Auditory White Noise Increases Visual Accuracy

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Abstract

Perception fluctuates over time and depending on internal states, such as attention, fatigue or arousal. A number of studies indicate that concurrent stimulation can influence perception. However, the direction of this influence is under debate, with some experiments finding detrimental effects, whereas others find that white noise can improve perception. In two experiments on visual perception we examined the influence of auditory white noise. Overall, we find that white noise improves perceptual accuracy, without changing response speed.

Keywords: Attention, Perception, White Noise, Resonance

# Auditory White Noise Increases Visual Accuracy

Here lives the introduction.

Summary of dual task studies

Summary of stochastic resonance idea

Open questions

Goal of experiment 1

Goal of experiment 2

## Experiment 1

The first experiment was aimed at testing the influence of white noise stimulation on attention-related parameters of visual perception. To this end, we used a visual flanker task in combination with and without auditory white noise stimulation in a sample of healthy young male adults. As an influence of white noise stimulation has already been shown in ADHD samples, we were especially interested in the influence of white noise on high-performing people with low scores on the ADHS index scale CAARS (Christiansen, Hirsch, Abdel-Hamid, & Kis, 2014).

### **Methods.**

#### Participants***.***

#### In the first experiment, 31 male adult participants gave informed consent and participated in the study for partial course credit or in exchange for 25 €. The study was conducted in accordance with the 2008 Declaration of Helsinki and approved by the ethics committee of the Philipps-University Marburg (approval number: 2018-44k). Due to disruptions in the experimental procedures, data of seven of these participants were excluded from further analysis. The resulting sample (N=24) was screened for attention deficits and split by the median of the CAARS-L scale. The German version of the CAARS-L: S assesses ADHD symptoms in adults aged 18 years or older. Symptoms are rated on a Likert-type scale (0 = not at all/never to 3 = very much/very frequently). The long version consists of 66 items that result in the four factors inattention/memory problems, hyperactivity/restlessness, impulsivity/emotional lability, and problems with self-concept. The present analysis focuses on the high performing participants. Therefore, analyses focused on the data of the 12 participants with CAARs scores below the group median (mean +/- SD age = 22.33 +/- 1.67 years). All participants had normal, or corrected-to-normal vision, and did not report any psychic or neurological diseases. Moreover, all participants were screened for behavior or events that could have influenced the dopamine system, such as caffeine consumption, illicit drug use and sleep quality.

#### Task***.***

The main experiment consisted of a flanker task based on the procedure described in Albrecht et al. (2008, figure XXX), programmed in Presentation v18.3 (Neurobehavioral Systems, Berkeley, CA, USA). The task comprised congruent and incongruent visual stimuli. Congruent stimuli consisted of a vertical row of three triangles pointing either to the left or the right. In incongruent trials, the center triangle (target) pointed to the opposite direction of the upper and lower (flanker) triangles. At the beginning of the trial, the flanker triangles were presented alone for 100 ms, followed by the flanker and target presentation for 150 ms. Within 1400 ms after target offset, the participants were asked to indicate the pointing direction of the target triangle using the left and right index fingers and an RB-840 response pad (Cedrus, San Pedro, CA, USA) as fast and accurate as possible. The task was presented in two sets, one with and one without white noise stimulation. For each participant, the order of the sets was randomized. Each set comprised 10 blocks with 40 trials each (i.e. 10 right congruent, 10 left congruent, 10 right incongruent and 10 left incongruent) in random order. After each block, participants received feedback on their performance, and were instructed to respond more accurate in case of more than 10% errors in the congruent or more than 40% errors in the incongruent condition, or faster in case of less than 10% errors in the congruent or less than 40% errors in the incongruent condition. Prior to the start of the main experiment, participants were given two blocks of 12 trials to familiarize themselves with the task. Prior to, during and after the flanker task, EEG was recorded from 64 electrodes. Presentation of the EEG data is beyond the scope of the current report.

#### Apparatus***.***

Visual stimuli were presented on an XXX screen with a viewing distance of XXX cm. Auditory white noise was presented at 78 dB(SPL) via two speakers positioned behind the participants. The noise loudness was chosen based on the recommendations by Sikström and Söderlund (2008) and Söderlund et al. (2010) for moderate loudness.

#### Analysis***.***

The current analysis focused on the dependent variables reaction time (RT) and error rate, depending on the independent variables Congruence (congruent and incongruent visual stimuli) and Noise (white noise stimulation and no white noise stimulation). For both dependent variables, repeated-measures 2x2 ANOVAs were performed. The Mauchly test was used to verify the assumption of sphericity and the Greenhouse-Geisser correction was applied when necessary to correct for non-sphericity. For these cases, the corrected degrees of freedom and p-values are reported. Further analysis of the significant effects was performed using post-hoc paired t-tests and the Bayes Factor (BF10, Rouder et al., 2009) as an indicator of the relative evidence. BFs between 1–3 indicate anecdotal support for the alternative hypothesis (H1) while BF between 3–10 and above 10 indicate respectively moderate and strong support for H1. BF = 1 indicates equal support for H1 and null hypothesis (H0) while BF between 1/3–1, 1/10–1/3 and below 1/10, provide respectively anecdotal, moderate and strong support for H0 (Aczel et al., 2017).

If the data were not normally distributed (failing the Lilliefors test for normality of distribution at alpha level 0.05) they were rank-ordered prior to the ANOVAs (Conover and Iman, 1981), and post-hoc Wilcoxon signed-rank tests were used to evaluate differences between conditions. In association with each pair-wise Wilcoxon test, we report the effect size (r; r = Z / n1/2, Z = Wilcoxon Z-value, n = number of observations). The Holm-Bonferroni correction (Holm, 1979) was applied for the all the post-hoc pairwise comparisons. An alpha level of 0.05 is used for all statistical tests.

### **Results.**

#### Accuracy***.***

Here lives the description of the error rates

#### RTs***.***

Here lives the description of the reaction times

### **Discussion.**

#### Accuracy***.***

Here lives the short discussion of the flanker results

#### RTs***.***

Here lives the discussion of the flanker reaction times

## Experiment 2

The second experiment was aimed at testing the influence of auditory white noise stimulation on cross-modal influences of visual perception. To this end, we used an audiovisual sound-induced flash illusion task (SIFI, Shams et al., 2000; Keil, 2020) in combination with different levels of auditory white noise stimulation in a sample of healthy young male and female adults.

### **Methods.**

#### Participants***.***

In the second experiment, 35 adult participants gave informed consent and participated in the study for partial course credit. The study was conducted in accordance with the 2008 Declaration of Helsinki and approved by the ethics committee of the German Psychological Society (approval number: KeilJulian2019-07-04VADM). All participants had normal, or corrected-to-normal vision. Due to disruptions in the experimental procedures, data of one participant were excluded from further analysis. One participant was excluded due to reporting a previous neurological disease. One more participant was excluded for not responding to more than one third of the trials. Previous studies have shown that there is considerable inter-individual variability regarding the perception of the SIFI (see Keil, 2020 and Hirst et al., 2020 for reviews). For the second experiment, we therefore focused on healthy participants that could reliably identify stimulation with two visual stimuli. Based on this, 12 participants that had an incorrect response in more than one third of the trials with two visual stimuli in isolation (A0V2) were excluded. Thus, the final sample for the second experiment comprised 20 participants (16 female, mean +/- SD age = 27.47 +/- 7.94 years).

#### Task***.***

Here lives the description of the task

#### Apparatus***.***

Here lives the description of the apparatus

#### Participants***.***

Here lives the description of the samples

#### Analysis***.***

### The current analysis focused on the dependent variables reaction time (RT) and hit rate, depending on the independent variable Noise (Baseline and seven levels of white noise stimulation). Importantly, in case of incongruent audiovisual stimulation (A2V1, A2V1late and A1V2), the illusion rate as an indicator of illusion perception was used. For both dependent variables, repeated-measures one-way ANOVAs were performed. The Mauchly test was used to verify the assumption of sphericity and the Greenhouse-Geisser correction was applied when necessary to correct for non-sphericity. For these cases, the corrected degrees of freedom and p-values are reported. Further analysis of the significant effects was performed using post-hoc paired t-tests and the Bayes Factor (BF10, Rouder et al., 2009) as an indicator of the relative evidence. BFs between 1–3 indicate anecdotal support for the alternative hypothesis (H1) while BF between 3–10 and above 10 indicate respectively moderate and strong support for H1. BF = 1 indicates equal support for H1 and null hypothesis (H0) while BF between 1/3–1, 1/10–1/3 and below 1/10, provide respectively anecdotal, moderate and strong support for H0 (Aczel et al., 2017).

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### **Results.**

#### Accuracy***.***

Here lives the description of the hit rates

#### RTs***.***

Here lives the description of the reaction times

### **Discussion.**

#### Accuracy***.***

Here lives the short discussion of the SIFI results

#### RTs***.***

Here lives the discussion of the SIFI reaction times

## General Discussion

Here lives the general discussion

Short summary of hypotheses and central findings

## Conclusion

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Nachname, Vornamen (Jahr). *Buchtitel.* Name des Orts: Name des Herausgebers

Tables

Table 1

Tabellentitel

| Spaltenüberschrift | Spaltenüberschrift | Spaltenüberschrift | Spaltenüberschrift | Spaltenüberschrift |
| --- | --- | --- | --- | --- |
| Zeilenüberschrift | 123 | 123 | 123 | 123 |
| Zeilenüberschrift | 456 | 456 | 456 | 456 |
| Zeilenüberschrift | 789 | 789 | 789 | 789 |
| Zeilenüberschrift | 123 | 123 | 123 | 123 |
| Zeilenüberschrift | 456 | 456 | 456 | 456 |
| Zeilenüberschrift | 789 | 789 | 789 | 789 |

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Figures



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