This registration is a frozen, non-editable version of this project (/muaj4/)

This registration is currently embargoed. It will remain private until its embargo end date, Friday, Jun 29, 2018.

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Study Information

Title

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

Does visual load decrease the auditory N1 and frequency MMN?

Authors

The author who submits the preregistration is the recipient of the award money and must also be an author of the published manuscript. Additional authors may be added or removed at any time.

Stefan Wiens, Malina Szychowska, Rasmus Eklund, Erik van Berlekom

Research Questions

Please list each research question included in this study.

Does visual load decrease the auditory N1 and frequency MMN?

Hypotheses

For each of the research questions listed in the previous section, provide one or multiple specific 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.

Primary hypotheses:
H1: The auditory N1 to pitch change is smaller (i.e., less negative) during high than low load.
H2: The frequency MMN is smaller (i.e., less negative) during high than low load.

Secondary hypotheses:
H3: The difference scores of load (high minus low) for N1 and MMN are negatively correlated with working memory capacity (WMC). For details, see Analysis plan.
H4. The auditory P3a to deviants is larger during low than high load.
H5: The difference scores of load (high minus low) for P3a are positively correlated with WMC. For details, see Analysis plan.
H6. Reaction times to visual targets are longer for deviants than standards, and this difference is smaller during high than low load.
H7. The difference scores of load (high minus low) for reaction time (see H6) are positively correlated with WMC.

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 do not hesitate to contact us if you have questions about how to answer this question (prereg@cos.io).

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. The purpose of this question is to assure that the line between confirmatory and exploratory analysis is clear.

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.

a. 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 either with one movie voucher or with course credits. Before starting the experiment, subjects are asked for their informed written consent.
b. 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.

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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 subjects and however many we can recruit until the end of April 2018 (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 until we reach a minimum Bayes Factor or the end of April 2018 (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 will 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 the primary hypotheses. Otherwise, a few subjects are recruited and added to the sample. Irrespective of the BF, recruitment ends at the maximum of 60 retained subjects and no later than the end of April 2018.

Variables

Manipulated variables

Describe all variables you plan to manipulate and the levels or treatment arms of each variable. For observational studies and meta-analyses, simply state that this is not applicable.

a. Two Visual Load conditions (low load = subjects respond to red crosses, and high load = subjects respond to upright yellow and inverted green crosses)—within-subjects variable.
b. Two Tone conditions (oddball descending and random control)—within-subjects variable.

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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.

a. Event-related potentials (ERPs): auditory N1, MMN, and P3a
b. Reaction time to targets
c. Working memory capacity (WMC)

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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 your 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.

a. For the N1, mean amplitudes for relevant electrodes and interval (see ERPs in Study design) are computed across trials in the random control condition, separately for each of the two load conditions.
b. For the MMN, mean amplitudes for relevant electrodes and interval (see ERPs in Study design) are computed across deviant tones in the oddball condition and across control tones in

the random control condition, separately for each of the two load conditions. In each load, the MMN is obtained by subtracting the response to the deviant tones in the oddball condition by the response to the control tones in the random control condition.
c. For the P3a, amplitudes for relevant electrodes and interval (see ERPs in Study design) are computed across deviant tones in the oddball condition.
d. Working memory capacity (WMC) is defined as the partial credit unit score (PCU) from an OSPAN working memory test.

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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.

Research personnel who interact directly with the study subjects (either human or non-human subjects) will not be aware of the assigned treatments.,Research personnel who analyze the data collected from the study are not aware of the treatment applied to any given group.

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.

a. Within-subjects design with two factors:
Visual Load (low and high), and Tone (oddball and random). The four combinations are presented in separate blocks.

b. Stimuli
Tones: 500, 550, 605, 666, 732, 805, 886, and 974 Hz (100-ms duration at circa 70 dB SPL)
Crosses: red, blue, yellow, green, and violet in upright and inverted orientation

c. Procedure.
Participants perform a visual search task on a sequence of crosses. On each 500-ms trial, a 100-ms cross is shown in one of five colors (red, blue, yellow, green, or violet) in one of two orientations (upright or inverted). Concurrently, a 100-ms tone is presented. Subjects are instructed to ignore the tones while responding to a target cross (as defined in the Load conditions below). Each block consists of 360 trials (* 0.5 s = 3 min), and the target is presented on 20% of the trials. Each block is one of the combinations of Tone (2 levels) and Visual Load (2 levels), as defined below (e.g., oddball and low load). For each subject, these four conditions are presented twice (in random order within each set of four). Thus, there are eight blocks. Afterwards, subjects perform a working memory capacity test (OSPAN).

d. The two visual load conditions are as follows:
In low visual load, subjects respond to any red cross (upright and inverted). In high visual load, subjects respond to upright yellow and inverted green crosses (conjunction search). Targets occur on 20% of the trials (for both the 500-Hz tone and the remaining tones). There are between 2 and 6 non-target trials between two consecutive target trials.

Each block consists of 72 targets and 288 non-targets (360 trials). Separately for targets and non-targets, the various combinations of color and orientation are presented equally often and in random order. The additional 7 non-target trials before each block are drawn randomly from the 8 possible non-target combinations.

e. The two Tone conditions are as follows:
In the oddball descending condition, a 500-Hz tone (deviant) is presented on 1/8th (12.5%) of the trials and a 550-Hz tone (standard) on the remaining trials. The order is random with the restriction that there are at least three standards before the next deviant. Before the occurrence of the first 500-Hz tone (i.e., deviant) per block, 7 standard trials are presented (but excluded in the data analysis).

In the random control condition, there are eight tones (500, 550, 605, 666, 732, 805, 886, and 974 Hz), and the order of the tones is randomized within each set with the restriction that between sets, no frequency is presented twice in a row. Before the occurrence of the first 500-Hz tone per block, one set without the 500-Hz tone is presented in random order (but excluded in the data analysis).

f. EEG recording.
EEG data are recorded from six electrodes at standard 10/20 positions (Fpz, Fz, Cz, Pz, P9, and P10) and two additional electrodes (tip of nose, and one on the cheek) with an Active Two BioSemi system (BioSemi, Amsterdam, Netherlands). Fpz, Fz, Cz, Pz, P9, and P10 are recorded with pin electrodes in a 64- electrode EEG cap; and the tip of the nose and the cheek are recorded with flat electrodes attached with adhesive disks. Because the left and right mastoids (M1 and M2) are not available in the EEG cap, we use the nearby positions P9 and P10 for convenience. Two additional, system-specific electrodes are recorded with pin electrodes in the

EEG cap. The CMS (between PO3 and POz) serves as the internal reference electrode, and DRL (between POz and PO4) as the ground electrode. Data are sampled at 1024 Hz and filtered with a software high-pass filter at 0.1 Hz and a hardware low-pass filter at 104 Hz.

g. EEG analysis.
Epochs are extracted for all trials (i.e., including target trials) from 100 ms before tone onset to 400 ms after tone onset for N1 and MMN analyses. For P3a analyses, epochs are extracted from deviant trials in the oddball condition from 100 ms before tone onset to 500 ms after. Tone onset is identified with a Stimtracker (Cedrus). Fpz, Fz, Cz, Pz, and the mastoids (M1 and M2) are referenced to the tip of the nose, and Fpz is also referenced to the cheek electrode (for vertical and horizontal EOG). Each epoch is baseline corrected with 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 of individual trials (i.e., tone, load, and target) and thus, this inspection avoids bias.

h. ERPs.
Mean amplitudes are extracted for the auditory N1, MMN and P3a. The first two are computed across Fz and Cz electrodes for each participant. For the N1, mean amplitudes are computed for the interval at 90 ms +/- 15 ms after tone onset across all trials in the random control condition, separately for low and high load. For the MMN, mean amplitudes are computed for the interval at 150 ms +/- 25 ms after onset of the 500-Hz tone, separately for each of the four conditions (i.e., random and oddball condition combined with low and high load). For the P3a, amplitudes are computed across Cz and Pz electrodes for each participant. Mean amplitudes are computed for the interval at 400 ms +/- 100 ms after onset of deviants in the oddball condition, separately for low and high load.

i. Working memory capacity (WMC)
After completing the load tasks, the subjects perform a working memory capacity test (OSPAN). The test consists of a sequence of letters to be remembered with a distraction question shown between the sequences. Participants are asked to judge if an equation is correct (e.g., 7 + 8 = 13). This is the distractor task. The to-be-recalled letters are presented for 1000 ms. The distractor question is presented until it is answered or until time out. The sequence of letters to be recalled varies between 2 and 6. Each sequence length is repeated three times, and the order of the sequences is randomized throughout the task. For each sequence in the test, the proportion of correctly recalled letters is computed. The partial credit unit (PCU) score is the mean of the proportions across all sequences.

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Randomization

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

For each subject, block order and trial order are pseudo-randomized (see Procedure).

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 that will be tested and remember that any test not included here must be noted as an exploratory test in your final article.

Primary hypotheses (H1 and H2): We hypothesize that N1 and MMN are lower (i.e., less negative) in the high than low load condition.
For the N1, the mean amplitudes during high load are subtracted by those during low load. This difference should be positive (i.e., a small negative value during high load minus a large negative value during low load equals a positive value). To compute a Bayes Factor, the alternative hypothesis is modeled as a uniform distribution with the limits defined between −1.5 and +1.5 μV, and the likelihood is modeled as a t distribution. We use Aladins R scripts (Wiens, 2017, https://doi.org/10.17045/sthlmuni.4981154) to compute the BF. We also report the 95% credible interval (with an uninformed prior) of the mean N1 difference between the high and low load conditions.
The MMN is obtained by subtracting the response to the deviant tone in the oddball condition by the response to the control tone in the random control condition, separately for each load. Each of these differences should be negative (i.e., MMN). Then, the MMN in high load is subtracted by the MMN in low load. This difference should be positive (i.e., a small negative value during high load minus a large negative value during low load equals a positive value). To compute a Bayes Factor, the alternative hypothesis is modeled as a uniform distribution with the limits defined between −1.5 and +1.5 μV, and the likelihood is modeled as a t distribution. We also report the 95% credible interval (with an uninformed prior) of the mean MMN difference between the high and low load conditions.

Secondary hypotheses: Because in general, both N1 and MMN are negative, subtracting the mean amplitudes during high load by the mean amplitudes during low load should result in positive difference scores if H1 and H2 are correct. For H3, these difference scores are hypothesized to correlate negatively with WMC; that is, the positive difference scores are larger for individuals with low than high WMC. For H5, the difference scores between high minus low load should be negative for P3a, and this difference should correlate positively with WMC; that is, difference scores are more negative for individuals with low than high WMC. For all secondary hypotheses, we report the 95% credible intervals (with an uninformed prior) for mean differences and for correlations.

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

Follow-up analyses

If not specified previously, will you be conducting any confirmatory analyses to follow up on effects in your statistical model, such as subgroup analyses, pairwise or complex contrasts, or follow-up tests from interactions? Remember that any analyses not specified in this research plan must be noted as exploratory.

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 H1 and H2, a Bayes Factor (BF) is computed with the alternative hypothesis modeled as a uniform distribution with the following limits (−1.5 to +1.5 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. We also report the 95% credible intervals (with an uninformed prior) of the differences.
For the secondary hypotheses, we report the 95% credible intervals (with an uninformed prior) for mean differences and for correlations.

Data exclusion

How will you determine which data points or samples (if any) to exclude from your analyses? How will outliers be handled?

Subjects are screened with pure tone audiometry (at 500, 750, and 1000 Hz) to ensure normal hearing (less or equal 20 dB HL).

A subject is excluded if the EEG data are too noisy (e.g., due to excessive eye blinks or other artifacts). This decision is made by viewing the raw EEG before any computation of ERPs.

A subject is excluded if there are fewer than 70% trials for an ERP in the primary analyses.

Missing data

How will you deal with incomplete or missing data?

We do not interpolate noisy electrodes but exclude the subject (because we have few electrodes to begin with).

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.

Scripts

Upload an analysis script with clear comments

This optional step is helpful in order to create a process that is completely transparent and increase the likelihood that your analysis can be replicated. We recommend that you run the code on a simulated dataset in order to check that it will run without errors.

no file selected

Other

Other

If there is any additional information that you feel needs to be included in your preregistration, please enter it here.