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This project is currently pending registration, awaiting approval from project administrators. This registration will be final and enter the embargo period when all project administrators approve the registration or 48 hours pass, whichever comes first. The embargo will keep the registration private until the embargo period ends.

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Study Information

Title

Provide the working title of your study. It may be the same title that you submit for publication of your final manuscript, but it is not a requirement.

Are auditory awareness negativity and late positivity affected by a response requirement?

Authors

Stefan Wiens, Rasmus Eklund, Billy Gerdfeldter

Description

Please give a brief description of your study, including some background, the purpose of the study, or broad research questions.

In a previous pre-registered study, we discovered the auditory awareness negativity (AAN) (Eklund & Wiens, 2019; https://doi.org/10.1016/j.concog.2019.03.008). The design of the present study is similar to that in the previous study. The main difference is that we test if the AAN and the late positivity are affected by response requirements (Koivisto, Salminen-Vaparanta, Grassini, & Revonsuo, 2016; https://doi.org/10.1016/j.neuropsychologia.2016.02.024).

The main research question is:
Are auditory awareness negativity and late positivity affected by a response requirement?

Hypotheses

List specific, concise, and testable hypotheses. Please state if the hypotheses are directional or non-directional. If directional, state the direction. A predicted effect is also appropriate here. If a specific interaction or moderation is important to your research, you can list that as a separate hypothesis.

The primary hypotheses are H1a and H2a.

H1: For the early interval, we predict a negative amplitude difference for aware trials minus unaware trials (as described below). We refer to this negative difference as the auditory awareness negativity (AAN).
H1a: This negativity does not differ between the response ERP and the non-response ERP.

H1b: This negativity is observed for the response ERP.
H1c: This negativity is observed for the non-response ERP.

H2: For the late interval, we predict a positive amplitude difference for aware trials minus unaware trials (as described below). We refer to this positive difference as the late positivity (LP).
H2a: This positivity is larger for the response ERP than the non-response ERP.
H2b: This positivity is observed for the response ERP.
H2c: This positivity is observed for the non-response ERP.

Design Plan

Study type

Please check one of the following statements

Experiment - A researcher randomly assigns treatments to study subjects, this includes field or lab experiments. This is also known as an intervention experiment and includes randomized controlled trials.

Blinding

Blinding describes who is aware of the experimental manipulations within a study. Mark all that apply.

No blinding is involved in this study.

Is there any additional blinding in this study?

Blinding (Other)

Inspection of the EEG data is blind to the condition of individual trials and thus, this inspection avoids bias.

Study design

Describe your study design. Examples include two-group, factorial, randomized block, and repeated measures. Is it a between (unpaired), within-subject (paired), or mixed design? Describe any counterbalancing required. Typical study designs for observation studies include cohort, cross sectional, and case-control studies.

Within-subjects (repeated measures) design.

Stimuli
A sinusoidal 100-ms tone (f = 1000 Hz) with 5-ms fade.

Procedure
Subjects perform a detection task that comprises 600 trials (480 critical, 60 control, and 60 catch). Critical trials contain a tone at the individual auditory awareness threshold (see below), control trials contain a tone at 10 dB above the individual awareness threshold, and catch trials do not contain a tone.

The trials are divided into six blocks. Each block comprises 100 trials (80 critical, 10 control, and 10 catch). There is a short break between blocks. For each subject and block, the order of critical, control, and catch trials is randomized within each set of 10 trials (8 critical, 1 control, and 1 catch).

On each trial, a black fixation cross (0.5 visual degrees) is shown for 500 ms. In critical trials, a tone is played 500 ms after trial onset (at the offset of the fixation cross). After the offset of the fixation cross, subjects have three seconds to respond whether or not they heard a soft tone. Before each block, subjects receive one of two instructions. In the respond-if-aware condition, they are instructed to press the spacebar if they heard a soft tone (and not to press the spacebar if they did not hear a soft tone). In the respond-if-unaware condition, they are instructed to press the spacebar if they did not hear a soft tone (and not to press the spacebar if they did hear a soft tone). The instructions alternate over blocks, and the starting condition alternates over consecutive subjects

Before the experiment, subjects familiarize themselves with the task by listening for a tone after the fixation cross disappears. This short practice session is done with clearly audible tones. Then, interleaved staircases are used to calibrate the tone to a level that each individual subject reports as aware on approximately 50% of the trials (individual auditory awareness threshold). The staircase procedure consists of three interleaved staircases (trials are presented in random order). One staircase starts at 4 dB. The other two staircases start at 20 dB above and below. The staircase procedure is as follows: If the subject reports hearing a tone, the level decreases. If the subject reports not hearing a tone, the level increases. For each staircase, reversal steps are 8, 8, 4, 4, 2, and 2 for the first six reversals, and 1 dB for the subsequent reversals. Every separate staircase stops after 12 reversals.

After the calibration, a validation block is run with 50 critical trials. The level of the critical tone in the validation procedure is determined from both the convergence of the three staircases (from visual inspection) and a psychometric response function. If the subject is not close to 50% of tones rated as aware, the tone level is adjusted by using a psychometric response function that estimates their threshold. Validations are repeated until we are satisfied that we have a good approximation of their awareness threshold. If the aware criterion from validations continuously deviates from the 50% threshold, new calibrations are run. If the threshold is not found after five blocks of calibration/validation, the subject is tested at a level that seems most

promising in capturing the individual auditory awareness threshold.

EEG recording:
EEG data are recorded from 64 electrodes at standard 10/20 positions and two additional electrodes (tip of the nose, and one on the cheek) with an Active Two BioSemi system (BioSemi, Amsterdam, Netherlands). The 64 standard 10/20 positions are recorded with pin electrodes in a 64-electrode EEG cap. The tip of the nose and the cheek are recorded with flat electrodes attached with adhesive disks. Two additional, system-specific positions are recorded with pin electrodes in the EEG cap. The CMS (between PO3 and POz) serves as the internal reference electrode, and the DRL (between POz and PO4) as the ground electrode. Data are sampled at 1024 Hz and filtered with a hardware low-pass filter at 104 Hz, and a software high-pass filter at 1 Hz.

EEG analysis:
Individual EEG electrodes are visually inspected to detect noisy electrodes. Any noisy electrodes are interpolated (spherical spline interpolation) from neighboring electrodes. However, if more than two noisy electrodes are neighbors and the total number of noisy electrodes exceeds five, the subject is excluded. Eye-blinks is corrected with ICA.

For all trials, epochs are extracted from 100 ms before tone onset to 600 ms after. Electrodes are referenced to the tip of the nose. Each epoch is baseline corrected with the mean of the 100-ms interval before tone onset. For each participant, amplitude ranges (i.e., max minus min) within individual epochs are extracted, and the distribution of these is visually inspected to exclude apparent outliers. Cutoffs are adjusted individually to retain as many trials as possible while reducing the potential effects of outliers. Inspection is blind to the condition (critical, control, or catch) and awareness rating of individual trials to avoid bias.

no file selected

Randomization

If you are doing a randomized study, how will you randomize, and at what level?

For each subject, trial order is randomized within each set of 10 trials (8 critical, 1 control, and 1 catch).

Sampling Plan

Existing Data

Preregistration is designed to make clear the distinction between confirmatory tests, specified prior to seeing the data, and exploratory analyses conducted after observing the data. Therefore, creating a research plan in which existing data will be used presents unique challenges. Please select the description that best describes your situation. Please see https://cos.io/prereg for more information.

Registration prior to creation of data

Explanation of existing data

If you indicate that you will be using some data that already exist in this study, please describe the steps you have taken to assure that you are unaware of any patterns or summary statistics in the data. This may include an explanation of how access to the data has been limited, who has observed the data, or how you have avoided observing any analysis of the specific data you will use in your study.

no data exist

Data collection procedures

Please describe the process by which you will collect your data. If you are using human subjects, this should include the population from which you obtain subjects, recruitment efforts, payment for participation, how subjects will be selected for eligibility from the initial pool (e.g. inclusion and exclusion rules), and your study timeline. For studies that don't include human subjects, include information about how you will collect samples, duration of data gathering efforts, source or location of samples, or batch numbers you will use.

Subjects are recruited from local universities in Stockholm and through online billboards. Recruitment stipulates a target age range of 18 to 40 years, no history of neurological diseases, normal or corrected to normal vision, and normal hearing. Subjects are compensated with a gift voucher. Before starting the experiment, subjects are asked for their informed written consent.

In the final sample, only subjects between the ages of 18 to 40 are included. Subjects should have no history of neurological diseases. Normal or corrected-to-normal vision and normal hearing are necessary. These questions are assessed by self-report.

no file selected

Sample size

Describe the sample size of your study. How many units will be analyzed in the study? This could be the number of people, birds, classrooms, plots, interactions, or countries included. If the units are not individuals, then describe the size requirements for each unit. If you are using a clustered or multilevel design, how many units are you collecting at each level of the analysis?

We test between 20 and a maximum of 50 retained subjects (see stopping rule).

Sample size rationale

This could include a power analysis or an arbitrary constraint such as time, money, or personnel.

We start with 20 subjects and then continue to recruit subjects until we reach a minimum Bayes Factor, a maximum of 50 retained subjects, or the end of June 2019 (see stopping rule).

Stopping rule

If your data collection procedures do not give you full control over your exact sample size, specify how you will decide when to terminate your data collection.

We recruit subjects until we retain a minimum of 20 subjects after data exclusion. Recruitment ends if the Bayes Factor (BF) exceeds 3 or is below 1/3 for each hypothesis. Otherwise, a few subjects are recruited and added to the sample. Irrespective of the BF, recruitment ends at the maximum of 50 retained subjects and no later than the end of June 2019.

Variables

Manipulated variables

Describe all variables you plan to manipulate and the levels or treatment arms of each variable. This is not applicable to any observational study.

Critical trials:
Tone level is calibrated to the individual auditory awareness threshold (see Procedure).

Control trials:
Tone level is 10 dB above the individual auditory awareness threshold.

Catch trials:
No tone.

no file selected

Measured variables

Describe each variable that you will measure. This will include outcome measures, as well as any predictors or covariates that you will measure. You do not need to include any variables that you plan on collecting if they are not going to be included in the confirmatory analyses of this study.

Awareness:
For each trial, subjects rate their subjective auditory awareness of a tone. In the respond-if-aware condition, subjects are instructed to report awareness by pressing the spacebar (and report unawareness by not pressing the spacebar). In the respond-if-unaware condition, subjects are instructed to report unawareness by pressing the spacebar (and report awareness by not pressing the spacebar).

Electroencephalography (EEG) from 66 channels.

no file selected

Indices

If any measurements are going to be combined into an index (or even a mean), what measures will you use and how will they be combined? Include either a formula or a precise description of your method. If you are using a more complicated statistical method to combine measures (e.g. a factor analysis), you can note that here but describe the exact method in the analysis plan section.

The EEG is processed to compute event-related potentials (ERPs) to the different trials (critical, control, and catch trials). For the hypotheses, four ERPs are of main relevance. These ERPs are derived from the critical tones (i.e., tones that are presented at the individual awareness threshold, see Procedure) in the respond-if-aware condition and the respond-if-unaware condition.

The aware response ERP is the mean ERP to critical tones that are rated as aware by pressing spacebar in the respond-if-aware condition.

The unaware response ERP is the mean ERP to critical tones that are rated as unaware by pressing spacebar in the respond-if-unaware condition.

The aware non-response ERP is the mean ERP to critical tones that are rated as aware by not pressing spacebar in the respond-if-unaware condition.

The unaware non-response ERP is the mean ERP to critical tones that are rated as unaware by not pressing spacebar in the respond-if-aware condition.

From these ERPs, two difference ERPs are computed:
Response ERP: aware response ERP minus unaware response ERP.
Non-response ERP: aware non-response ERP minus unaware non-response ERP.

For the early interval (H1), mean amplitudes are calculated across 15 electrodes (C3, C1, Cz, C2, C4, CP3, CP1, CPz, CP2, CP4, P3, P1, Pz, P2, and P4) in the interval between 160 and 260 ms after tone onset.

For the late interval (H2), mean amplitudes are calculated across 15 electrodes (C3, C1, Cz, C2, C4, CP3, CP1, CPz, CP2, CP4, P3, P1, Pz, P2, and P4) in the interval between 350 and 550 ms after tone onset.

no file selected

Analysis Plan

Statistical models

What statistical model will you use to test each hypothesis? Please include the type of model (e.g. ANOVA, multiple regression, SEM, etc) and the specification of the model (this includes each variable that will be included as predictors, outcomes, or covariates). Please specify any interactions, subgroup analyses, pairwise or complex contrasts, or follow-up tests from omnibus tests. If you plan on using any positive controls, negative controls, or manipulation checks you may mention that here. Remember that any test not included here must be noted as an exploratory test in your final article.

The primary hypotheses are H1a and H2a.

H1a: For the early interval, the mean amplitude does not differ between the response ERP and the non-response ERP (BF from a Bayesian one-sample t test).
H1b: For the early interval, the mean amplitude for the response ERP is less than zero (BF from a Bayesian one-sample t test).
H1c: For the early interval, the mean amplitude for the non-response ERP is less than zero (BF from a Bayesian one-sample t test).

H2a: For the late interval, the mean amplitude is larger for the response ERP than the non-response ERP (BF from a Bayesian one-sample t test).
H2b: For the late interval, the mean amplitude for the response ERP is greater than zero (BF from a Bayesian one-sample t test).
H2c: For the late interval, the mean amplitude for the non-response ERP is greater than zero (BF from a Bayesian one-sample t test).

no file selected

Transformations

If you plan on transforming, centering, recoding the data, or will require a coding scheme for categorical variables, please describe that process.

none

Inference criteria

What criteria will you use to make inferences? Please describe the information you'll use (e.g. specify the p-values, Bayes factors, specific model fit indices), as well as cut-off criterion, where appropriate. Will you be using one or two tailed tests for each of your analyses? If you are comparing multiple conditions or testing multiple hypotheses, will you account for this?

For all hypotheses, a Bayes Factor (BF) is computed with the alternative hypothesis modeled as a uniform distribution with the following limits (−1 to +1 μV). We use BF greater than 3 or less than 1/3 as the cut off. We use Aladins R scripts (Wiens, 2017, https://doi.org/10.17045/sthlmuni.4981154) to compute the BF. In the analyses, the likelihood is modeled as a t distribution. We also report the 95% credible intervals (with an uninformed prior) for the effects of interest.

Data exclusion

How will you determine which data points or samples if any to exclude from your analyses? How will outliers be handled? Will you use any awareness check?

If subjects have noisy EEG electrodes, these are interpolated from neighboring electrodes. However, if more than two noisy electrodes are neighbors and the total number of noisy electrodes exceeds five, the subject is excluded. This decision is made by viewing the raw EEG before any computation of ERPs.

Missing data

How will you deal with incomplete or missing data?

If subjects have noisy EEG electrodes, these are interpolated from neighboring electrodes. However, if more than two noisy electrodes are neighbors and the total number of noisy electrodes exceeds five, the subject is excluded. This decision is made by viewing the raw EEG before any computation of ERPs.

Exploratory analysis

If you plan to explore your data set to look for unexpected differences or relationships, you may describe those tests here. An exploratory test is any test where a prediction is not made up front, or there are multiple possible tests that you are going to use. A statistically significant finding in an exploratory test is a great way to form a new confirmatory hypothesis, which could be registered at a later time.

Other

Other

If there is any additional information that you feel needs to be included in your preregistration, please enter it here. Literature cited, disclosures of any related work such as replications or work that uses the same data, or other context that will be helpful for future readers would be appropriate here.