Study Registration for the KPU Study Registry

Modifications

28 September 2018:

Question 6: Added the statement that as of this writing 2 participants have been tested. Question 10, Part 3 was updated to reflect the fact that all 50 participants were tested for the first part of the experiment (however, the final analysis is not ready yet as of this writing). Question 10, Part 4 was re-written to clarify artifact rejection techniques (we will use a standard EEG technique of rejecting epochs where the potential deviates too much from the mean). Also, only the pre-stimulus region will be used for the primary analysis but theory analyses will use both pre- and post- stimulus regions. A description of the band-pass filter was added Question 10, Part 4 to reflect the manufacturer’s recommendation that a high-pass or band-pass filter with lower limit 0.5 Hz be used.

25 September 2018:

Added the division between requiring key press (green start screen) and not (red start screen) modifying question 5 part C and question 10 procedure section B. 2/50 subjects have been tested at this point.

The registration information for the study is given below. Each section can be expanded as needed.

1. The title or name of the experiment (for listing the experiment in the registry).
Follow-up Study of Pre-Stimulus EEG Response to Random Light/Sound Stimuli

2. The name, affiliation, and email address for the lead experimenter(s) for the study.
Stephen Baumgart, University of California at Santa Barbara, stephenbaumgart@ucsb.edu
Sharon Su, University of California at Santa Barbara, sharonjanetsu@gmail.com
3. A short description or abstract of the purpose and design of the experiment.
This research project is based on attempting to replicate and further understand a phenomenon being detected by other laboratories whereby physiological activity (including brain activity, heart rate, pupil dilation, and skin conductance) is predictive of random events up to several seconds in the future at above chance levels when no inference is possible from existing information. A meta-analysis of such experiments consisting of only pre-planned analyses (thus avoiding common "questionable research practices" such as p-hacking) indicated $d = 0.21$ (95% CL: 0.15 to 0.27), $z = 6.9$, $p < 2.7 \times 10^{-12}$ using a fixed effect size and $d = 0.21$ (95% CL: 0.13 to 0.29), $z = 5.3$, $p < 5.7 \times 10^{-9}$ using a random effect size (Mossbridge, Tressoldi, & Utts, 2012) for these effects. Mossbridge et al. call this phenomenon "predictive physiological anticipation" but it is also called "presentiment" or "unconscious precognition". The paper also states that, "The cause of this anticipatory activity, which undoubtedly lies within the realm of natural physical processes (as opposed to supernatural or paranormal ones), remains to be determined." With this understanding in mind, research psychologist Dr. Michael Franklin and physicist Dr. Stephen Baumgart designed a research program to attempt to further understand this apparently precognitive effect. To begin the research, we felt it beneficial to start with simple stimuli but with high sensory contrast - a light turning on in darkness and a loud beep from white noise. Indeed, several studies in the meta-analysis had used one or the other of simple light or sound stimuli. However, most studies of the meta-analysis used calm or emotional images. But this strategy could possibly lead to confounds when images are not chosen with equal probabilities (e.g. more calm pictures than emotional ones). Therefore, we chose stimuli which can be selected with equal probabilities to avoid any potential confounds.

4. A statement or list of the specific hypothesis or hypotheses being tested, and whether each hypothesis is confirmatory or exploratory. (confirm/explore guidance)
A) Hypotheses to be tested
These hypotheses are based on the meta-analysis and on theoretical considerations.

1) The pre-stimulus EEG is predictive of the random stimulus at an above-chance level (statistically significant).

2) (if 1 is verified) The directionality of the pre-stimulus effect is the same as for the post-stimulus effect but the effect size is much smaller. (i.e. a decrease in alpha wave power after the stimulus will be accompanied by a much smaller decrease in alpha wave power before the stimulus)

There are two general theoretical models which predict the above hypotheses, Consciousness Induced Restoration of Time Symmetry (Bieman, 2010) and resonance models such as those proposed by Marshall (Marshall, 1960), Sheldrake (Sheldrake, 2003), and Taylor (Taylor, 2014). In the resonance models, since the brain state is very similar at close points in time, the future effects of the stimulus may leak backwards.
CIRTS posits a reflection of some forward-in-time effects in the opposite time direction. This experiment cannot distinguish between the models listed in this paragraph (one would need to identify structure in the pre-stimulus effects) but can verify whether the experimental results conforms to the models or not. Since no previous experiments have used similar stimulus intensities and durations (the most similar experiments are Radin and Lobach, 2007 and Radin, Vieten, Michel, and Delorme, 2011), this experiment should be considered exploratory.


B) Previous Experimental Results

A preliminary analysis has been performed on 40 subjects (out of 50 planned - the experiment is incomplete as of the writing of this report) for the previous experiment in this series measuring response to simple light and sound stimuli using EEG. The follow-up experiment is similar with the primary differences being a merged light and sound stimulus and randomly requiring a key press of the participant for blindly selected sessions at a 50% probability. The previous experiment’s results are described in this section utilizing four different analysis techniques.

1) **Mean Alpha Wave Suppression**

Epochs are divided into time periods. The baseline is defined as 7 to 14 seconds before the stimulus begins (t = -14 to -7 seconds) and is assumed to be far enough away from any events to act as "clean" EEG. The pre-stimulus region is defined to be 0 to 7 seconds before the stimulus (t= -7 to 0 seconds). The post-stimulus region is defined as 0 to 7 seconds after the stimulus. A transformation (Fourier transform) was made to obtain the power of the waves making up the EEG signal. T-tests were performed on mean alpha wave (brain waves with frequencies of approximately 8 to 12 Hz) power and compared to the baseline in both pre- and post- stimulus regions. All EEG sensors (electrodes) were used for this analysis (except for references). T-tests compared either the light or sound trials to the null (control) trials. Result are show below in Table 1. An earlier report given to KPU showed pre-stimulus results with the artifact checker turned
off for the post-stimulus time-period; here the artifact check is on for both pre- and post-stimulus time periods.

**Table 1: T-Tests on Alpha Wave Power Change**

<table>
<thead>
<tr>
<th>Comparison Type</th>
<th>Pre-Stimulus</th>
<th>Post-Stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light-Null</td>
<td>Sound-Null</td>
</tr>
<tr>
<td>T-Value</td>
<td>2.1</td>
<td>1.1</td>
</tr>
<tr>
<td>p-value</td>
<td>0.019</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Post-stimulus alpha wave suppression from the light stimulus is extremely robust. Pre-stimulus alpha wave suppression from the light stimulus appears to be slightly statistically significant. The sound stimulus appears much less effective in terms of inducing alpha wave suppression compared to the light stimulus.

It should be noted that the mean test requires artifact detection since extreme outliers caused by sudden electrode impedance changes called "electrode pops" can drastically affect the means. Electrode pops may be detected by finding extreme amplitude changes. The data reported here utilized an artifact rejection method of eliminating epochs which exhibit a total change of 500 \( \mu V \) over 10 data acquisitions (0.04 seconds). Without artifact detection, statistically significant effects are lost as is shown in Table 2 below.

**Table 2: T-Tests on Alpha Wave Power Change, No Artifact Detection**

<table>
<thead>
<tr>
<th>Comparison Type</th>
<th>Pre-Stimulus</th>
<th>Post-Stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light-Null</td>
<td>Sound-Null</td>
</tr>
<tr>
<td>T-Value</td>
<td>-1.1</td>
<td>-1.0</td>
</tr>
<tr>
<td>p-value</td>
<td>0.87</td>
<td>0.85</td>
</tr>
</tbody>
</table>

2) **Simulated Real-Time Predictions Based on Alpha Wave Power Threshold**

The preceding mean alpha wave suppression analysis depends on averaging a physiological measure (alpha wave power). But this measure may be vulnerable to subtle biases (Kennedy, 2013). Therefore, a real-time predictive system is ideal. Since this analysis is post-hoc, real-time predictions in this analysis are simulated by checking pre-stimulus alpha wave power against a threshold to mimic a real-time prediction system.

A problem arises in the setting of the threshold value. Naively, one can use zero but in the simplest model where the alpha wave power for null stimuli does not change over the epoch one would already have a misidentification rate of 50% for null stimuli. Ideally the threshold should be set somewhere below zero. This
value should be pre-registered for a confirmatory experiment and be based on exploratory evidence.

Binomial statistics are used to analyze results. These results for a threshold of $10^{-6} \mu V^2$ for alpha wave power change are shown in Table 3 below.

**Table 3: Simulated Real-Time Predictions for Alpha Wave Power Threshold**

<table>
<thead>
<tr>
<th>Comparison Type</th>
<th>Pre-Stimulus</th>
<th>Post-Stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light-Null</td>
<td>Sound-Null</td>
</tr>
<tr>
<td>Correct</td>
<td>761</td>
<td>768</td>
</tr>
<tr>
<td>Incorrect</td>
<td>678</td>
<td>714</td>
</tr>
<tr>
<td>Hit Rate</td>
<td>0.53</td>
<td>0.52</td>
</tr>
<tr>
<td>Z-score</td>
<td>2.2</td>
<td>1.0</td>
</tr>
<tr>
<td>p-value</td>
<td>0.014</td>
<td>0.16</td>
</tr>
</tbody>
</table>

The results here are comparable to using a t test on the means. An important benefit of this technique is resilience to artifacts. In fact, it appears results which were statistically significant with artifact rejection are still significant with artifact rejection turned off as is shown in Table 4 below.

**Table 4: Simulated Real-Time Predictions for Alpha Wave Power Threshold, No Artifact Detection**

<table>
<thead>
<tr>
<th>Comparison Type</th>
<th>Pre-Stimulus</th>
<th>Post-Stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light-Null</td>
<td>Sound-Null</td>
</tr>
<tr>
<td>Correct</td>
<td>939</td>
<td>950</td>
</tr>
<tr>
<td>Incorrect</td>
<td>862</td>
<td>857</td>
</tr>
<tr>
<td>Hit Rate</td>
<td>0.52</td>
<td>0.51</td>
</tr>
<tr>
<td>Z-score</td>
<td>1.8</td>
<td>0.87</td>
</tr>
<tr>
<td>p-value</td>
<td>0.035</td>
<td>0.19</td>
</tr>
</tbody>
</table>

The downside to this type of analysis is that testing models of precognition (such as CIRTS) may require evaluating means using a t test instead.


3) **Mean Potentials Analysis**
Analysis can also be done on mean potentials (a simpler analysis than a frequency analysis). The results are shown in Table 5 below.

### Table 5: T Tests on Mean Potentials

<table>
<thead>
<tr>
<th>Comparison Type</th>
<th>Pre-Stimulus</th>
<th>Post-Stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light-Null</td>
<td>Sound-Null</td>
</tr>
<tr>
<td>T-Value</td>
<td>0.64</td>
<td>0.79</td>
</tr>
<tr>
<td>p-value</td>
<td>0.26</td>
<td>0.22</td>
</tr>
</tbody>
</table>

However, this analysis is not quite appropriate because of interpersonal differences between participants. Therefore, an analysis must be done per participant to obtain event-related potentials (ERPs) as is reported in the next section.

4) Euclidean Distance Classifier

A classification analysis was done using a Euclidean distance algorithm with the same time regions used for the other analyses of this experiment. A description of a Euclidean distance classifier can be found in (Jolij, 2015). Results are shown in Table 6 below.

### Table 6: Euclidean Distance Classifier Technique

<table>
<thead>
<tr>
<th>Comparison Type</th>
<th>Pre-Stimulus</th>
<th>Post-Stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light-Null</td>
<td>Sound-Null</td>
</tr>
<tr>
<td>Correct</td>
<td>669</td>
<td>695</td>
</tr>
<tr>
<td>Incorrect</td>
<td>665</td>
<td>663</td>
</tr>
<tr>
<td>Hit Rate</td>
<td>0.50</td>
<td>0.51</td>
</tr>
<tr>
<td>Z-score</td>
<td>0.11</td>
<td>0.87</td>
</tr>
<tr>
<td>p-value</td>
<td>0.46</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Only post-stimulus measurements were statistically significant using the Euclidean classifier technique. Interestingly, the sound-null differentiation was stronger than for light-null.

EEG experts consulted for this experiment expressed opinions that an alpha wave measurement is the most promising technique for the experimental design and that frequency-based analysis should be the priority. This matches what has been observed in data so far.

C) Analysis of follow-up experiment

The methodology and reporting of results will follow that of subsections B 1 to 4 listed above. By reporting various techniques, other researchers can learn which techniques are promising and which techniques are not. The differences with the follow-up experiment are that: 1) light and sound stimuli are merged into a single stimulus, and 2) participant key press is asked for upon noticing the stimulus (a detailed description is provided in section 10) for a blindly selected set of trials (at 50% probability).

Key press reaction times will be measured in order to see if there is any correlation with any other factors. The same will be done with questionnaire responses.

5. The planned number of participants and the number of trials per participant.
50 participants with 120 trials per participant

6. A statement that the registration is submitted prior to testing the first participant, or indicating the number of participants tested when the registration (or revision to the registration) was submitted.

As of the 28 September 2018 revision 2 out of 50 participants have been tested.

The following additional information is needed for studies that include confirmatory analyses:

7. Specification of all analysis decisions that could affect the confirmatory results, including: the specific statistical test for each confirmatory hypothesis, whether the test is one-sided or two-sided, the criterion for acceptable evidence, any transformations or adjustments to the data, any criteria for excluding or deleting data, and any corrections for multiple analyses. Checklists and examples for registering classical analyses, permutation and bootstrap analyses, Bayesian analyses, and classification analyses are provided in the statistics registration document. (This information can be included in section 4 above for simple experiments.)

As this is an exploratory experiment, analysis is described in section 4.

8. The power analysis or other justification for the number of participants and trials.
This result is calculated based on the pre-stimulus alpha wave power simulated real time analysis without artifact detection. This choice was made because that set up is likely closest to how a proof-based demonstration would be designed.

The hit rate is approximately 0.52 (procedural changes and equipment improvements are expected to cause an increase but this can act as a conservative estimate). For a power of 0.8, 3382 trials are required. 14.625% of data was marked as bad or unusable (due to technical problems) during the first experiment. We expect the rate to be lower for the follow-up experiment as the experimenters are more experienced and the Faraday protection was improved. But assuming that bad data rate, 3962 trials are needed, which is more than covered by taking 120 trials per subject for 50 subjects (only 33 are needed to meet minimum requirements).

9. The methods for randomization in the experiment. If a pseudorandom generator is used, specify how and when the seed(s) will be obtained.

A quantum random number generator (QRNG) is used to select stimuli. It is a Quantis USB type device manufactured by ID Quantique and certified by the government of Switzerland. A QRNG is used instead of an algorithmic pseudorandom number generator (like what is included in Matlab) in order to make it impossible in principle for a participant to infer any algorithmic strategy to guess upcoming stimuli. Because the experimenters themselves do not know the stimulus sequence in advance in essence they are performing a blind experiment.

10. A detailed description of the experimental procedure.
(The following has been adapted from the protocol submitted to the UCSB Human Subjects Committee.)

1) Equipment

A sound isolation booth is used for this experiment to shield against distracting noises. The interior of the sound isolation booth has dimensions of 1 meter by 2 meters. Nickel-copper mesh is affixed to the sides of the sound isolation booth to act as Faraday shielding against electromagnetic noise. The sound isolation booth can always be opened from the inside. No mains power is used in the sound isolation booth or within two meters of it; this is because the AC current flowing through mains lines creates large amounts of 60 Hz noise in EEG data. Therefore, all equipment within the sound isolation booth is powered by battery.

Within the sound isolation booth are a chair, table, and laptop (Lenovo Thinkpad T530). A 7 cm X 10 cm photovoltaic cell is attached to the upper-left hand corner of the laptop monitor to detect when the light stimulus is active. Near the laptop is a buzzer which is controlled by a USB relay connected to the laptop. The laptop is configured such that the monitor and relay can be fully controlled from a desktop computer located outside of the sound isolation booth. During experimentation, when the stimulus start time is
reached, the computer will query the random number generator to select the stimulus and then immediately send the appropriate command for the selected stimulus to the laptop computer. There is also an identical second laptop located outside the sound booth which the participant cannot see. The second laptop is set up identically to the first laptop with a photovoltaic cell attached. The purpose of the second laptop is to act as a control. When a control trial is selected by the random number generator, the second laptop will display a light stimulus which is only detected by the photovoltaic cell, not seen by the participant (this is important to detect whether any electrical artifacts are being transmitted to the EEG system by the photovoltaic measurements).

To collect data a Mobita wireless EEG system is used, sold by BIOPAC Inc. (https://www.biopac.com/product/mobita-32-channel-wireless-eeg-system/). The Mobita consists of a shower cap-like cap with 32 channels attached, an amplifier/transmitter box, a grounding wristband (TMSi Patient Ground Wristband), and associated software ("AcqKnowledge"). We follow the manufacturer's recommendations as closely as possible with regards to equipment use. It is important to note that the Mobita system has some important differences when compared to most common EEG systems:

1) Electrodes are attached using absorbent strips soaked in water. New absorbent strips will be used for each participant. No gel is used to attach electrodes. This makes the experiment much more convenient for participants because they don't have to wash gel off of their heads after the experiment.

2) No impedance measurements are made by the experimenters. The Mobita system automatically drops EEG channels which have bad impedance. In fact, an experimenter attempting to measure impedances beforehand would likely damage the system.

3) The Mobita amplifier unit is a small portable box which can be placed on the table in the sound booth or held in the participant's lap. We don't enforce any requirements on where participants put the unit; as long as it is comfortable, it is acceptable.

The Mobita cap comes in three sizes and can be tightened or loosened to fit a participant's head comfortably, if need be. The Mobita has 32 EEG channels which are used to record data as well as one digital channel which is used to record stimulus start times and type. Data acquisition is done at 1,000 samples per second. Electrodes in the mastoid positions are used as references. A headband is used to secure the mastoid electrodes. The ground wire is attached to a wristband which the participant wears. During data collection the experimenters monitor data acquisition in real time from a lab computer located outside of the sound isolation booth.

The Mobita's digital channel is used to measure voltage across the buzzer (for sound stimuli), the photovoltaic cell on the participant's monitor (for light stimuli), and the photovoltaic cell on the hidden laptop (for null stimuli). The digital channel gives an accurate reading of the exact time the stimulus begins. In a precognition experiment it is extremely important that data not be confounded by data collected after the stimulus starts; therefore, careful recording of stimulus start times is essential.
Finally, participants are given an alert button to hang on a lanyard around their neck and instructed if to press it if they feel anxiety or if something is wrong. Pressing the button rings a doorbell-like sound in a device (Anpress Wireless Alarm System for Home Safety) near the experimenters and indicates the experiment is to be interrupted and possibly terminated. If the experimenters hear the alarm, they must terminate data collection immediately and open the sound isolation booth to ask about the participant's situation.

2) Procedure

a) Preparation

A participant who shows up at the lab is first greeted and led to a couch to sit down and read the consent form. Experimenters answer any questions participants might have about the experiment. If the participant agrees to the procedure and signs the consent form, they will also be asked to fill out a questionnaire asking for age, gender, and meditation experience. A participant identification number (PIN) is generated using a random number generator (RNG) to protect the participant's identity during analysis and publication. The PIN is used to mark the participant's questionnaire and physiological data. A participant's name will only appear on the signed consent form and the UCSB payment log; all analysis and publications will use only the PIN to identify participants.

The participant is then given an alert button to wear on a lanyard and is instructed to press it if the experiment needs to be interrupted for any reason, including if the participant is feeling anxiety inside of the sound isolation booth.

The participant is led to the sound isolation booth and told to sit down and relax for two minutes with the door closed. This is primarily a check to see if the participant has any claustrophobic reactions inside the sound isolation booth. After the two minutes, the sound isolation booth is opened and the participant is asked if they felt anxiety while waiting inside. If the answer is "yes", the participant will be dismissed from the experiment with full compensation. During the two-minute interval, one of the experimenters makes final preparations with the EEG cap by ensuring all electrodes are properly wet to ensure conductivity.

The cap will then be fitted on the participants head and the participant instructed to put on the grounding wristband. The experimenters will begin data collection and check for bad channels using the AcqKnowledge software because unconnected and high impedance channels are zeroed out in the display. Cap adjustments will be made to obtain all channels if possible. The participant will be asked if the cap is still comfortable after adjustments. If it is impossible to obtain almost all of the channels comfortably, the experimental session will be cancelled at this point and the participant given full compensation.

b) Experimental Trials
While an EEG is being recorded the subject will sit in front of the laptop. There is mild white noise to block out any distracting sounds not protected by the sound isolation booth. These measures are necessary because a neighboring office sometimes creates distracting sounds which can be heard in the laboratory area. With the sound isolation booth and white noise, distracting sounds are no longer perceivable.

The stimulus lasts 0.6 seconds and is a combined sound (1) and light (2) stimuli.

1) The sound stimulus was measured to have an intensity range of 78.3 to 89.7 dBa (decibels, A-weighted) at ear position when sitting at the table with systematic measurement errors giving a wider possible range of 73.1 to 90.2 dBA. The background white noise level when no stimulus is occurring was measured to be approximately 32.4 to 34.7 dBA. The decibel level is believed to be safe due to the fact that the buzzer sound is short and very intermittent (0.6 seconds duration with a minimum 18 seconds between beeps).

2) The light stimulus is created by turning on a laptop monitor for 0.6 seconds to display a white screen. Our measurements indicated a wide possible range of luminous flux from 9 to 37 lux, depending on the height of the participant and how far away they lean back or forward from the monitor. But most measurements were in the 10 to 20 lux range. The booth is dark when there is no light stimulus (0 lux) to increase contrast with the light.

There are 18 to 22 second gaps between stimuli. Compared with the previous light/sound EEG experiment register by this lab, the two stimuli are combined into one, a possible key press acknowledgement is tested to see whether it adds to participants' attentiveness of the stimulus, and the experiment is accelerated by fifty percent. Key presses are required on a per-session basis. The participant will either see a red start screen (no key press) or a green start screen (key press) with instructions at the beginning of the experiment to tell whether a key press will be required.

30 stimuli are presented per session.

Each session will last approximately 10 minutes. Each participant will do 4 sessions with short breaks in between. The breaks are an opportunity to stretch or have a drink of water. Participants must put a mark on the questionnaire indicating how alert they were feeling during the experiment.

A major advantage of the Mobita EEG system is the relatively rapid preparation time since no gel needs to be applied or manual impedance measurements made. Therefore, approximately 20 to 30 minutes will be taken by the reading of consent form, claustrophobia test, and preparation of the EEG headcap. Data taking will last approximately 50 minutes (assuming 3 minute breaks between sessions).
c) End of Experiment

At the end of the experiment or if the experiment was terminated early for any reason, participants will be given a copy of the consent form signed by either the P.I. or the most senior experimenter present if the P.I. is unavailable. After the participant leaves, the two experimenters will both sign the questionnaire and copy the data onto thumb drives.

Participants will be offered bottled water during the experimental breaks since the laboratory site does not have a public water fountain.

3) Research Integrity Protections

To prevent meta-analyses from being biased due to experiments with multiple unreported analyses ("p-hacking") experiments can be divided into two types, exploratory experiments where post-hoc modifications to analysis procedures are allowed and confirmatory experiments where a full detailed procedure, including the full analysis method, is preregistered in advance and no modifications are allowed after the start of data collection. This light/sound experiment (both variants) will be preregistered as an exploratory experiment because the duration of the pre-stimulus effect is not yet known. If a promising avenue of research appears in the exploratory data, a confirmatory experiment will be designed and preregistered.

50 subjects have been tested under the previous version of the experiment, out of a goal of 50 subjects. It appears that alpha wave suppression before a light stimulus is the most promising line of research. Therefore, the current experiment will be performed on an additional 50 subjects with modifications intended to increase effect size and increase the amount of data available for t tests by a factor of 2.25.

In order to deter fraudulent tampering with the data, a two-person control system will be utilized whereby two experimenters must be present at all times during data collection. Furthermore, after each participant is tested each experimenter shall copy the raw data collected to the experimenter's own thumb drive, to be kept with the experimenter (not stored at the lab). This is to prevent any one person from modifying, replacing, or deleting data and also provides a useful backup in case data is lost on the laboratory computer. The experiment program will also be uploaded to experimenters' thumb drives at the beginning of each shift, again to deter tampering with the software.

Raw data, experiment software, and analysis software will be made available to other scientists upon request.

4) Analysis

Both time-frequency and event-related potential (ERP) analyses will be performed. The time-frequency analysis uses 1 second Hann windows to find alpha wave power. Based on feedback from other EEG researchers, it is believed that a time-frequency analysis of alpha waves will be most effective in predicting stimulus types for this experiment.
Interpersonal differences between each subject will make an ERP analysis more difficult since no probe stimulus is used (unlike in the face detection experiment protocol also submitted by this laboratory). Both pre- and post-stimulus data will be analyzed for this experiment. A band-pass filter will be used with range 0.5 to 40 Hz. The lower limit is set to 0.5 Hz due to the manufacturer’s recommendation for the Mobita water-based cap.

Automated artifact rejection will be used primarily to avoid distortions caused by sudden impedance changes (otherwise known as "electrode pops"). Epochs with potentials which deviate beyond a threshold from the mean will be marked as having an artifact. The long epochs used in this experiment mean that a relatively large fraction of trials will be marked as having artifacts. For the primary analysis, only the pre-stimulus region will be used for artifact rejection. However, to test theories such as time-symmetry between pre- and post-stimulus regions artifact rejection will be extended to both pre- and post-stimulus regions.

If there is an equipment failure or failure to follow procedure by either experimenters or participant, then a data block can be marked as “bad/unusable” but only before analysis and only upon agreement of both experimenters present. Data marked bad are not deleted in case there is an audit of the data to see if there was bias in marking data as bad.

The experiment is being preregistered as exploratory to allow search for new effects and to determine the time duration of any pre-stimulus effect.
Appendix A: Consent Form

Research Participant’s Consent Form

Principal Investigator:

Dr. Stephen Baumgart (Assistant Project Scientist, University of California at Santa Barbara)
Phone: (408) 455-0752
stephen.baumgart@psych.ucsb.edu

You have been asked to participate in an experiment that is part of a research project about the brain's possible precognitive response to a light and sound stimulus occurring. This research may lead to a better understanding of human intuition. Dr. Stephen Baumgart is the principal investigator of this experiment.
In this experiment, you will sit passively in a chair while being subjected to sound and light stimuli. We will provide you with specific instructions prior to the experiment. During the session we will be recording EEG data. Careful measurements of your responses will be used to relate brain activity with selected stimuli. To ensure that we can record your brain activity accurately the following steps will be taken:

1. You will sit in a chair in a dark room of dimensions 1 meter X 2 meters (roughly 3 feet X 6 feet) with white noise in the background. Experimenters cannot see you inside the room but you can press the alert button given to you if you need help.

2. Before the experiment begins, you will sit in the chair for two minutes. If you feel a sense of panic during these two minutes, please tell an experimenter and we will terminate the experiment for full compensation.

3. An EEG headcap will be placed on your head and adjusted so that it fits comfortably. We will run a diagnostic program to test the connections and adjust the headcap as needed. If the headcap feels too tight or too loose or in any way uncomfortable, please tell the experimenter – we can try a different cap size or re-adjust the tightness. A headband will be used to hold some of the electrodes in place. If the headband feels uncomfortable at any point during the experiment, please tell the experimenters. If no headcap is available which can comfortably fit your head, the experiment will be terminated and you will receive full compensation.

4. A laptop will sit on a table immediately in front of the chair. You will roll the chair up such that you can place your hands on the table.

5. Every 18 to 22 seconds one of these two events (stimulus) will happen completely randomly:
   a) LIGHT+SOUND: A computer screen will briefly (~0.6 seconds) flash to white and a buzzer will ring at the same time. The sound may startle and may be mildly uncomfortable.
   b) NOTHING: Nothing happens.

If you saw the **GREEN** start screen before the experimental run: press **any key** on the keyboard immediately when the light+sound stimulus happens.
If you saw the **RED** start screen before the experimental run: you shouldn’t do anything when the stimulus happens, just **sit still**.

6. You must **sit still** as much as possible in order to keep the EEG electrodes in the same place.

7. We will review ways to interrupt the experiment or stop early. You can:
   
a) Press the alert button (You will be given this before data-taking begins. The button is worn using a lanyard).
   
b) Open the door to your right and say “stop experiment” (or anything similar).

If, at any time, you start to feel panic or anxiety (or any other discomfort) please use either of the above methods to halt the experiment.

Experimental runs will last approximately 10 minutes each. Each participant will be involved in 4 runs. The experimenters will check on you between runs. If the EEG cap is becoming uncomfortable, we can extend the break and take off the cap temporarily. We also ask you to complete a brief questionnaire before the experiment and between each 10-minute run. Before the experiment you will fill out gender, age, and meditation experience. You may leave any response blank if you so choose. Between each 10-minute run, you will mark your alertness level from 1 to 10.

The experiment will take approximately a maximum of 1 hour 30 minutes (preparation, experimental runs, and breaks) and you will receive $20 in exchange for your participation. Aside from this compensation, your participation in this study will likely be of no direct benefit to you. If technical problems arise and the experiment is taking longer to complete, you will be offered the option of staying longer for an extra $20 in compensation. Taking this option is completely voluntary and has no effect on receiving the first $20.

Your participation in this research will be kept strictly confidential. To help preserve your anonymity, a randomly generated Participant ID code will be used instead of your name when data is stored and analyzed. Your name will not be published and will only be used on this form and the payment log returned to UCSB. Any information that you provide will be available only to members of the research team for approved research purposes.
If you feel uncomfortable at any time during the experiment please inform us immediately. Participation in this study is voluntary and you are free to discontinue your participation at any time. If you decide not to participate, your refusal will involve no penalty and you will still receive full compensation. The experimenters may also terminate the experiment at any time (generally if the equipment doesn’t work). If you have any questions about this research or concerns about your participation, please contact Dr. Stephen Baumgart.

It is known that this experiment may pose risk to people with claustrophobia and photosensitive epilepsy. If you suspect that you have these risk factors, you must not participate in the experiment. Please review the full exclusions list below.

Exclusions:
If you have any of the following, you must not participate in this experiment:

1) PTSD
2) Claustrophobia
3) Panic disorder
4) Serious neurological disorder
5) Diagnosis of epilepsy
6) History of migraines
7) Ever had a seizure due to flashing lights

You will receive full compensation if you must withdraw now due to any of these reasons.

If you have any questions, concerns, complaints, or side-effects from participation in this research and wish to contact the laboratory, please contact TANC Lab at info@tanclab.org or by mail to 81 David Love Place, Suite D, Santa Barbara, CA 93117.

Alternatively, the Independent Review Board can be contacted. If you have any questions regarding your rights and participation as a research subject, please contact the Human Subjects Committee at (805) 893-3807 or hsc@research.ucsb.edu. Or write to the University of California, Human Subjects Committee, Office of Research, Santa Barbara, CA 93106-2050
If you are injured as a direct result of research procedures, you will receive reasonably necessary medical treatment at no cost. The University of California does not provide any other form of compensation for injury.

PARTICIPATION IN RESEARCH IS VOLUNTARY. YOUR SIGNATURE BELOW WILL INDICATE THAT YOU HAVE DECIDED TO PARTICIPATE AS A RESEARCH SUBJECT IN THE STUDY DESCRIBED ABOVE. YOU WILL BE GIVEN A SIGNED AND DATED COPY OF THIS FORM TO KEEP.

Your signature below indicates that you consent to participate in this study.

_________________________  ______________________  __________
(Participant signature)  (Print Name)  (Date)

_________________________  __________
(Experimenter signature)  (Date)
Appendix B: Questionnaire

Experiment Questionnaire

Experiment Type (circle one): pilot / formal

Participant Identification Number: ________________

Gender (circle one): M / F  Age: ________________

Estimated Hours of Lifetime Meditation Experience: ________________

How alert did you feel during experimental trials? Place an “X” in the appropriate box for each session.

<table>
<thead>
<tr>
<th>Session</th>
<th>Not at all alert →→→→→→→→→→→→ Very alert</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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<tr>
<td>2</td>
<td></td>
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<tr>
<td>3</td>
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<td>4</td>
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</tbody>
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Two-Person Control (to be filled out by experimenters at end of experiment):

“I testify that the experiment was performed as planned without fraud.”

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Printed Name</th>
<th>Signature</th>
</tr>
</thead>
</table>