

Webinar Q&A Report:

Integrating Eye Tracking Data with Physiological Measurements

Q: Is the data in AcqKnowledge software coming in from eye tracker (pupil data). That is, the three lower panels are from eyetracker?

Yes, the two data channels shown during the live demo of the screen-based scenario are coming from the SMI eye tracker. As an example they show x and y pupil diameter but you are free to import other data such as gaze position.

Q: Can I use SMI software when I am only measuring eye movement data without any combined physiological measure?

SMI Experiment Suite Scientific eye tracking software features tailored tools for stand-alone eye tracking research and studies that require integration with other data streams. Its two integrated components, SMI Experiment Center and SMI BeGaze, support the entire workflow from experimental design through data recording and analysis. You can use a variety of stimulus formats, e.g. image, text, video, web and composite stimuli. During the recording, you can observe the experiment and also annotate behavior in real time. Furthermore, in SMI BeGaze, you can analyze your eye tracking data using visualizations and statistics.

Q: Can we use Eye Tracking System to evaluate baroreflex sensitivity in humans?

The AcqKnowledge software has a fully automated [Baroreflex Sensitivity \(BRS\) analysis](#) routine that provides options for both the Sequence and Slope methods of analysis. The baroreflex analysis requires a noninvasive blood pressure signal and an ECG waveform. BIOPAC has a Continuous [Noninvasive Blood Pressure System NIBP100D](#) and also an [Electrocardiogram Amplifier ECG100C](#). When these devices are used in conjunction with the [MP150 system](#), it is possible to perform a detailed BRS analysis. The eye tracking system will combine with the other physiological signals to provide one file that contains physiological signals and eye tracking data.

Q: Can you refer some materials about the use of SMI and BIOPAC, that show us how to use the two equipment types together

- Video Demonstration of *AcqKnowledge* software where BIOPAC physiological data is synchronized and merged with SMI BeGaze eye tracking data:
http://www.biopac.com/video/?video_category=data-integration&v=smi-begaze-import-and-synchronization
- More information on the screen-based integration:
<http://www.smivision.com/en/gaze-and-eye-tracking-systems/products/smi-eye-tracking-connected/smi-integration-with-biopac.html>
- More information on the mobile integration:
<http://www.smivision.com/en/gaze-and-eye-tracking-systems/products/smi-eye-tracking-connected/smi-mobile-integration-with-biopac.html>

Q: Regarding the three methods that were discussed for synchronizing data... is one method better than the other and if so in what situations?

All three methods have their pros and cons:

TTL trigger are the best option for highly precise synchronization with lowest latencies – mostly relevant in screen-based scenarios. The laptop computer that comes with the screen-based solutions can be equipped with a parallel port for delivery of TTL trigger information.

In case of clock synchronization, you do not need any connection between the two recorders during the recording, which is important in the mobile scenario.

The advantage of using physiological signals is that you do not need any additional hardware. But it might be more difficult to detect the onset of an important event equally well in the physiological and in the eye tracking data.

Q: In the mobile application, what is the maximum number of physiological signals that can be recorded on a subject?

The [BioNomadix Logger](#) can interface with up to three BioNomadix transmitters and each transmitter is typically dual channel. The Logger also includes an Accelerometer that provides an additional three channels of data, plus an audio journal and subject event marking system. That means that each Logger can collect a maximum of nine channels of data. Multiple BioNomadix Loggers can be used on the same subject to increase the number of channels of physiological data being acquired. Information on BioNomadix Logger, transmitters, and receivers can be found [here](#).

The practical criteria is that the amount of sensors should not change the behavior of the participant. This is why the small size of the SMI/BIOPAC equipment is so important.

Q: What is the difference between a specific and a “non-specific” skin conductance response?”

Skin conductance responses are typically classified as Specific (SRR) or Non-Specific Skin Conductance Responses (NS.SRR) in event related applications. A [Skin Conductance Response](#) is classified as specific if the response onset starts within a specific time window after a stimulus is presented to the subject. The time window for onset is >1 second and <4 seconds after the onset of stimulus. A Non-Specific Skin Conductance Response is any response that occurs outside of the time window. The [Event Related EDA analysis](#) in the [AcqKnowledge software](#) marks the onset of the response, the peak response and the end of the response. It also identifies Specific and Non-Specific Skin Conductance responses and provides a frequency analysis of SRR and NS.SRR.

Q: Is it possible to collect data for separate eyes (left vs. right)? Can this be viewed in the SMI software?

Yes, it is possible to collect data for both eyes and view both collected streams in the eye tracking software. This data is also available for analysis with the physiological data using BIOPAC's [AcqKnowledge software](#).

Q: Is it possible to synchronize SMI Glasses and BIOPAC systems?

Yes, for in-depth explanation please watch the human factors use case presented during the [webinar](#).

Q: Can a source of data be fNIR combined with eye tracking data? If yes, how would this be done?

BIOPAC offers a number of options for function Near Infrared Spectroscopy and the eye tracker can be interfaced with [fNIR](#) and other physiological data. The fNIR signals can be merged with other physiological signals and eye tracking for one complete data set. The [fNIR system](#) also comes with a unique software package for analyzing fNIR data.

Q: Can one computer be used for both technologies? Why are two separate PCs required?

Yes, it is possible to use one computer for stimulus presentation, eye tracking and physiological data collection, but we recommend using two computers for demanding experiments with each system having its dedicated recording device which is optimized for the purpose. The first computer is used for presenting the stimuli and the second is used for recording the physiological data. The second computer is typically located in the experimenter area and is monitored throughout the recording session. For analysis, both SMI BeGaze and BIOPAC [AcqKnowledge software](#) can be installed on the same computer.

Q: Can you please specify a little bit more the flow of markers/triggers and the role of the independent presentation module? The triggers come from SMI experiment center, right? And then what happens?

For the screen-based scenarios, Experiment Center can output a TTL pulse each time a new stimulus is presented to a subject. The pulse is sent through a parallel port that is attached to the eye tracking computer. A cable runs from the parallel port to the [MP150 system](#), via the [STP100C module](#) and is recorded with the physiological signals.

These triggers are used to synchronize and align the eye tracking data with the physiological signals. The same can also be achieved when using [E-Prime](#), [SuperLab](#) and other presentation systems capable of outputting a trigger pulse.

Q: When recording both eye movement and EEG excessive eye movement would lead to artifacts in the EEG signal. How do you recommend coordinating both of these signals in an experiment?

BIOPAC offers a range of [EEG options](#) for a variety of applications and the eye tracking data can be merged with the EEG data. *AcqKnowledge* software contains tools for automatically analyzing [EEG data](#) and eliminating eye blink contamination. The eye tracker also helps when identifying excessive eye movements.

Q: For the mobile integration - can you set up the gaze tracker to analyze moving AOIs (a person walking on the street) rather than use static AOIs (e.g., windscreen)

Yes, in SMI BeGaze you can create moving AOIs. Physiological signals can be recorded as well using the BIOPAC BioNomadix wireless transmitters and [BioNomadix Logger](#) and then analyzed using [AcqKnowledge software](#).

Q: For the visual stimuli presented - does it need to be an actual image or colored visual stimulus? Can we have text or black & white images as visual stimuli?

SMI Experiment Center allows you to use a wide variety of stimulus formats, e.g. images (also black and white), text, video, web and composite stimuli.

Q: Have you come across any issues using mobile eye tracking glasses with EMG since some of the sensors are placed in areas that might get in the way of where the glasses are worn?

The glasses should be positioned on the subject in such a way that they do not interfere with the actual electrodes. Facial [EMG electrodes](#) are relatively small and low profile so it's possible to position the glasses so that they are not pushing up against the electrodes. The electronics in the eye tracking glasses will not interfere with the EMG signals from the subject.

Q: What is the best solution to measure and analyze the gaze of driver to visual smog (billboards) in your opinion?

The best solution for this is to use the SMI Eye Tracking Glasses Analysis pro. This package contains also our semi-automated analysis software BeGaze which allows you to quantify the visual distraction caused by the visual smog very precisely and easily.

Q: Is there a BioNomadix transmitter with more than 2 channels available?

The BioNomadix transmitters are typically dual channel and three units can interface with one Logger. It is also possible to use more than one Logger per subject and thus increase the total number of channels. BIOPAC also has the [Mobita system](#) which is a 32 channel wireless biopotential recording system that can record ECG, EEG, EGG, EMG, and EOG.

Q: How long does the clock synchronization provide accurate synchronization?

We have found that the clocks deviate only a few milliseconds over a multi-hour recording and provide reliable alignment throughout the recording session.

Q: How would you use this technology to compare a wild-type and a model animal with altered neurological pathways? Could you present an image of food and compare the speed it takes them to search for food?

While BIOPAC systems support a wide variety of animal research, this is a question very specific to your field of research. We recommend you [contact a representative](#), or you may browse our eye tracking publication database to search for similar research questions:

<http://www.smivision.com/en/gaze-and-eye-tracking-systems/support/publications.html>

Q: I have a question about the synchronization of eye-tracking data and skin conductance activity. I mean that the latency of the skin conductance activity from the initial action and the reaction is more than corresponding eye-movement. So there is no just technical synchronization here.

The *AcqKnowledge* software [Skin Conductance Response \(SCR\) analysis](#) identifies Specific and Non-Specific SCRs. SMI's Experiment center sends a TTL pulse each time a stimulus event is presented. The onset of a specific skin conductance has to occur within a time window after a stimulus event was presented to be classified as a specific response. The standard window is >1 second and < 4 seconds after event onset. The response latency is reported and the user can identify the exact point the response started and correlate the eye position to the electrodermal data.

Q: I understood some measurements can be poorly aligned with events (stimuli). e.g., there was a 1~3 seconds differences between the measurement of eye-tracking data and the event. Is this issue only for eye-tracking data or for all physiological data? If this problem occurs in cases of all physiological measurement (e.g., EDA or respiration), then how can I be sure whether this problem occurred or not?

The problem you are referring to relates to electrodermal activity and specifically the classification of [Specific Skin Conductance Responses](#) (SSR). A SRR occurs within a certain time window after a stimulus is presented to a subject. The response must start >1 second and <4 seconds after the stimulus event is presented for it to be classified as a specific response. If the skin conductance response occurs outside of this time window, the response is considered to be a Nonspecific Skin Conductance Response (NS.SRR). *AcqKnowledge software* identifies and places event marks at the onset, peak and end of the SCR and identifies whether the SCR is specific or nonspecific.

When the eye tracking data is merged with physiological data such as [EDA](#), [ECG](#), [Respiration](#), *AcqKnowledge* software synchronizes all of the signals and time aligns them based on the synchronization method selected. With proper synchronization it is possible to take accurate measurements across physiological signals and eye tracking data.

Q: I want to know your opinion about using a head mounted eyetracker as a physiological sensor for arousal, via pupillometry.

Changes in pupil size are an indicator of cognitive load but they can also be influenced by changing lighting conditions. Therefore, we would recommend verifying reactions with additional physiological data streams such as [EDA](#).

Q: I was wondering if synchronization is possible (or even recommended) if not using SMIs Experiment Center to present stimuli (for instance if using Matlab or E-prime).

SMI Experiment Suite is a comprehensive tool which offers a dedicated workflow for stand-alone and connected eye tracking research. For recording synchronized physiological signals, it is ideally paired with BIOPAC's data acquisition and analysis systems—such as the [MP150](#) or [BioNomadix Logger](#)—and [AcqKnowledge software](#).

However, you are free to use SMI Eye Tracker with other stimulus software such as E-Prime, Superlab, Matlab and NBS Presentation. The stimulus software has to be set up to send markers to the SMI and BIOPAC data files. Also, experiments performed with these non-SMI stimulus presentation software can be loaded into SMI BeGaze analysis software for in-depth eye tracking analysis and the automated data synchronization in BIOPAC *AcqKnowledge* software works similar as with Experiment Center.

Q: Is a particular version of *AcqKnowledge* software required to integrate eye-tracking measurements?

The latest version of [AcqKnowledge software](#), which is v4.4.1, includes the SMI BeGaze integration. This [link](#) will provide upgrade information.

Q: Is it possible to set up the region of interest (ROI) in motion video from the SMI glass, or just for still images? Is there some functionality for changing the ROI during the video?

Yes, in SMI BeGaze you can setup moving AOIs. You can “pause” them when an object “disappears” and “reactivate” them when the object is visible again.

Q: Is there a camera on the eyeglasses that records what the person is seeing?

The eyeglasses include a high definition, forward-facing scene camera that records the subject's field of view. The eye tracking software will also place a mark on the video to show the subject's gaze point. This video shows the video from the [glasses with the synchronized physiological data](#) from the subject.

Q: Is there any ability to apply these region definitions to movies?

Yes, in SMI BeGaze you can create moving AOIs. You can “pause” them when an object “disappears” and “reactivate” them when the object is visible again. You can also resize and move the AOI when objects are moving in the video.

Q: Please elaborate on Methods of synchronization. To what degree BIOPAC sensors were synchronized to eye tracker?

In the [webinar](#), TTL trigger pulses were sent from the Experiment Center software to the physiological recording device. The TTL pulses were used to align the eye tracking data to the physiological data. This method provides the highest degree of accuracy when synchronizing the two systems.

Q: Questions for Frazer, can we review how to import the eye tracking data to the BIOPAC? Also, how to match the pupil data with the scan path data in BIOPAC?

This [screen cast](#) will provide you with a demonstration of the *AcqKnowledge* BeGaze import feature. It walks you through importing the data and aligning it with the physiological signals.

Q: Are you planning on integrating object recognition into the analysis software in order to trace objects automatically rather than having to manually adjust the area of interest?

SMI is working on an Automated Analysis solution for mobile eye tracking data and beta customers are already testing it:

<http://www.prnewswire.com/news-releases/smi-announces-automated-analysis-for-mobile-eye-tracking-537494791.html>

Q: We have ECG and Respiration on Bioharness (wireless) and SCR on BIOPAC - is it possible to combine all of them with BeGaze ?

Yes, BeGaze eye tracking data can be merged with any other signals recorded by *AcqKnowledge*. However, the synchronization with the BioHarness will be tricky because it is a separate system. We suggest you [contact us](#) to discuss your application and possible solutions.

Q: What cable was used to connect SMI to BIOPAC?

In a dual-PC setup (recommended), the SMI laptop is connected to the BIOPAC system via a parallel port ribbon cable.

In the mobile scenario, for initial clock synchronization BIOPAC and SMI systems are connected to a laptop via USB.

Q: What is the difference between pupil diameter and pupil width?

Pupil diameter is measured in mm, pupil width (size) in pixel.

Q: What is the total system cost for one laptop setup with hardware (not mobile) and software?

Please contact us to request pricing for your individual research needs:

For physiological data collection systems, please [contact BIOPAC](#). For SMI Eye tracking solutions, [contact SMI](#):

Q: Will SMI eyetracker interface with BIOPAC MP35?

The BeGaze import feature is available for *AcqKnowledge* software, which requires an MP36 unit or the recommended [MP150 system](#). From your question, we assume you are using a BIOPAC Student Lab system to record the physiological data. Please contact BIOPAC to discuss your specific needs and upgrade information.

Q: How do you align the eyetracking data to the physiological data? Is there a way to get time stamps for entering into a certain interest area to the acknowledge software?

In the webinar, TTL trigger pulses were sent from the Experiment Center software to the physiological recording device. The TTL pulses were used to align the eye tracking data to the physiological data. This method provides the highest degree of accuracy when synchronizing the two systems. The sample rate of the physiological data can be set to accommodate the TTL pulses that are sent from Experiment Center and the pulse width can also be adjusted. In the mobile scenario, for initial clock synchronization BIOPAC and SMI systems are connected to a laptop via USB. AOI information can be imported from BeGaze to BIOPAC *AcqKnowledge* software. To see how the data is aligned in both the laboratory and mobile environments, the human factors use case presented during the [webinar](#).

Q: What is the cost of the BioNomadix Logger?

The [BioNomadix Logger](#) and transmitters are available in different configurations. To ensure you receive the right combination for your experiment, please [contact us](#).

Q: For which purposes we can use Eye Tracking System in cardiovascular physiology?

Psychological stress is a good application for eye tracking and physiological monitoring. This can take place in the lab using a [remote eye tracking device](#) or mobile using the [SMI Eye Tracking Glasses](#). BIOPAC can combine signals such as [ECG](#), [blood pressure](#) and [impedance cardiography](#) to gain a better understanding of a subject's cardiovascular response to different stressors. The stressors can come in many forms: public speaking, mental tests, interpersonal relationships, etc. In each case, the physiological and eye tracking data is synchronized and aligned for analysis.

Q: How do you set the internal clock between the two pieces of equipment?

For the mobile application, where both the [BioNomadix Logger](#) and the SMI Eye Tracking Glasses are connected to one PC via USB to synchronize both clocks, BIOPAC and SMI have developed a dedicated synchronization tool which is provided in the software.

In the laboratory experiment, TTL trigger pulses were sent from the Experiment Center software to the physiological recording device. The TTL pulses were used to align the eye tracking data to the physiological data. This method provides the highest degree of accuracy when synchronizing the two systems.

Q: Is it possible to add triggers, like record when the user is doing some specific action on their smart phone? Or have a second person follow the participant and triggering manually?

The [SMI Eye Tracking Glasses](#) solution allows external operators to observe a participant's eye movements on the real-world scene live from a remote computer connected by WLAN. Via this wireless connection, you have full control and can for instance add live annotations on a user's behavior.

For screen-based applications, the observer can add live annotations on user behavior in [SMI Experiment Center software](#).

It is also possible to add event marks to the physiological data. This is much easier in the lab because it is easier to observe the subject while they are in a small room. For remote applications, the participant can add event marks to the [BioNomadix Logger](#) and audio notes for later playback. The events and audio notes are downloaded to *AcqKnowledge* and they are time aligned with the eye tracking data.

Q: Can these devices send the collected data to another application in real time?

SMI Eye Tracking solutions ([screen-based](#) and [mobile](#)) support real-time data streaming to other applications. BIOPAC also offers [Network Data Transfer](#) which allows users to access the data for real-time streaming. This includes the raw physiological signals and online calculation channels.

Q: Can you import fixation analysis data so that you could time-lock physiological data with the where the participant was looking?

For the screen-based scenarios, you can import eye event data from SMI BeGaze into [AcqKnowledge software](#).

Q: What is the cost for BIOPAC transmitter, sensors and logger (BioNomadix portion)?

The [BioNomadix](#) transmitter and Logger come in a variety of configurations to meet specific research needs. It's best to [contact us](#) to discuss your application so we can furnish you with accurate pricing on the correct package.

Q: Is it a good idea to use SMI eye tracker with infants? What is the youngest age that these technologies can be used with?

Our [screen-based eye trackers](#) are used by renowned customers with infants aged 3+ months and they are routinely used with infants aged 6 months onward. Customers are using our [SMI Eye Tracking Glasses](#) with children aged 3+ years.

Q: In the mobile eye tracking in combination with other measures, do you have to hand-code the video frame-by-frame or can you use dynamic AOI's?

For qualitative analysis of single user videos you can create moving AOIs in SMI BeGaze analysis software. You can “pause” them when an object “disappears” and “reactivate” them when the object is visible again.

In addition, with our fixation-based Semantic Gaze Mapping module for BeGaze, you can efficiently aggregate eye tracking data of several participants onto reference images.

SMI is also working on an Automated Analysis solution for mobile eye tracking data and beta customers are already testing it: <http://www.prnewswire.com/news-releases/smi-announces-automated-analysis-for-mobile-eye-tracking-537494791.html>

Q: Through your eye tracking glasses, can you extract heatmaps of surfaces, and if yes, can you do so without using markers around the surfaces?

With our fixation-based Semantic Gaze Mapping technology you can efficiently aggregate eye tracking data of several participants onto reference images.

SMI is working on an Automated Analysis solution for mobile eye tracking data and beta customers are already testing it: <http://www.prnewswire.com/news-releases/smi-announces-automated-analysis-for-mobile-eye-tracking-537494791.html>

Q: Can I combine the BioNomadix Logger with an eye-tracker that is not developed by SMI?

Yes, the [BioNomadix](#) Logger can be used with other eye trackers. However, you have to create a reliable way to synchronize the two devices.

If you want to combine the eye tracking data in [AcqKnowledge](#) you will also have to ensure that the third-party eye tracker can export the data in a suitable file format. *AcqKnowledge* supports many file formats including: Binary, EDF, CSV, Text, Matlab and Igor.

For a plug & play setup that offers automated synchronization of both data streams using the *AcqKnowledge* software one should consider using the solutions presented in the webinar from SMI and BIOPAC.

If you have additional questions for [BIOPAC Systems](#) and [SensoMotoric Instruments \(SMI\)](#) regarding content from their webinar or wish to receive additional information about their solutions for eye tracking and physiological measurements please contact them by phone or email:



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