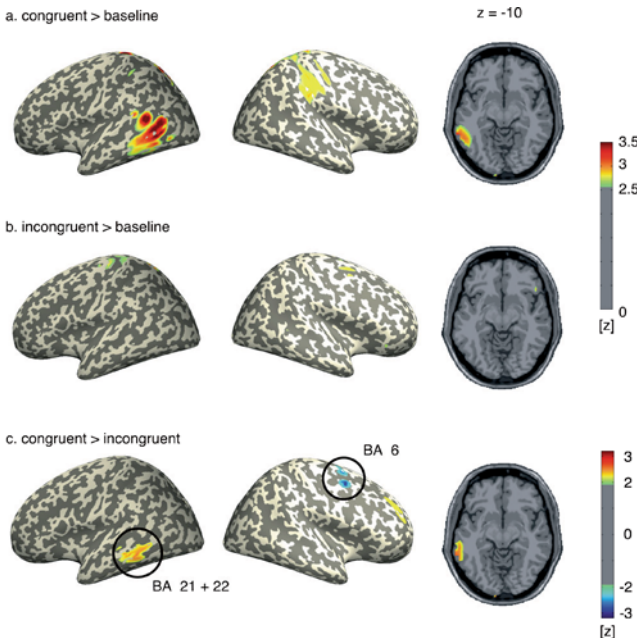

Fig. 2: Source analysis using linear beamforming showing the total power gamma band response (50-70 Hz, 200-400 ms). Results for the congruent (a) and for the incongruent condition (b) versus pre-stimulus baseline activity and (c) statistical differences between the congruent and the incongruent condition.

stronger for the congruent compared to the incongruent condition.

Source analysis of the enhanced gamma-band response (Figure 2) revealed enhanced activity in the left middle temporal gyrus (MTG) and superior temporal sulcus (STS). Neural activity was enhanced for the congruent compared to the incongruent condition in these areas. Additionally an incongruency effect was found in the right middle frontal gyrus, showing enhanced gamma power for the incongruent compared to the congruent condition.

Conclusion

Our results suggest that crossmodal semantic matching is reflected in enhanced neural activity in the gamma-band in MTG and STS. STS has been repeatedly identified as a region of multisensory convergence (Beauchamp, 2005). In line with earlier results from a visual-to-auditory priming paradigm (Schneider et al., 2008a) our results provide evidence that synchronized oscillatory activity is involved in multisensory processing.

In a more recent study of our group the same haptic-to-auditory priming paradigm was used to investigate crossmodal processing in blind individuals (Schepers et al., 2012). Enhanced activity in the high gamma-band was observed in the blind in occipital areas usually involved in visual processing in the sighted. Most interestingly this neural response was also modulated by semantic congruency suggesting that neural activity in the deprived visual areas is functional. Moreover connectivity analyses revealed that the auditory and the deprived visual cortex are functionally coupled in the blind, suggesting that the deprived visual cortex is integrated in an extended network supporting non-visual processing.

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News in brief: Conferences

22. Deutsches EEG/EP Mapping Meeting	Gießen (Germany), Oct 12th to 14th, 2012	*in cooperation with EASYCAP.*
Neuroscience 2012	New Orleans, LA (USA), Oct 13th to 17th, 2012	*in cooperation with Brain Vision LLC*

For more information on the conferences we are about to attend, please visit our website at www.brainproducts.com/events.php

Support Tip

Did you know how to use the new features of the Edit Channels transformation in BrainVision Analyzer 2?

by Dr. Filipa Campos Viola

I would like to use this opportunity to present the new features available in the Edit Channels transformation in BrainVision Analyzer 2. The aim of the latest update is to offer a more straightforward and time effective manipulation of channel properties. You can now select a range of features that include changing the order of the channels or loading/saving channel positions from/into an external BrainVision electrode file. Another highlight is the "copy/paste" functionality which saves a considerable amount of time when re-naming channels and/or altering positions.

In this article I will present three typical examples of how the new features of Edit Channels facilitate your daily analysis.

Case 1: Defining channel positions for EEG recordings using non-standard caps

It is now easier to define the channel properties for the case of EEG data recorded using caps where the electrodes are not placed according to the 5% international system. You can copy the channel labels and positions stored in another file (see table in Figure 1) and paste them directly into the corresponding column of the Edit Channels interface simply by right-clicking on the relevant cells (see Figure 2A). Note that the typical keyboard shortcuts can also be used (e.g. CTRL-C; CRTL-V).

	A	B	C	D
1	Name	Radius	Theta	Phi
2	e01	1	0	0
3	e02	1	23	90
4	e03	1	23	30
5	e04	1	23	-30
6	e05	1	23	-90
7	e06	1	-23	30
8	e07	1	-23	-30
9	e08	1	46	74
10	e09	1	46	41
11	e10	1	46	8
12	e11	1	46	-25
13	e12	1	46	-57
14	e13	1	46	-90
15	e14	1	-46	57
16	e15	1	-46	25
17	e16	1	-46	-8
18	e17	1	-46	-41
19	e18	1	-46	-74
20	e19	1	69	76
21	e20	1	69	49
22	e21	1	69	21
23	e22	1	69	-7
24	e23	1	69	-35
25	e24	1	69	-62
26	e25	1	69	-90
27	e26	1	-69	62
28	e27	1	-69	35
29	e28	1	-69	7
30	e29	1	-69	-21
31	e30	1	-69	-49
32	e31	1	-69	-76

Fig. 1: Table containing the original labels and positions of the equidistant channels.

After filling out all fields, you should press the "OK" button and then the channel properties will be updated (see Figure 2B).

Please note that in this particular example (see Figure 2B) alphanumeric channel labels were introduced (e.g. channel 1 was changed to channel eO1). Using labels containing characters is a good approach, especially when you intend to use the Formula Evaluator transformation. This transformation does not interpret numbers as channel names (e.g. 2 - 1 ≠ channel 2 - channel 1).

After updating the channel properties of a single dataset, it is possible to apply the same procedure to the remaining datasets in the workspace either by using the "drag and drop" functionality or by creating a history template.

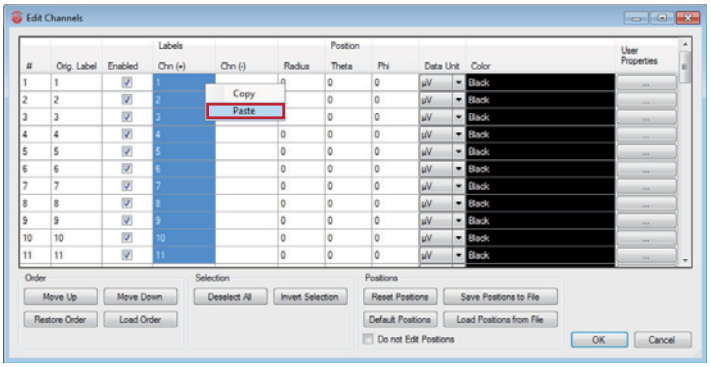


Fig. 2A: How to copy/paste information from/into the Edit Channels interface. The options "copy/paste" can be selected when you right-click on a group of cells.

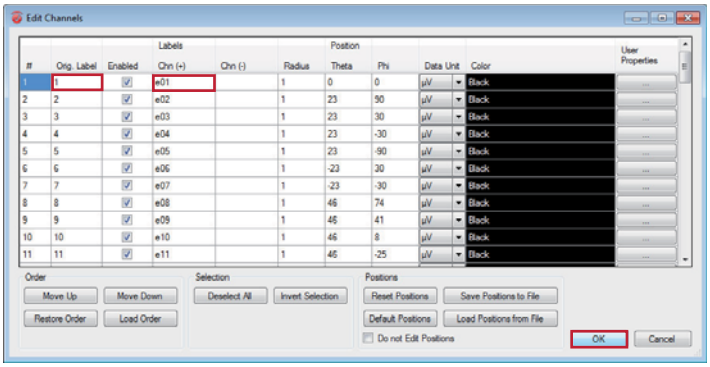


Fig. 2B: Defining labels and positions for equidistant channels. Please note that the labels of the channels were changed from numerical values to characters (red boxes). You need to select "OK" so the new channel properties will be stored.

It could be also the case that the same type of caps has already been used (or will be used) when recording another EEG experiment. In such situations it would be useful to store these channel labels and relevant positions in a BrainVision electrode file which could then be automatically loaded when analyzing another workspace. The current Edit Channel transformation includes an extra feature called "Save Positions to a File" which makes it possible to create a BrainVision electrode file containing the information

available in that node (see Figure 3). This file will be stored in the export folder associated with the current workspace. When processing a new workspace the BrainVision electrode file can be loaded using the new feature "Load Positions from File" in the Edit Channels interface. Another option is to set this file as the default using the option "File -› Preferences -› Electrodes". This means that BrainVision Analyzer 2 will treat those labels and coordinates as the defaults when it reads in new datasets.

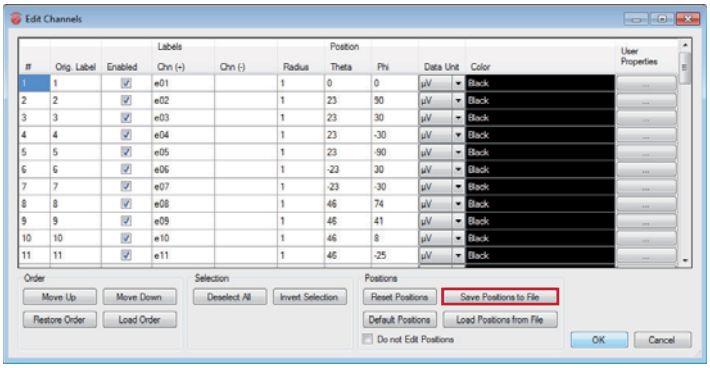


*Fig. 3: A BrainVision electrode file can be created using the new feature "Save Positions to a File" in the Edit Channels interface. The *.bvef file will be stored in the export folder associated with the current workspace.*

For those who may not be familiar with this concept, the BrainVision electrode file is a special type of .xml file and is labeled with a *.bvef file extension. The structure of this file is described in the BrainVision Analyzer 2 manual in the section entitled "Appendix J: BrainVision electrode files".

Case 2: Changing the order of the channels in a dataset

Maybe not all of you are aware that in BrainVision Analyzer 2 the channels across datasets are matched in terms of their labels and not their order within the dataset. This means that even when the order of the channels differs between datasets the transformations deliver meaningful results.

Nevertheless in certain situations it may be useful to re-order

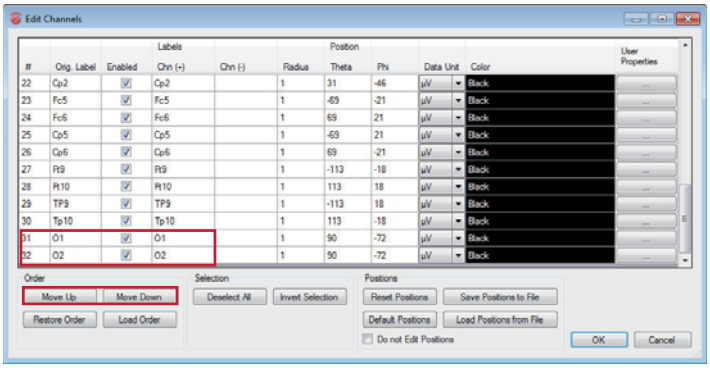


Fig. 4A: Channels O1 and O2 are not stored in the original positions (9th and 10th position)

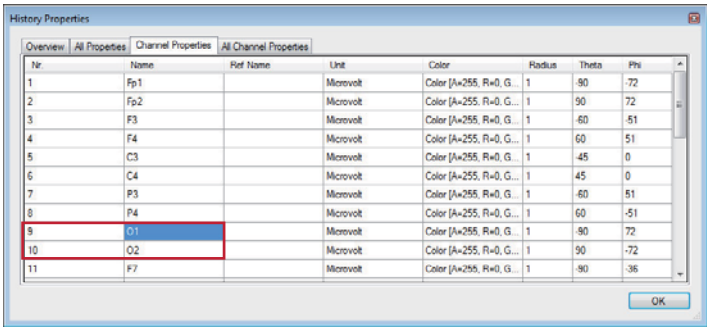


Fig. 4B: Channels O1 and O2 were re-ordered back to their original positions using the new features "Move Up/Move Down" in the Edit Channels interface (shown in Fig. 4A).

the channels. A typical case would be to avoid inconsistencies when exporting the datasets into a software package where channels are matched by the order. Let us assume that for a particular dataset the occipital channels O1 and O2 had to be excluded during the pre-processing and were afterwards interpolated using the Topographical Interpolation transformation. Note that when the channels selected to be interpolated are not part of the current node, they will be added either at the top or to the bottom of the dataset. In our particular example O1 and O2, originally stored in the ninth and tenth position, would be stored in the last two positions after using the Topographical Interpolation. It is now possible to re-arrange the order of the channels by using the new features "Move Up/ Move Down" in the Edit Channels interface (see Figure 4A). In this case you could then easily re-order these two channels to their original positions in the dataset (see Figure 4B).

Case 3: Changing channel labels without changing the respective positions

Many EEG laboratories use tracking systems in order to measure individual electrode positions. As explained in case 1 it is now straightforward to define the respective individual positions for each dataset using, for instance, the "copy/paste" functionality. However there may be situations afterwards where during the analysis you may want to change a particular label for all datasets without affecting the respective individual

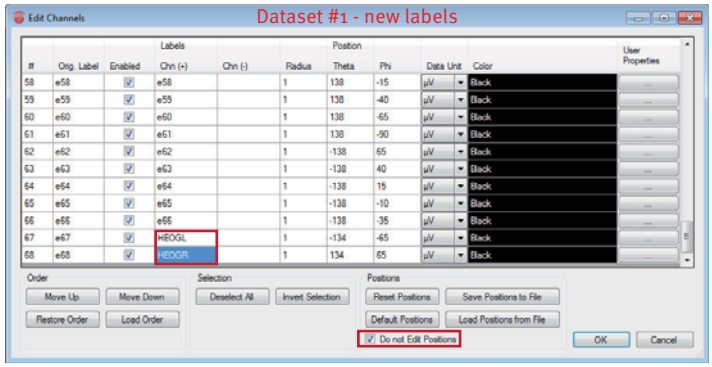
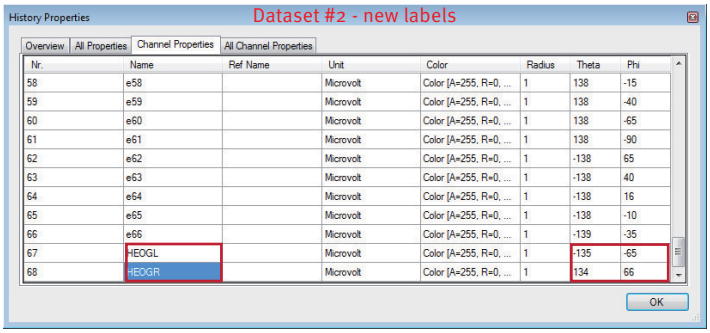


Fig. 5A: Changing the channel labels in Dataset #1 without changing their positions. The output node will be used in a history template (not shown).



Nr.	Name	Ref Name	Unit	Color	Radius	Theta	Phi
58	e58		Microvolt	Color [A=255, R=0, ...	1	138	-15
59	e59		Microvolt	Color [A=255, R=0, ...	1	138	-40
60	e60		Microvolt	Color [A=255, R=0, ...	1	138	-65
61	e61		Microvolt	Color [A=255, R=0, ...	1	138	-90
62	e62		Microvolt	Color [A=255, R=0, ...	1	-138	65
63	e63		Microvolt	Color [A=255, R=0, ...	1	-138	40
64	e64		Microvolt	Color [A=255, R=0, ...	1	-138	16
65	e65		Microvolt	Color [A=255, R=0, ...	1	-138	-10
66	e66		Microvolt	Color [A=255, R=0, ...	1	-139	-35
67	HEOGL		Microvolt	Color [A=255, R=0, ...	1	-135	-65
68	HEOGR		Microvolt	Color [A=255, R=0, ...	1	134	66

Fig. 5B: After running the template, the channel labels were updated in Dataset #2 but the individual positions were not changed. This was possible because "Do not Edit Positions" (shown in Fig. 5A) had been selected in the Edit Channels interface.

positions. One typical example is where you want to rename the ocular channels (for instance using the labels HEOGL and HEOGR) and include this step in a history template. In order to be able to rename these two channels in the different datasets without changing the individual positions, the user should select the new option "Do not Edit Positions" in the Edit Channels interface (see Figure 5A). The output would be an update in the channel labels without affecting the original individual positions (see Figure 5B).

I hope that after showing you these three cases you are convinced that the Edit Channel transformation now includes a set of versatile features that significantly improve the manipulation of channel properties. ●

Product Developments

actiPOWER

by Dr. Roland Csuhaj

I am pleased to introduce the new actiPOWER battery pack. The actiPOWER is a lead rechargeable battery pack, specifically for the actiCHamp amplifier. Recharging is quick, typically taking no more than three hours at room temperature. Once the batteries are fully charged, the actiPOWER offers the same long operation time as the familiar PowerPack, namely up to six hours of continuous recording with the actiCHamp amplifier.

Fig. 1: actiPOWER

The actiPOWER has the same dimensions as the PowerPack and a similar weight. It has slightly higher capacity and provides power only for one amplifier unit, since the actiCHamp is an integrated system and one device handles all channels.

The actiPOWER requires only basic regular maintenance. It is a good practice to recharge the actiPOWER battery pack directly after use. If it is not used regularly it should be connected to the charger at least monthly, in order to avoid deep discharge.

For more details see the latest version of the 'actiCHamp Operating Instructions', available in the download section of the actiCHamp/PyCorder forum. ●

Brain Products Inside

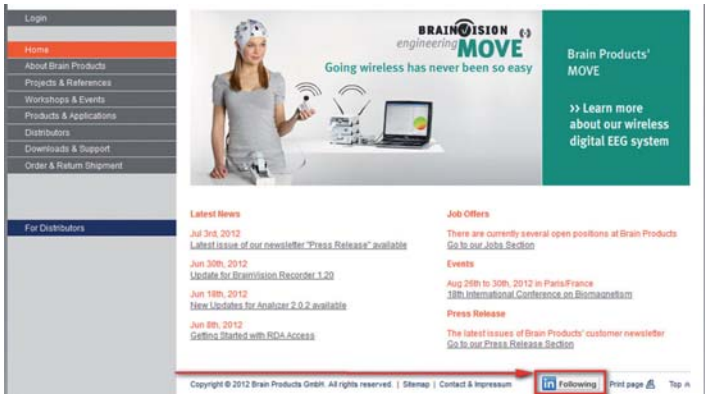
Don't miss us on LinkedIn

by Stefanie Rudrich

Social networking websites like Facebook and Twitter are popular all over the world. Having weighed up the options carefully for a while, we believe we have finally found the right platform for us as a commercial company and have set up a Brain Products page on LinkedIn.

If you are a member on LinkedIn, we'd be happy to see you following us at: http://www.linkedin.com/company/brain-products-gmbh

By doing so, you will always be up to date on new products, updates as well as job offers, and other news from Brain Products.



As you may have already noticed, you can also follow us simply by clicking on the link on our website. Add our company to your profile and stay informed easily and automatically! ●

Support Tip

PyCorder Q&A – receiving markers in PyCorder

by Dr. Roland Csuhaj

The actiCHamp amplifier can now be operated by the BrainVision Recorder software (commercial licence) – see issue 1/2012, Vol. 42. Naturally though, the actiCHamp comes with our open-source recording software, the BrainVision PyCorder. This Python-based signal acquisition software not only allows the base modules to be modified, it also permits user-defined modules to be integrated in accordance with the requirements of a particular research application.

Today we would like to show you how PyCorder interprets the incoming triggers and how easy it is to modify its behaviour to your needs.

Question

Which marker codes should I use in the experiment control software to get S1 - S15 and R1 - R15 in PyCorder? Can I use more than 30 triggers?

Answer

The actiCHamp uses a standard method to receive markers. Like many amplifiers, it is equipped with an 8 bit trigger input port, which expects a TTL signal. All widely used experiment control programs, like Presentation®, E-Prime®, MATLAB®, are able to send such a signal through the parallel port.

An unmodified PyCorder divides the available 8 bits into two categories: the first four pins belong to the 'Stimulus', while the second four bits are designated to the 'Response' group. Sending marker '1' from the experiment control software results in marker 'S 1', because it activates only the first bit of the Stimulus category. Following the same logic, sending '2' results in 'S 2' and so on up to 'S 15', which is the largest Stimulus marker by default (see Figure 1 for further example).

The next value, the '16', corresponds to 'R1', while you have to send '32' from the stimulation software to get 'R2'. It is easier to understand the process, if the numbers are shown in binary format. The binary code of the decimal 16 is '0001 0000', and 32 is '0010 0000'. Here I used eight digits in two groups to show the numbers, because in this way each digit corresponds to one bit. However the order is in fact reversed, so that the first digit corresponds to the last bit and vice versa. Therefore the four digits on the right side are responsible for the 'Stimulus' marker, while the four on the left side define the 'Response' marker. As you can see, there is no stimulus marker in the two examples above, because every pin is zero. There is decimal one and two on the left side, which corresponds to the 'R1' and 'R2' markers.

To determine the codes for the remaining 'Response' markers, just multiply the desired value by 16. Do you need 'R11' in PyCorder? Just send 176 (11 x 16) from the stimulus presentation program. In some software, like in E-Prime®, you can define the marker values in hexadecimal code as well. It is quite convenient, since one hexadecimal digit corresponds to 4 four bits, so that the whole Stimulus group or Response group can be covered by one hexadecimal digit. Therefore if two digit hexadecimal numbers are used, the left digit defines the Response code, while the right one corresponds to the Stimulus. If you want to send only a response marker, put the value to the left side and a zero after it to the right side: the code of 'R11' is B0 in hexadecimal format (Figure 2). It has to be entered as "&HB0" in E-Prime®, because the "&H" marks the hexadecimal format.

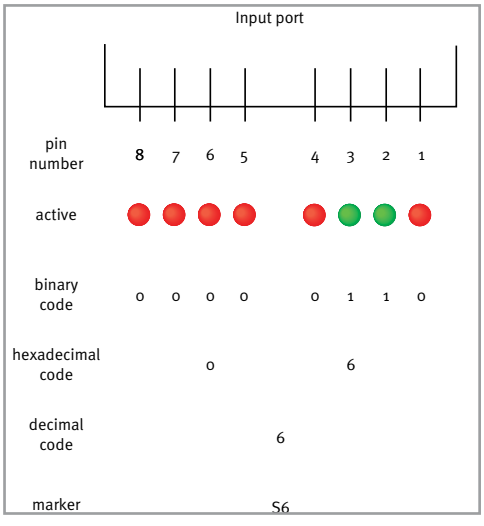


Fig. 1: Binary, hexadecimal and decimal representation of a Stimulus marker (S6). The upper part of the figure shows which pins of the input port are active (green dots).

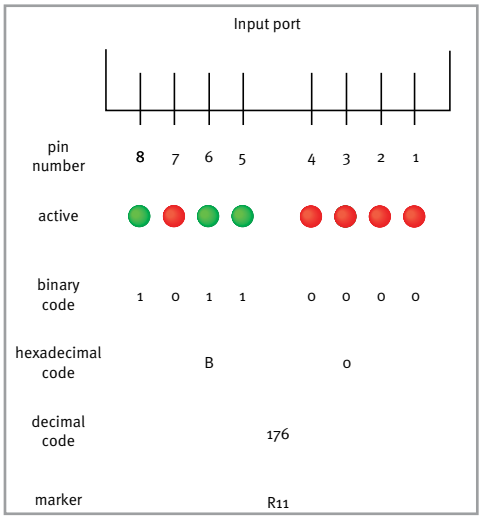


Fig. 2: Binary, hexadecimal and decimal representation of a Response marker (R11). The upper part of the figure shows which pins of the input port are active (green dots).

Modify the source code of PyCorder

So far we have described how the unmodified PyCorder behaves. However, it is an open-source software, so it can be customized. If you do not like the two groups with 15-15 triggers, but would rather prefer to have one category with 255 different triggers, you can do it easily. In BrainVision Recorder you would open the 'Digital port settings' graphic user interface to make this change, in PyCorder you should open the 'trigger.py' file, which is located in the 'src' directory of the installation folder. Search for the following lines:

```
# search for trigger events
        if in_out == 0:
        trigger = np.bitwise_and(self.data.trigger_channel[0], 0x000F) # mask trigger input channels 0-3
        elif in_out == 1:
        trigger = np.bitwise_and(self.data.trigger_channel[0], 0x00F0) # mask trigger input channels 4-7
```

As the comments indicate, the two lines after the 'if' statements define the groups. The hexadecimal numbers, which are marked by an "0x" prefix, are the trigger masks. Those bits which are one in the trigger mask are part of the group, while the zeros are not. The only missing piece of information is the connection between the trigger bits and the hexadecimal

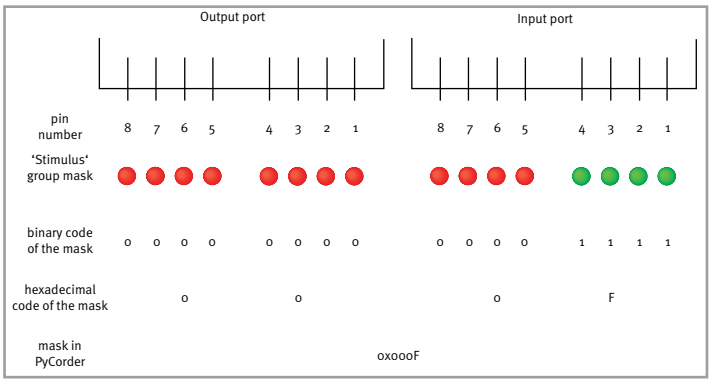


Fig. 3: Illustrates the Stimulus marker mask, as it is implemented in PyCorder. Only the pins marked with green dots are part of the mask. The binary and hexadecimal representation of the mask are also shown.

digits. The first two digits represent the output port, which explains why they are zero in both lines. The last two digits correspond to the 8 bits of the input port. As explained above, the order is reversed, so that the last digit represents the first bits and each hexadecimal digit covers four bits.

Following the logic it is understandable how the first line defines the 'Stimulus' group (see Figure 3 for graphical illustration). Only the last hexadecimal digit has a value here (namely 'F'), which covers four bits (as '1111'), the rest are zero, therefore the manual of the software is correct, indeed the first four input bits belong to this category. If we want to involve all input bits to this group, the penultimate digit should also be 'F'. If so, we do not need the second mask, all values should be zero here. Consequently the lines should look like this:

```
# search for trigger events
        if in_out == 0:
        trigger = np.bitwise_and(self.data.trigger_channel[0], 0x00FF) # mask trigger input channels 0-7
        elif in_out == 1:
        trigger = np.bitwise_and(self.data.trigger_channel[0], 0x0000) # no "R" trigger markers
```

Save the file and do not forget to test the changes.

We hope this Q&A excerpt gave you an idea of how to edit BrainVision PyCorder's source code yourself.

If you require support for PyCorder or the actiCHamp amplifier, please visit our user-forum at http://www.actichamp.com/forum. Both products belong to the sub-series "engineering" of our BrainVision hardware and software series and support for them is exclusively provided through the forum. ●

Please note: PyCorder and actiCHamp are intended to be used for research applications only and are not sold, designed or intended to be used as medical devices as defined in EU Directive 93/42/EEC, nor are they intended to be used for other medical applications such as diagnosis or treatment of disease. The entire software is open source. The hardware is freely configurable. Brain Products shall not be liable for any use other than pure scientific and research applications. The actiCHamp hardware has been tested and certified as per the relevant EMC and electrical safety standards. A non-medical CE certificate is available on request.

Product Developments

Multitrode – the One-for-all-Purposes Electrode

by Falk Minow, EASYCAP

To get good EEG signals it has been necessary to reduce the skin-to-electrode impedance. The better the signal from the brain to the electrode the less noise from other sources is contained in the recorded signal. Impedance is minimized most effectively by degreasing and mechanical abrasion of the outermost skin layers. With 64, 128, or more electrodes, this becomes an increasingly time-consuming task.

The easiest way to save time is not to do the impedance minimization. Thus a number of technical developments aim at achieving lower noise levels despite high skin-to-electrode impedances. These measures include amplifiers with input-impedances in the megohm range or active electrodes on the electronic side, and advanced filter techniques or analysis methods like ICA or template-matching on the data-processing side. On the sensor side, projects have been tried using dry electrodes without gel or wet electrodes with only salty liquids.

These measures can bring signal quality to a level which is sufficient for some applications, but even in combination, they do not reach the signal quality and data reliability of classic passive electrodes mounted with impedance levels of 5 kOhm or less. Furthermore, some of these measures like active electrodes cannot be used in EEG recordings with other techniques such as fMRI or MEG.

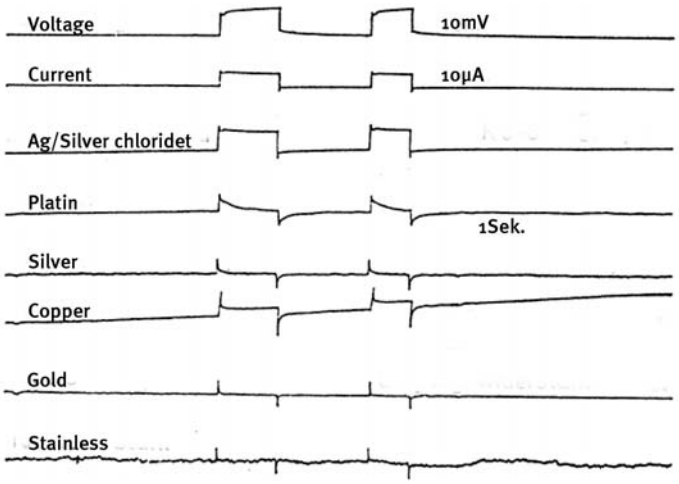
Thus, when the data of interest are very small or easily obscured, when it is necessary to exclude as many confounding factors as possible, or when there are technical obstacles, the use of passive electrodes at low impedances is still the best choice.

To these users and applications we can now introduce a new electrode shape, the Multitrode.

The Multitrode is long-living, it allows for as easy, painless, and effective impedance minimization as possible, and it can be used on skin, in hair, or in caps.

Multitrode: Materials

The sensor material is sintered Ag/AgCl. This is the only sensor material that reproduces quick and slow changes of the signal amplitude truthfully, and so it can be used for the entire frequency range from DC to brain stem potentials.



Sintered Ag/AgCl needs no re-chloriding, the Cl-ions do not leave the sensor, and the electrodes are non-polarizable. The sensor is massive, not plated, and so it is not damaged by abrasive materials or by cleaning.

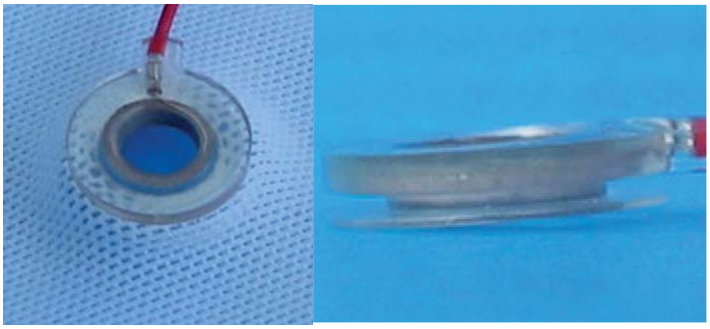
The sensor and the cable are sealed into the housing by a special resin, making the whole ensemble water-tight. All materials can be disinfected.

The cable has very flexible tinsel wire as conductor. The insulation is extremely tough. Electrode cables often break where the flexible cable enters the housing, so this will elongate the life-span significantly.

Multitrode: Mounting

The Multitrode has a flat contact surface without sensor material, so it can be attached to bare skin by washers (double-sided adhesive rings), or glued into hair with conductive paste. The outer groove means it can be buttoned into the slits of a cap (see picture below). The very flat profile of less than 3.5 mm makes the electrode comfortable to lie on.

The large central opening makes it possible to do all skin



treatment and gel-filling after the electrode has been fixed to the skin or the cap has been put on. Especially in the case of washers this means that the electrode is fixed to dry, clean skin with no gel present. Thus any EOG- or ECG-electrode will be secured reliably and will not be in danger of falling off.

Multitrode: Easy Impedance Minimization

For optimal impedances, the skin must be free of grease and other isolating materials such as shampoo conditioners, the outermost ceratinized skin layers must be removed, the contact area between gel and skin must be as large as possible (several square millimetres), and the contact between skin and electrolyte gel (or paste) and between gel and sensor surface must be good.

The Multitrode simplifies achieving these goals by its ring shape with a central opening of 6 mm diameter, where the inside walls are made of the Ag/AgCl sensor material:

- the 6mm-opening is large enough to comb aside the hair underneath, e.g. with the wooden end of a cotton swab. This ensures that the skin is visible and accessible, so that the following steps can be performed on the skin purposeful and controlled – you see what you're doing.
- degreasing (unless subjects arrive with freshly washed hair) of the skin can be done with an alcohol-soaked cotton swab through the opening.
- abrasion too can be done by twirling a cotton swab dipped in abrasive gel on the skin. This method is extremely effective, it needs no pressure, only speed, and so does not hurt or leave reddening or even scurf.
- if an abrasive electrolyte gel has been used then the work is already done: the twirling has pressed the electrolyte into the skin and along the inner walls of the sensor cylinder. Impedances and contact will be fine by now and only for reliability a little more gel can be filled in.

Keep in mind that what is described here is a careful and elaborate way to reliably achieve impedances below 5 kOhm, when they are needed. Even so, using Multitrodes will accelerate your prepping time compared to former ring-shaped electrodes. For most subjects it will be enough to only do the abrading with a little subsequent filling. As a result, we are in a time-range for cap mounting comparable to scratching and filling with blunted needle, but we get there painlessly and end up with better and more consistent impedances.

Multitrode: Variants and Caps

The Multitrode is a very versatile electrode that can be used for many applications in EEG, or as ECG- or EOG-electrodes, for EMG, or GSR. We can supply the Multitrode in many different realisations.

The basic Multitrode is available

- in any cable length (please specify)
- with heavy-duty lead wire (recommended for single electrodes)
- with light-duty lead wire (recommended for bundled or fixed electrodes as in caps)
- with 1.5mm-touchproof safety sockets (the most common type)
- or with other single connectors (please specify)
- or as cable-tree where many electrodes are terminated on multi-channel connectors

If required we can equip the Multitrode with micro-coax-connectors or separate Gnd-connector and

- heavy-duty shielded cable, or
- light-duty shielded cable

For recordings simultaneous with other techniques, available specialized types are

- Multitrodes for TMS
- Multitrodes for fMRI
- Multitrodes for MEG

We will use the Multitrode in all EEG recording caps where the electrodes are built-in permanently (or at least are meant to stay at the same site for long periods) under the generic term "BrainCap". The other cap family with detachable, single electrodes is the "EasyCap".

Beside customized caps, the following BrainCaps are available in Standard Versions:

- **Standard BrainCap with Multitrodes** for normal EEG/ERP without other simultaneous techniques with 22, 32, 64, 96, or 128 channels
- **Standard BrainCap MR** with 32, 64, 96, or 128 channels
- **Standard BrainCap for TMS** with 21, 32, 64, or 128 channels
- **Standard BrainCap for MEG** with 23, 32, 64, or 128 channels

In addition to this new and optimized way to perform classic research EEG with low impedances and passive electrodes, we also have other types of electrodes/caps and recommend them where advantageous. We know that the variety of methods and applications together with the numerous hardware and technical affordances makes choosing the appropriate electrode/cap a tedious distraction from a scientist's goals. But for us this is our daily work, and we invite you to contact us for further information or details at info@easycap.de. ●

Brain Products Projects

Our contribution to research in neuromarketing

by Birgit Trogisch

Yes indeed, cognitive sciences, emotion psychology and neurosciences are involved in research for marketing and advertising today, in order to understand the links between advertising, perception, and purchase decision (memory effect). First of all, people have to be made aware of something by attracting their attention. If interest is aroused it can generate a wish or an urge to purchase. And what about the role of emotions? Do people buy things in order to experience positive emotions or to avoid negative ones? Obviously, this is a complicated interaction of various factors which we try to investigate using various theories. It seems that most of our decisions are made on the basis of feelings and are not rational. For example, in 1994, a study revealed that patients with damage in certain brain regions (frontal cortex) and impaired emotional activity were not able to plan their lives because they could not differentiate between important and unimportant information (Damasio 1994, p. 85)[1].

Nowadays, market research uses a variety of new procedures to appraise advertisements, television episodes, or movie trailers. Often neurophysiological data of the test persons are measured, such as electrodermal activity, skin resistance, pupil width, and heart rate. Eye-tracking has become popular in order to see where exactly a person is looking. Recording a person's brain activity and analyzing the data is the most sophisticated method that is widely utilized in the USA. However, it is still impossible to measure emotions even if we use high-resolution EEG techniques. The only thing we can do is to recover statistically significant information about cortical areas engaged while watching particular scenes in a commercial. Temporal resolution of hundred of milliseconds or less is necessary to track the shifts of brain activity closely related to the processing of visual and acoustic stimuli provided by fast moving commercials (Fig 1.).

Action	Local brain activity
emotion processing	right-inferior frontal lobe right temporal lobe
language processing	left-temporal lobe
sound	left-auditory cortex
emotion processing + anticipatory responses	inferior-frontal lobe left-orbital-frontal lobe
attention	superior-parietal lobe
anticipation and prediction	orbital + inferior-frontal lobe
primitive drives	anterior-temporal lobe (amygdala)

Fig. 1: The table on the left shows what such a differentiation could look like.

This field of using neuroimaging tools to examine human behavior in economic games and decision making between different commercial advertisements is called NEUROMARKETING. The objective is to explain how the exposure to a message, made up of images, text, and audio, is able to trigger persistent stimuli in the consumer's mind leading to an interest, preference, and purchase. This is important because marketers should be reassured that a new advertising campaign would work and not waste money.

Functional Magnetic Resonance Imaging (fMRI) and magnetoencephalography (MEG) are techniques that are used for investigation purposes, but they have their limitations and, in particular, cannot be used for large groups of test subjects. In spite of the poor spatial information content delivered by electroencephalography (EEG) it is a suitable method to carry out investigations on the brain activity of many test persons with reasonable costs.

This is the moment where Brain Products comes into play. As a company specialized in neurophysiological research we are interested in continuously developing our products. Neuromarketing represents a current challenge that we want to face. Therefore, we joined forces with K&A Brand Research, a market research company near Nuremberg, and the Leibniz Research Centre for Working Environment and Human Factors (IfADo) in Dortmund. Our project consortium was successful in getting funded by the Federal Ministry of Economics and Technology on the basis of a German Federal Parliament decision. One objective is to develop a comfortable, easy-to-apply EEG cap or headset with dry electrodes that can be used in market research for large test groups, another aim is to create an algorithm during a classification procedure that will detect the meaning of brain activity in different cortex areas.

This project started on 1 September 2012 and will last for 2 years. We will keep you posted on the results. ●

[1] *Damasio, A.R. (1994): Descartes' Error: Emotion, Reason, and the Human Brain, New York, N.Y.*

Brain Products Inside

Looking for a new challenge in the private sector? – Join our Team!

by Stefanie Rudrich

Celebrating its 15th anniversary this year, we at Brain Products are happy to have been a prosperous and growing company in terms of the number of customers, revenue, and employees over the past years. Thanks to all those who are working with our products – and who recommend them to other researchers – we are (fortunately) quite busy every day.

In order to keep matching your expectations and the level of service you are used to, we are continuously expanding our team and YOU might be a perfect candidate for us.

So, if you are looking for a new challenge in the private sector and if you are considering joining our open-minded, international, and mixed team of former researchers (e.g. in sales, support and R&D) and experts in a range of fields (regulatory affairs, HR, marketing, etc.), we'd be happy to receive your application and welcome you on board.

For further information and application, please visit www.brainproducts.com/jobs.php.

Even if the current job postings don't match your qualifications, feel free to send your speculative application to our HR department (contact: Melanie Petrich) anytime (email: mep@brainproducts.com). We'd be happy to meet you in person! ●

A Technical Writer

Place of Employment: Gilching (20km out of Munich) or Freiburg / Germany

Job description:

As a technical writer you will be responsible for technical documentation (Hardware, Software, Quality Control) and will act as an interface between Research &Development and Quality Management Departments.

Duties and responsibilities:

- Conceptual design and compilation of documentation for hard- and software products
- Conception, compilation and updating of user manuals for hard- and software products
- Preparation and management of quality management files for software products (e.g. work procedures, forms, process documentation)
- Supporting the Software Development Team in project documentation

Applicant requirements:

- Excellent written and spoken English; preferably also knowledge/fluent in French
- Excellent writing skills
- Competence in working with MS Office and Adobe FrameMaker

Candidates with experience in the field of quality management/ISO 9001 and/or a background in EEG will be particularly favoured.

A Scientific Consultant in Technical Support

Place of Employment: Gilching (20km out of Munich)

Job description:

As a member of the technical support team you will be responsible for supporting users of our products with technical problems & questions. Experience with our products is absolutely required as well as practical experience in relevant fields of applications e.g. EEG& fMRI, ERP recordings, etc.

Technical understanding is needed as well as the qualification to find out about the source of a problem from reported results in a logical and systematic way. Solutions must be communicated and should lead to a general improvement to prevent similar questions/problems. Working on technical documentation for further developments is also a part of the job.

Applicant requirements:

- Excellent written and spoken English
- Academic degree (preferably PhD) in a relevant field of neurosciences, psychology, physics, biophysics, biomedical technology, or related field
- Detailed experience in setting up, analyzing and supervising neurophysiological studies.
- Experienced user of our software products (especially in human EEG and Evoked Potential studies)
- High level of analytical skills, quick comprehension and pleasure in finding solutions
- Ability to communicate complex scientific and technical concepts to different target audiences from all over the world
- Willingness to travel from time to time (to attend conferences, user workshops and visit customers)

Candidates with experience in programming, MATLAB® or technical signal analysis will be particularly favoured.

In the Public Eye

Brain Products Media Coverage

by Stefanie Rudrich

As you know, one of our main objectives is to support all of you who are involved in neurophysiological research on a daily basis. And, seeing the fruits of your work successfully published in leading scientific journals makes us happy and a bit proud, too.

As a commercial company we are also happy to see your research and our products mentioned on TV, radio or in the press. As we suppose some of the reports might be of interest for you too, we have created a "Media Coverage Section" on our website which features newspaper/magazine articles, TV reports, etc. Recently we added some reports on "Baby EEG", and on a "robotic exoskeleton" that Jose Luis Contreras-Vidal and his team from the University of Houston are currently developing.

To give you another example: This summer we received a quite unusual request for the actiCAP. German actress Esther Schweins was promoting the "13th Shocking Shorts Award" for young directors in the context of the Munich Film Festival 2012. As this years' motto for the short movies was "Hochspannung" (high tension), photographer Gert Krautbauer (http://krautbauer.net/) came up with the idea of using the actiCAP for the shooting (see picture).

Visit http://www.brainproducts.com/references.php?tab=4 to learn more. If you know about any TV broadcast or newspaper/magazine article on your research, we'd behappy to post it on our website as well (marketing@brainproducts.com) ●

Pic. 1: German actress Esther Schweins wearing a Brain Products actiCAP to promote the "13th Shocking Shorts Award" at the Munich Film Festival 2012.

Brain Products Conferences

Neuroscience 2012

by Stefanie Rudrich

This years' annual meeting of the Society for Neuroscience (SfN) will once again be attracting tens of thousands of researchers from all over the world, and hundreds of exhibitors. Neuroscience 2012 will be held in "The Big Easy" (New Orleans, LA) from October 13th – 19th and offers you a chance to learn more about our latest product developments, as well as what's in the pipeline for the future.

Brain Products will be co-exhibiting with its distributor for the US and Canada, Brain Vision LLC; a representative of our partner company EASYCAP will also be on-site. Don't miss the opportunity to stop by at our booths #1419 & #1421. Staff members from our support and sales team will be on hand to answer your questions about our software programs, amplifiers (incl., the wireless EEG system MOVE), or sensors, electrodes and electrode caps, at your disposal.

We look forward to meeting you in New Orleans! For more events that Brain Products is attending, check out our website at: http://www.brainproducts.com/events.php.

For more information on Neuroscience 2012 visit: http://www.sfn.org/am2012/ ●

Brain Products Distributors

C&P International FZC

by Paolo Piccotti, C&P

C&P International FZC was founded in Dubai (UAE) by a group of professionals with varied backgrounds, with experience in management, consulting, technology and with a real passion for the biomedical field.

Our combined experience gained in worldwide missions and cooperation projects gives us a unique ability to connect different geographic areas with specific intellectual and cultural richness.

We aim to bring to the MENA (Middle East and North Africa) market the most innovative European technologies in the clinical and research field.

For a few months now, we have been enthusiastically representing Brain Products in Lebanon, Qatar, Saudi Arabia, and the UAE, where we were able to tie up strategic cooperation agreements with very high profile professionals operating in the fields of medicine, biomedicine and neurophysiology.

Several countries in the Middle East have invested heavily in the education and research sector, inviting top level US and European Universities to open campuses in the region.

World class facilities and top level professors and researchers have been able to attract postgraduate students from across the world.

They have also been able to deliver top-end research and to create more robust educational and social transformation through human resource capacity.

In the specific fields of neurophysiology research and clinical applications we are also witnessing an impressive growth in both interest and technical capability.

We met the Brain Products team at the Arab Health in 2010 in Dubai and immediately felt we shared with them values and a business philosophy which puts the customers' needs first, guaranteeing post sales assistance and training.

The reputation of a company able to provide high quality products and unbeatable after-sale support, convinced us they would be our ideal business partners.

We are glad to be part of the Brain Products network and we are looking forward to sharing and promoting their knowledge and technology with the most renowned neurophysiology experts in the region for many years to come ●

Brain Products Charity Projects

Brain Products supporting the Salberghaus

by Olga Herrmann

For almost all children and young people, the family summer holidays are the best time of the year. However, not everyone may be as blessed as we, our kids and grandchildren are and that's why Brain Products has been constantly supporting the Salberghaus children's home for a couple of years. Without our (and others) support children from its therapeutic residential groups could not enjoy their holidays as much as they can with it, because they are not able to live with their own family due to domestic problems.

"We are extremely grateful for Brain Products' support and the opportunities it opens up for our children.", comments Wolfgang Pretzer, director of the Salberghaus.

We at Brain Products are sure that you - our customers and partners - will appreciate that we again use some portion of our turnover in 2012 to keep supporting the Salberghaus instead of sending out Christmas presents.

We will be keeping you updated about further developments and new projects in the Salberghaus. ●

Summer Holidays for Salberghaus children

Projects & References

Did you know … about our "EEG/fMRI list of publications"?

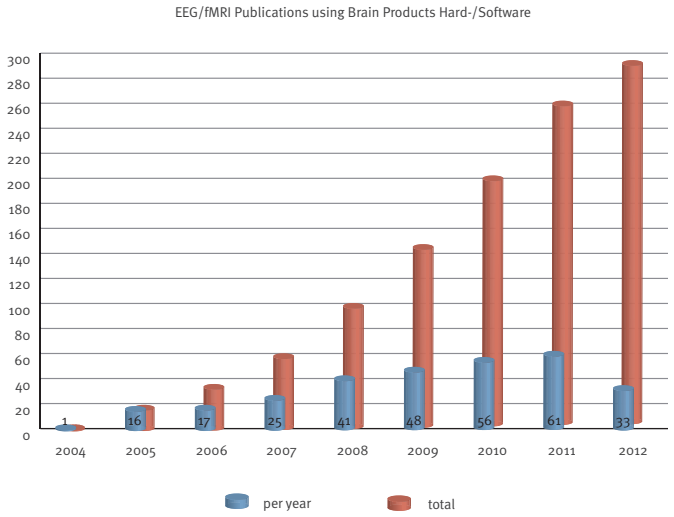
by Stefanie Rudrich

If you are working in the EEG/fMRI field, you know that this type of co-registration has been on the increase internationally over the past decade.

As one of the leading manufacturers for amplifiers, EEG electrode caps, software and accessories for EEG/fMRI applications, we are proud that by now almost 300 valuable scientific papers have been published on research work using our equipment.

If you are not yet aware of this summary of helpful literature, check out the Projects & References section of our website at http://www.brainproducts.com/references2.php to browse these publications or download the complete list (including links to PubMed) as a pdf-file.

If your publication is missing from the list, feel free to notify us (marketing@brainproducts.com). ●



News in brief: Downloads, Programs and Updates

Sep 20th, 2012 / BrainVision Analyzer Automation Reference Manual updated

An updated version of the reference manual for Analyzer automation is now available and can be downloaded in in the manuals section (www.brainproducts.com/downloads.php?kid=5&tab=2) of our website.

Aug 31st, 2012 / New Updates for Analyzer 2.0.2 available

New updates for Analyzer 2.0.2. („Edf Reader", „Artifact Rejection", „CB Correction", DC Trend", „Edit Channels", „Edit Markers", „Pooling" , „XLTek Reader", „LORETA" and „ICA/OcularCorrectionICA") can now be downloaded in our Analyzer 2 Download Area (http://www.brainproducts.com/downloads.php?kid=9&tab=2)

Aug 28th, 2012 / Product Video introducing the MOVE System

A short video introducing the MOVE system and demonstrating how easy it is to convert your EEG system into a wireless one, can be found at: http://www.brainproducts.com/move.php

Jul 16th, 2012 / Updated Operating Instructions for actiCHamp amplifier

Updated operating instructions for the actiCHamp amplifier, which from now on is powered by a new rechargeable battery, the actiPOWER, are now available in the in the actiCHamp/PyCorder Forum.

All Updates and New Modules can be downloaded on our website at www.brainproducts.com/downloads.php. If you'd like us to keep you posted on any new Update for BrainVision Analyzer 2, please register for our Analyzer 2 Newsflash at www.brainproducts.com/a2_newsflash.php

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