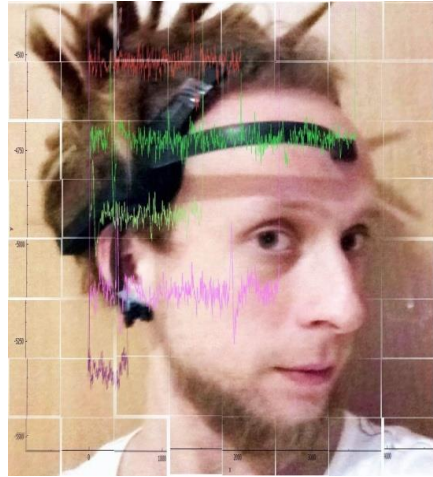
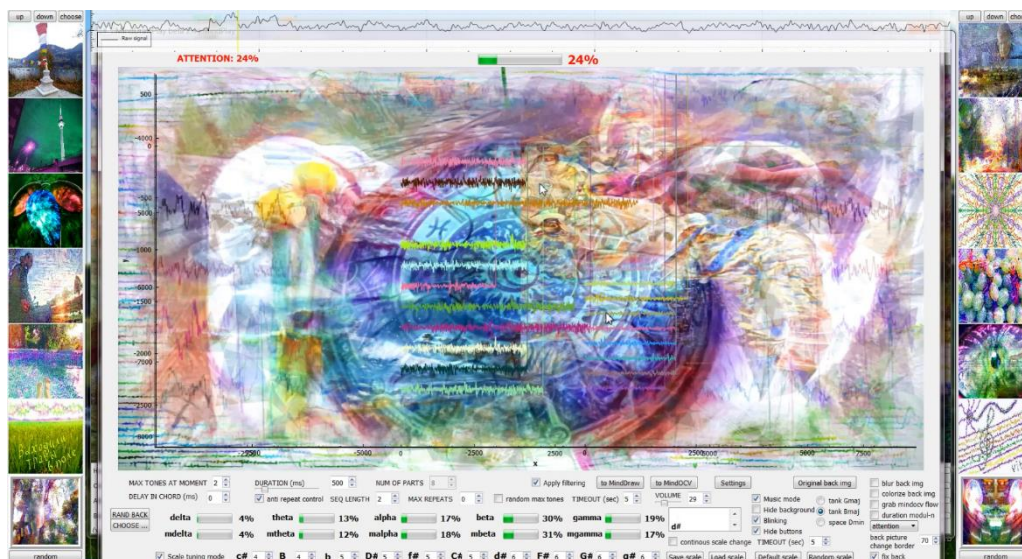
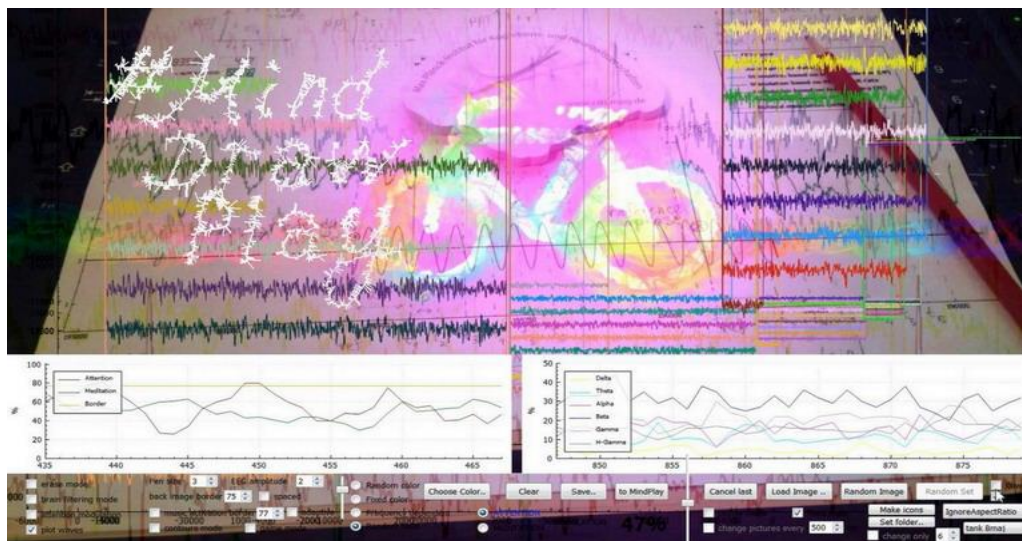


# MindDrawPlay

MindDrawPlay – is a project of experimental interactive audio-visual art, representing translation of brain waves to drawing, visual and musical spaces, flows and controls. It has been grown on a base of research work in the direction of Brain-Computer Interfaces. Combining technology advances – such as mobile EEG devices (*in particular, MindWave Neurosky*) and musical knowledge – such as pentatonic scales (*hang and tank drums tones*), it allows everyone to see, to hear his brain activity represented by set of sounds and to use brain waves as a brush for drawing, as parameters for image filtering, attention modulated color-overlay pictures flows, in “puzzle gathering”, “find the same” and “go through” games. MindDrawPlay is much more than a neurofeedback app with sounds and visualizations, it provides with a unique experience of interactive immersion into flows of your mindspace.



Pic. 1 Mobile EEG (MindWave NeuroSky, <http://neurosky.com>), data acquisition device for brain waves.

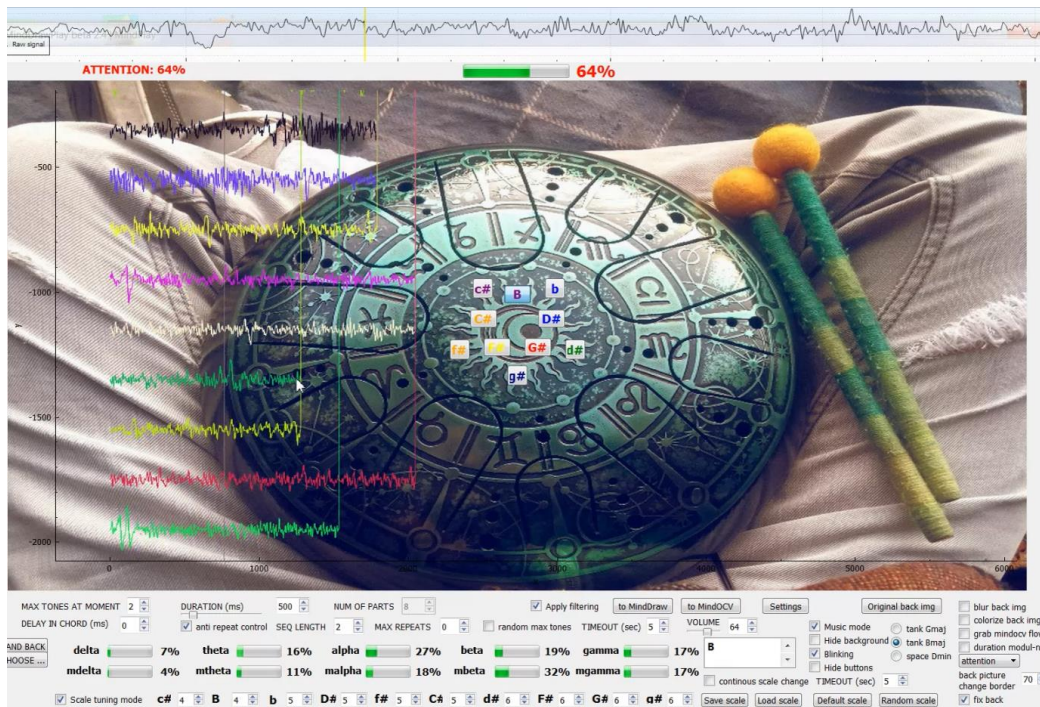


Pics 2-3. Screens of the application, promo video: <https://vimeo.com/396706503>

Thanks to mobile EEG, it is simple in usage, does not require any preparation procedures (like with traditional EEG devices), just wear, observe and play with your mindscape. Application allows user to control different parameters, for example, in case of music – duration of tones, number of tones in a moment and their distribution (how often which tones play), in case of drawing – different color modes of brush and amplitude of brain signals as a brush, in case of visual space flow – how many pictures in a puzzle will change and how fast. You can observe in a real-time dynamics of your brain waves on plots, your attention / meditation level changes and how actions in application or your mental activity states influence brain waves. Therefore, essentially, MindDrawPlay is form of an interactive art, neurofeedback application and a tool for exploring brain activity patterns.

Basically, there are three windows in the application, additionally on the top of all - there is a plot with real-time raw brain signals from EEG device.

**1<sup>st</sup> window is “MindPlay”,** which allows translation of brain waves to music by playing samples of tones from 2 tank drums and 1 hang drum. The background image (.jpg) can be filtered at the same time with effects – blurring and change of colors by HSV (hue) filter, blurring depends on the brain activity: higher attention/meditation levels produce less blurred image. Besides, background image can be changed by condition: when attention/meditation > border value. Music by brain waves can be combined with usual playing of samples by user.



Pic. 4 Screen of “MindPlay” window with brain waves flow,

video: <https://vimeo.com/363065676>, <https://vimeo.com/373804169>, <https://vimeo.com/341203496>

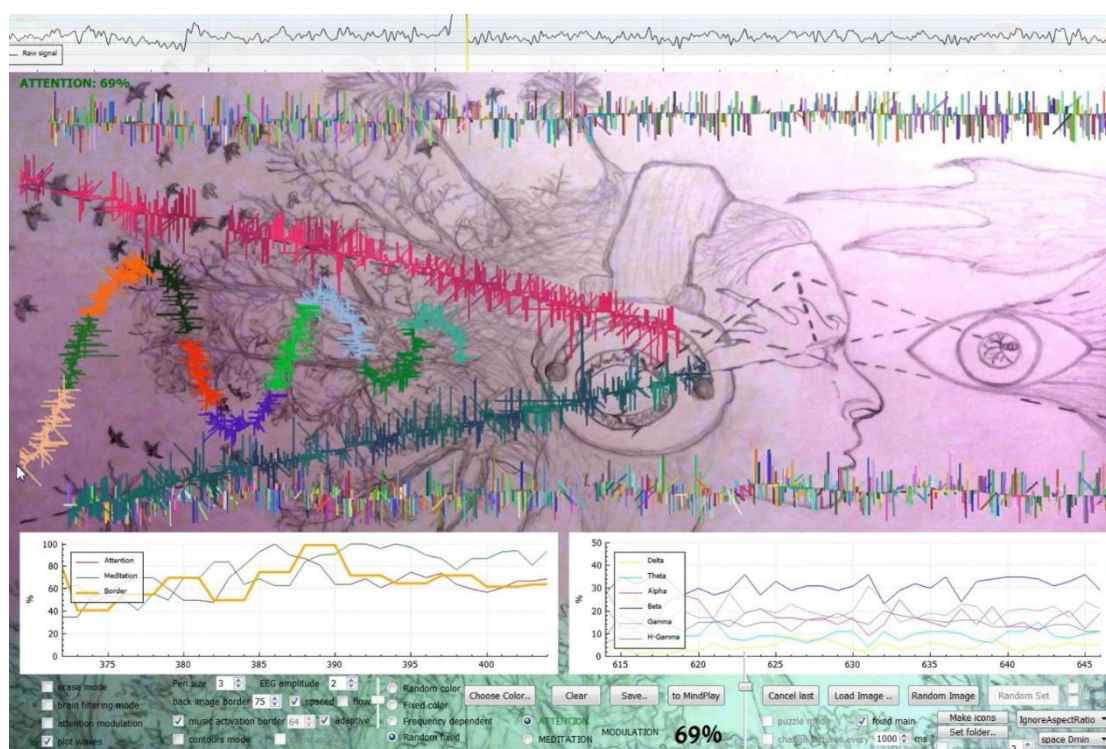
### How does it work?

In short – it gets brain signals (electrical activity in microvolts) from 1 electrode (on frontal lobe area, Pic.1) and transmits it via bluetooth to the application, where it is processed in short intervals (1, ½ sec or less) and frequency distribution for every interval is analyzed. Different musical tones are linked to different brain waves (*delta*, *theta*, *alpha*, *beta*, *gamma*), depending on which of them are more expressed in relation to deviation from its average value – particular corresponded tones will play. Thanks to pentatonic scale (which is used in hang or tank drums),



the sounds are always in harmony. Attention / meditation levels, which are estimated by build-in algorithm in EEG device (or by Fourier transform values from raw signal) are related with volume control: when you are more focused – sounds play louder, and optionally with tones duration, where with a higher level of attention/meditation – tones play longer. Brain waves are visualized by these short intervals in a flow (Pic. 4), which you can scale and move.

**2<sup>nd</sup> window is “MindDraw”** with 5 different modes representing various graphical spaces and controls of them. In all modes there is an option to show in real time brain waves and attention / meditation levels on the plots. It represents your brain activity patterns, when you simply look on the application window or do something there (or wherever within limits of bluetooth). Therefore, you can see how your interactions influence your brain activity, for example, when you start drawing a line – your attention and beta waves usually increase, when you are closing eyes or relaxing – alpha waves usually get higher. Moreover, there is an option for combining drawing with music – when your attention/meditation level is higher than some value (like 80% or adaptively defined) – musical space is activating and you hear sounds from "MindPlay" window.

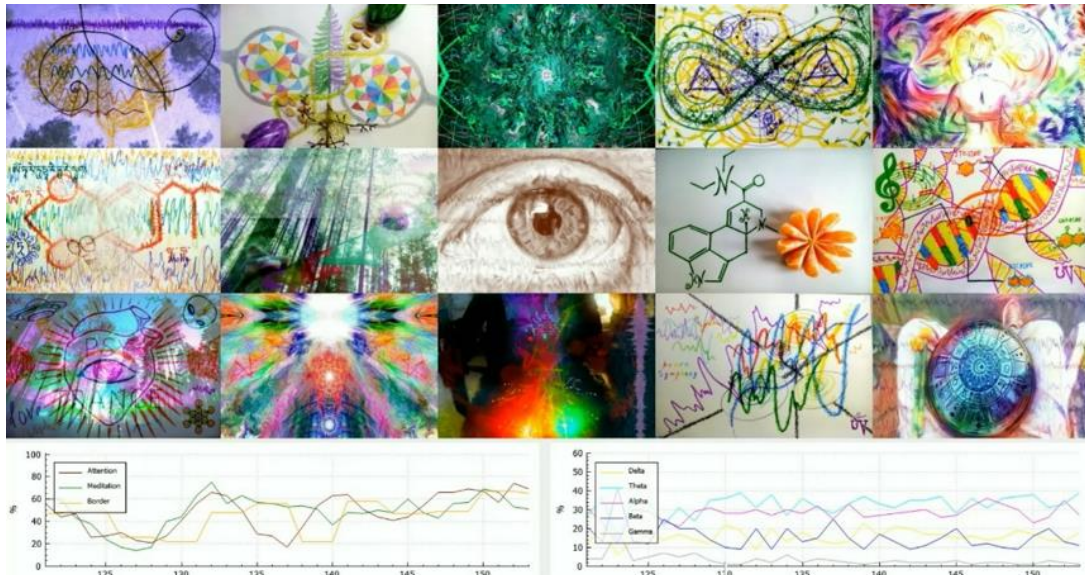


Pic. 5 Screen of “MindDraw” window in “drawing mode”,

video: <https://vimeo.com/374172719>, <https://vimeo.com/331878650>, <https://vimeo.com/363152405>

**1<sup>st</sup> mode** – drawing with brain waves as a brush: when you press and move the mouse – signal from your brain (amplitude of brain oscillations from EEG device) is projecting on a plot with direction always orthogonal (90°) to mouse movement. There are several options and parameters, such as color control (brain frequency dependent, random, fixed), amplitude (fixed, attention/meditation modulated), modes for instant drawing and drawing by contours. As in “MindPlay” window, any image can be used as a background layer also in a filtering flow mode.

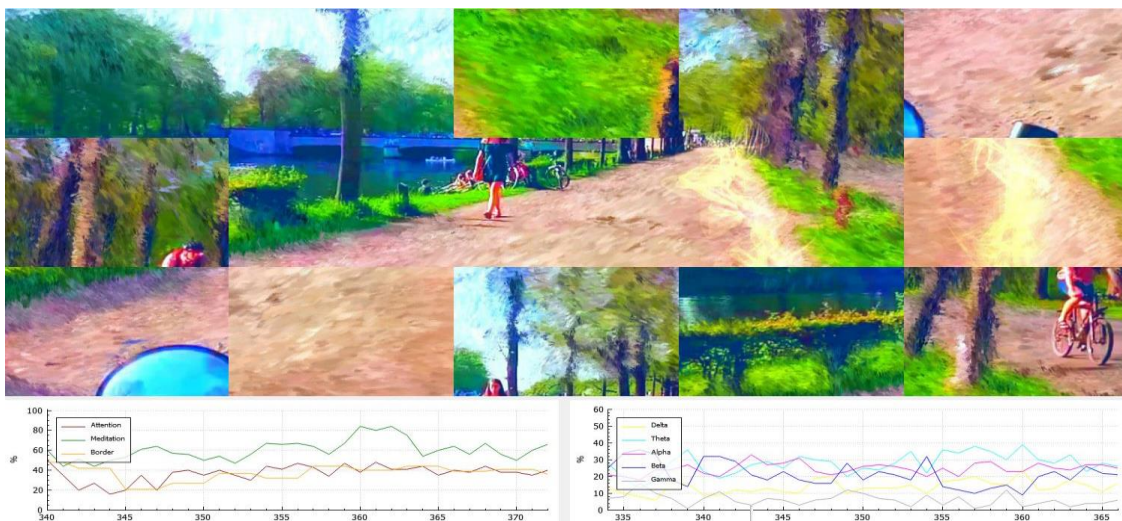
**2<sup>nd</sup> mode** – puzzle flow representation of an image set: it has 15 small puzzles with images and you can control with attention/meditation levels – how many of 14 images around the central one and how fast will be changed in a way, when you are focusing – less puzzles are changing and slowly. Additionally, this mode can be used for representation of the most similar or different pics in a relation to a chosen pic (the central one) based on color histogram similarity analysis.



Pic. 6 Screen of "MindDraw" window in "puzzle mode",  
video: <https://vimeo.com/374183779>

"Draw" and "Play" windows can be switched and used with the same picture and all options available in two windows, so you can observe pictures from a set, choose the one you like and go for drawing or playing, then go back to the set, choose another one or just observe the flow. (video: <https://vimeo.com/332093098>)

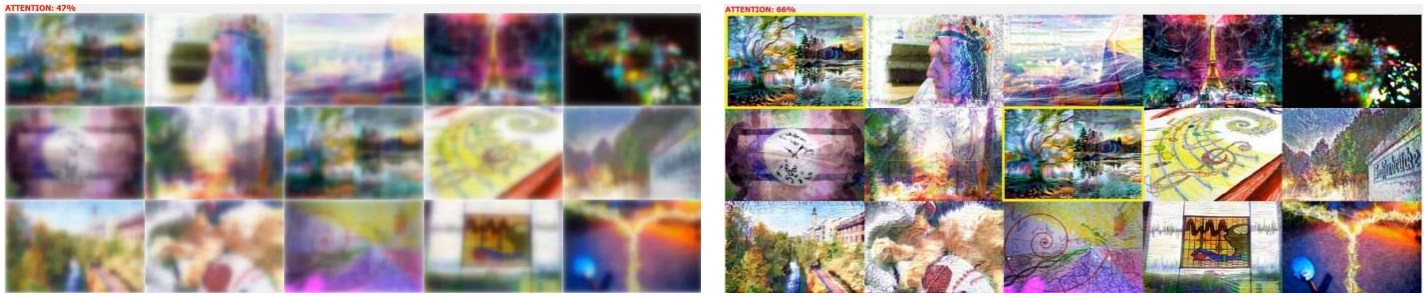
3<sup>rd</sup> mode – "puzzle gathering" game, where with attention/meditation level you need to complete the picture from 15 randomly shuffling fragments. There are 2 options in this mode, when puzzle has fragments only of the one picture or when it is represented by the background picture and a set of small randomly changing overlapping images. The idea is that, when you are more focused / relaxed – the puzzle is more complete, less fragments are in the wrong positions (or less overlaps with background picture) and changing slowly.



Pic. 7 Screen of "MindDraw" window in "puzzle gathering" game mode,  
video: <https://vimeo.com/362443658>

4<sup>th</sup> mode – "find the same" game, where you need to find two the same pictures among 15, when all of them are blurring depending on attention, when you are more focused – pictures are more clean, and it is usually easy to find the same.

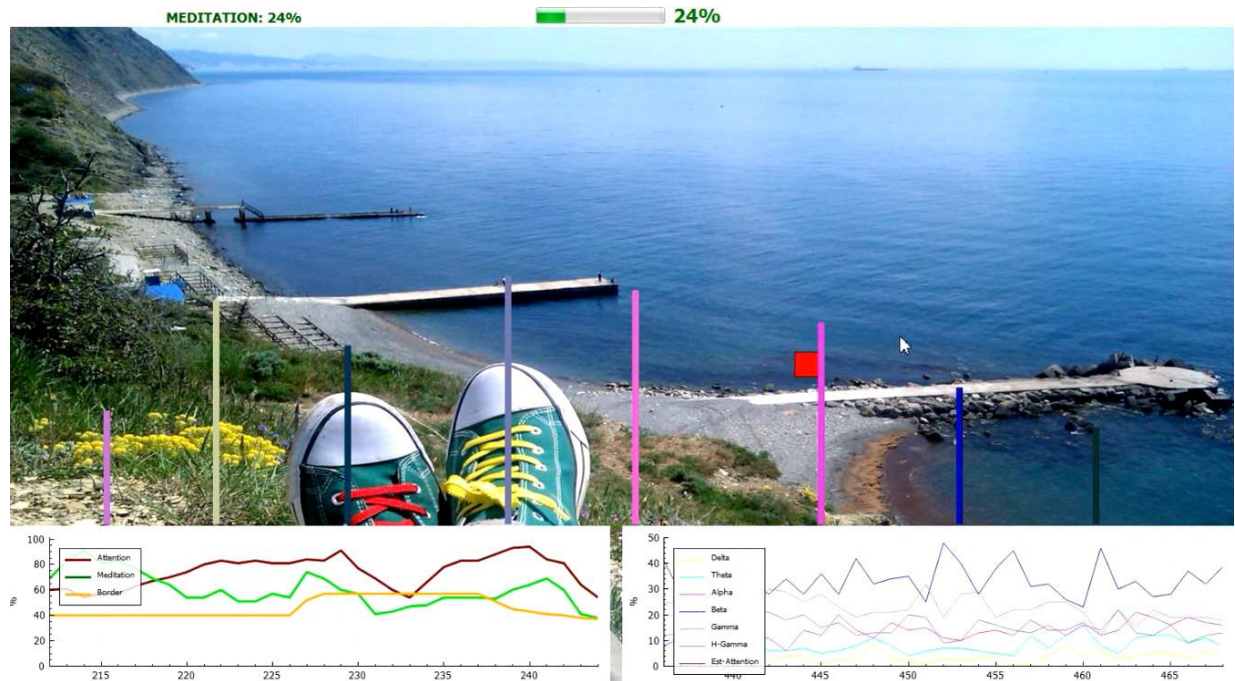




Pic. 8 Screen of “MindDraw” window in “find the same” game mode,  
video: <https://vimeo.com/372210884>, <https://vimeo.com/404384963>

5<sup>th</sup> mode – “go through” game, where you need to pass the item through number of lines or obstacles by your attention / meditation level, the item moves faster – when your mental activity level is increasing and, at the same time – the obstacles becomes lower; if your mental activity value is going down – the item moves slower and obstacles increase; if your attention/meditation level is below a certain chosen value, the item either stops or moves down (at the obstacle border). Additionally, when the item hits the obstacle or overcomes it – sound tones are played, therefore, your mental activity is also translated to music here, which will play faster or slower depending on how the item moves through the space with obstacles. When all obstacles over one space (image) are passed, then background image is changed and new game round is started.

This mode is kind of a prototype for 3D / VR-spaced game, where usual user controls and interactions can be combined with brain waves translations and modulations.



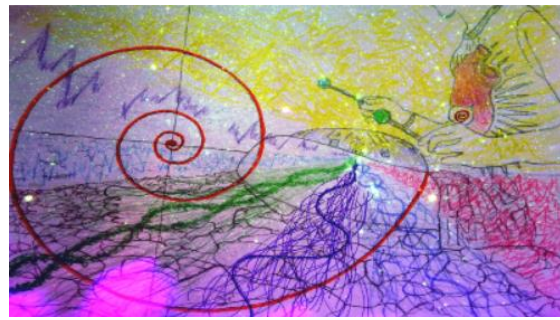
Pic. 9 Screen of “MindDraw” window in “go through” game mode,  
video: <https://vimeo.com/426068418>

**3<sup>rd</sup> window of the application is “MindOCV”** (based on OpenCV library) with the left and the right panels to choose the main and the overlay pictures from an image set. There are 4 modes in this window, 3 of them are flows: color-overlay flow, dreamflow, puzzle gathering flow; and the last mode is a simple graphical editor / collages creator tool.

1<sup>st</sup> mode: color-overlay flow – here attention modulates rate (how fast) overlay and color changes are applied for a chosen couple of pictures, attention also controls the transparency of the main pic (more focused – more solid), at the same time main pic is changing colors with HSV (hue) filter.

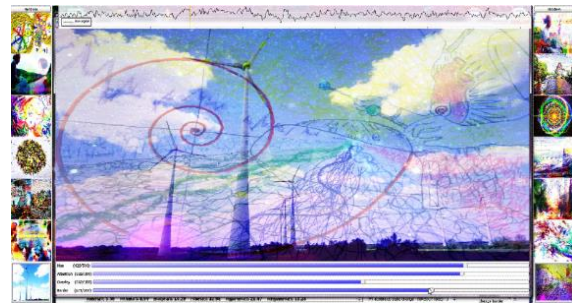
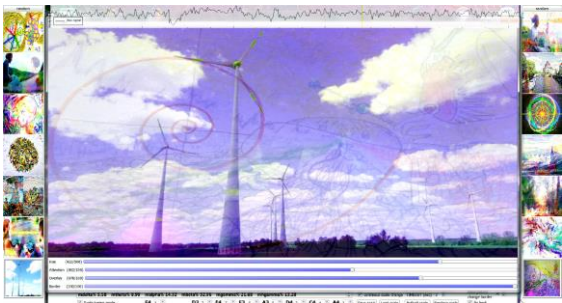


main pic



overlay pic

pics from resulting flow:



Pic. 10 “MindOCV” window with color-overlay flow, video: <https://vimeo.com/387225095>

There is an option to use a camera input as a source for overlay pictures, which provides with an experience of being inside the flow, while observing and interacting with it (both by attention and usual controls). Streaming of the flow to “MindPlay” and “MindDraw” windows – allows to watch yourself or space from camera with overlay of your brain waves and mental activity levels.



Pic. 11 “MindOCV” window, color-overlay flow with camera input, video: <https://vimeo.com/398709793>



**2<sup>nd</sup> mode:** dreamflow – smoothly filling visual space with parts of different pictures, either in a fully / partially user controlled way or in autonomous – when attention can modulate how fast fragments appear, their size, transparency and number of points in polygons for fragments (if polygon option is chosen, otherwise – fragments appear as circles / boxes of different sizes).

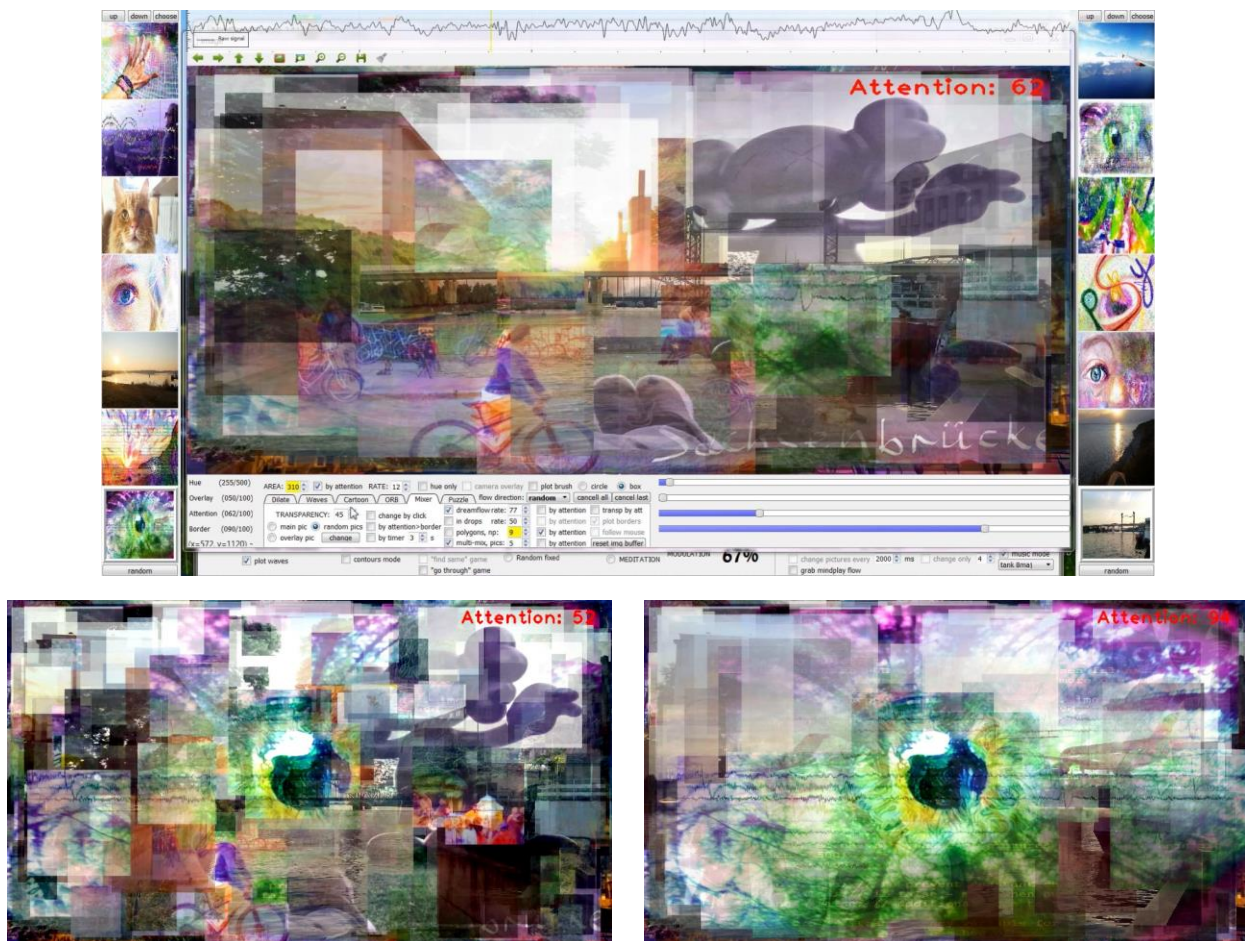
a) single mix: space is filling with random fragments of one image until change of the image



Pic. 12 “MindOCV” window, dreamflow, single-mix

video: <https://vimeo.com/396094596>, <https://vimeo.com/396226013>, <https://vimeo.com/396294651>

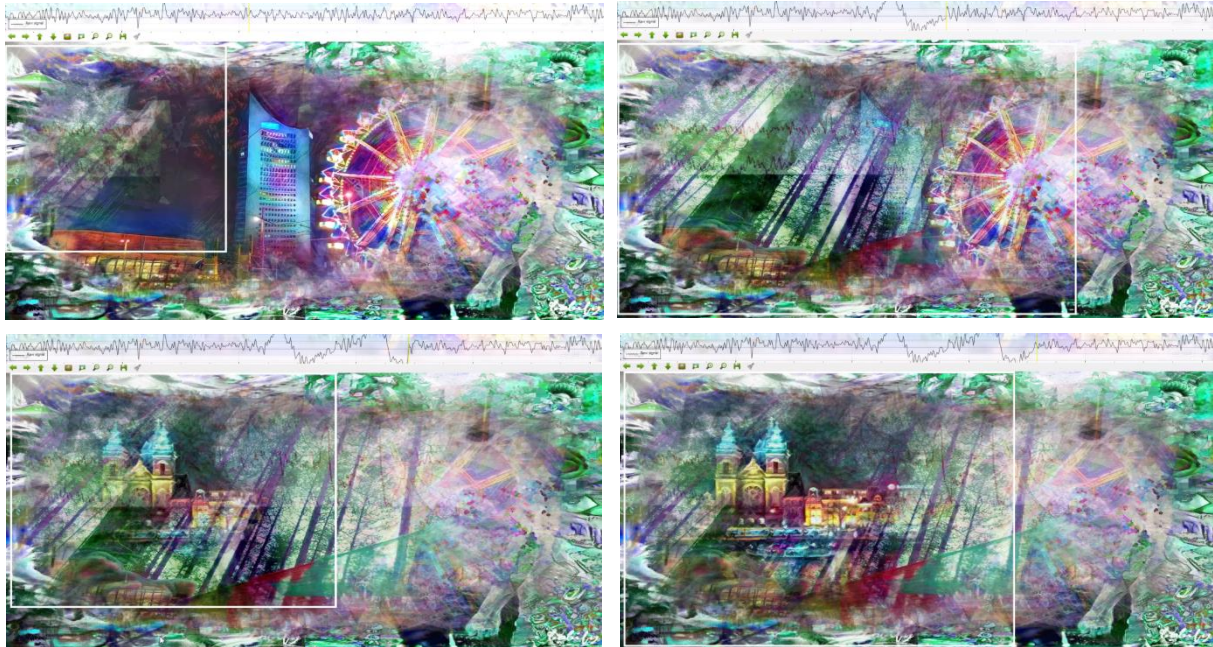
b) multi-mix: with each new fragment space is filling with parts of different images from a small set, where 1<sup>st</sup> image – main pic, 2<sup>nd</sup> – overlay pic, next N in the set are random; number of images in the current flow-moment can be controlled by user or by attention, when with a higher concentration – less number of pics are used, for example: with attention > 80% - only 2 pics (main and overlay) will be manifested, and with attention > 90% - only the main pic.



Pic. 13 “MindOCV” dreamflow, multi-mix, video: <https://vimeo.com/419927090>



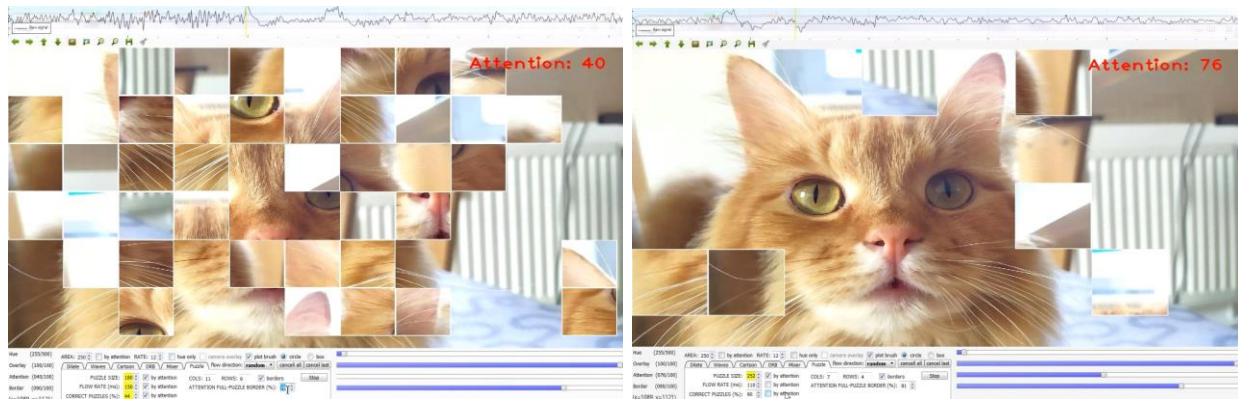
Additionally, both “single” and “multi-mix” dreamflows can be used with “drops” mode – where fragments of pictures appear in growing windows (drops), the rate of drops area increase can be modulated by attention, such as with a higher focusing – drops grow faster, new drops appear either at random position or at a current mouse position.



Pic. 14 “MindOCV” dreamflow, drops mode,

video: <https://vimeo.com/397576948>, <https://vimeo.com/397859469>, <https://vimeo.com/399557745>

3<sup>rd</sup> mode: puzzle gathering flow: similar to puzzle gathering game in “MindDraw” window, but allows more options, such as change of puzzles size, percentage of correctly placed puzzles and how fast wrongly placed puzzles change their positions; also it is possible to choose control between attention and meditation, and set a border value (%) for completing the puzzle.



Pic. 15 “MindOCV” puzzle-gathering flow,

video: <https://vimeo.com/434909901>, <https://vimeo.com/437115484>

In all “MindOCV” flows pictures can be changed by user action, time interval or condition: when attention > border value (for example, 80%) in color-overlay flow – the overlay pic becomes main pic and a new overlay pic is randomly chosen; in a single mix dreamflow – new picture for filling space is randomly chosen, in multi-mix dreamflow – the main pic is updated; with “drops” mode – new picture is also chosen, when the current drop area fills full screen. Instead of a random choice for next picture, there is an option to set the direction of the flow – to similar or opposite in relation to a current picture, the similarity is based on color histogram analysis of pictures.



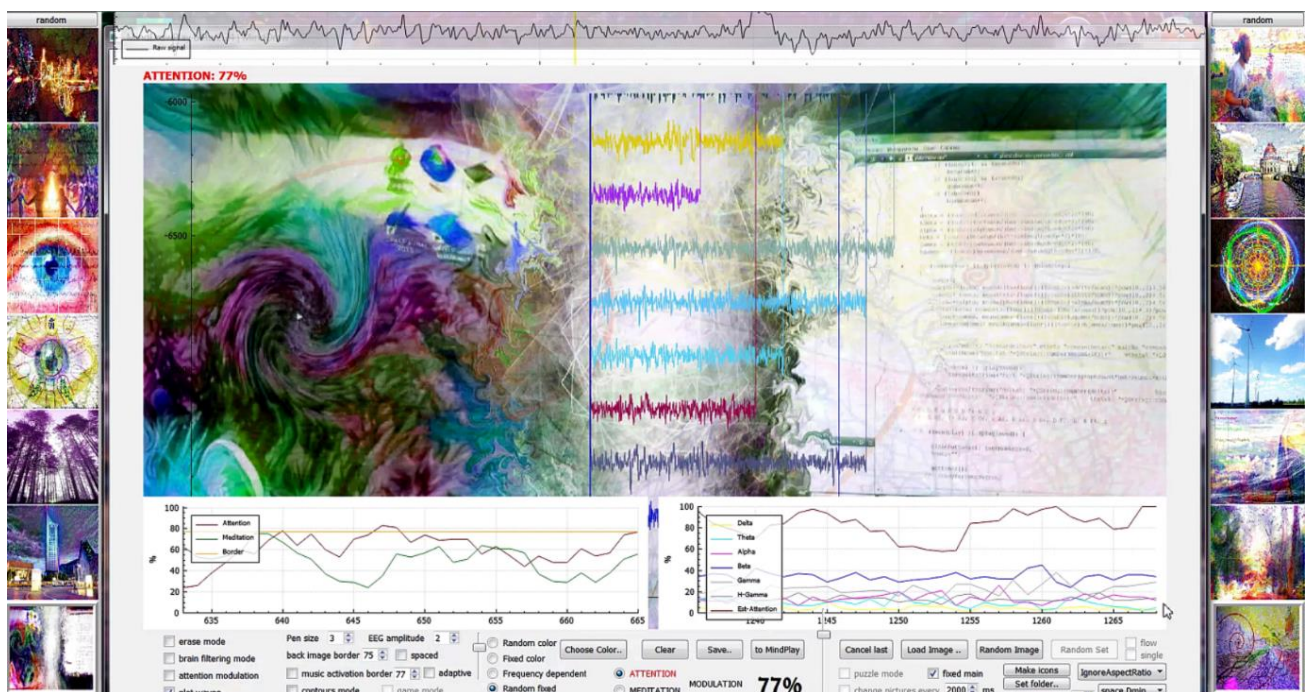
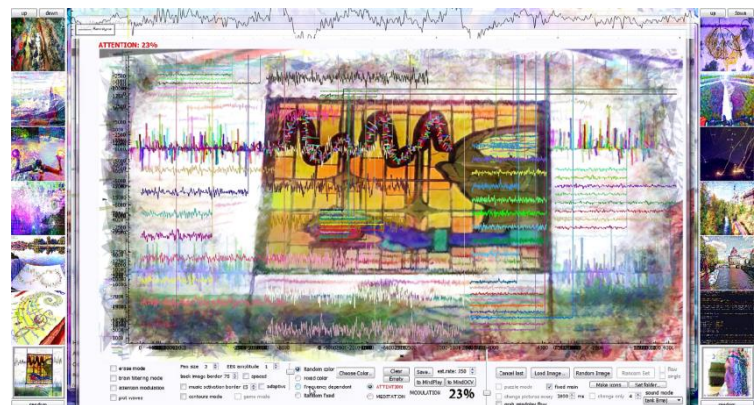
4<sup>th</sup> mode: a simple graphical editor / collage creator tool – currently with 5 filters (Dilate, Waves, Cartoon, ORB features, Mixer), this mode is more for exploring OpenCV filters and other image transforms, but also can be used during dreamflow mode or when one of the flows is stopped. The brush size and other filter-specific parameter can be attention modulated.

Importantly, all “MindOCV” flows and pictures can be streamed to “MindPlay” and “MindDraw” windows and used there as a background layer, the images from those windows can also be send to “MindOCV”. Such transfers allow to observe and create various combinations of flows, drawing and filtering with pictures, sounds and brain waves.

*MindDrawPlay* is a part-time hobby project written in C++/Qt and currently tuned for MindWave EEG device, but it can be adapted for other mobile or full EEG systems. There are many ideas and ways for development and improvement. Author is interested and opened for any potential collaborations, especially, with mobile and VR applications developers.

### Presentations:

18.03.2020 Berlin, TOP Project Space,  
Brain Awareness Week (postponed)  
31.01.2020 Leipzig, Basislager Coworking  
04.12.2019 Berlin, Wild Code School  
04.10.2019 Leipzig, Halle 14  
20.06.2019 Leipzig, Krudebude  
24.03.2018 Leipzig, Pilotenkueche  
17.03.2018 Leipzig, Kunstraum Ping-Pong



More examples of drawings and pictures made with the app:

<https://www.artstation.com/neur0forest/albums/1338653>

Screen recordings demonstrating work of the app:

<https://www.artstation.com/neur0forest/albums/1425498>