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Research article

# Stress effects on cognition: Evidence for stress-related disruption of attention and inhibitory control

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A R T I C L E I N F O

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A B S T R A C T

While stress can impair cognitive functions, including attention and inhibition, it is not always deleterious; e.g., stress could also increase alertness, motivation, and concentration. Limited research has examined these effects in clinical populations experiencing high perceived stress. The current study investigated the impact of perceived stress levels, as measured by the Perceived Stress Scale (PSS), on attention and inhibition in 91 participants grouped into high, moderate, and low perceived stress levels. Participants completed online versions of the Stroop and Go/No-Go tasks to assess attention and inhibition. Results revealed that participants with higher perceived stress exhibited longer reaction times and fewer correct responses than those reporting lower stress across both tasks. ANOVA revealed significantly poorer performance on the Stroop and Go/No Go tasks among individuals in the high-stress group compared with the moderate- and low-stress groups. Introducing auditory or visual interference further disrupted cognitive performance in the high-stress group. These findings indicate that raised perceived stress negatively impacts attention and inhibition. The study provides evidence that chronic stress may impede cognitive abilities and suggests that further research should examine stress effects in clinical cohorts. This investigation makes a meaningful contribution by demonstrating the deleterious impacts of high perceived stress on cognition in a clinical sample, addressing a gap in the literature.

## 1. Introduction

Stress is a nonspecific systemic response to environmental and mental tensions, which activates the autonomic nervous system [1]. Research indicates that stress diminishes the efficiency of information transfer and reduces the brain regions responsible for regulating the stress response susceptible to disruption [2]. Long and high levels of stress can have destructive impacts on mental health [3], cognitive function, and wide-ranging aspects of brain functioning, such as memory [4], attention [5], inhibition [6], and performance [7]. The scratch of stress on cognitive capabilities can be positive and negative, depending upon its level, time, and origin [8]. On the one hand, reasonable and short-term stress can improve cognitive rendition by increasing alertness [9,10], motivation [11], and concentration. For instance, students may perform better on tasks if they experience some stress beforehand. This positive form of stress, often referred to as eustress [12,13], can be understood within the framework of Selye's General Adaptation Syndrome, which distinguishes between beneficial stress responses (eustress) and harmful ones (distress) [14,15]. Additionally, the Yerkes-Dodson Law

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suggests that an optimal level of arousal can enhance performance, implying that moderate stress levels might contribute positively to cognitive outcomes [16,17].

However, it is essential to note that the improvements above apply only to cases of short-term or situational stress, rather than chronic stress. Stress is often accompanied by other psychological aspects, such as anxiety and depression, and can affect emotional regulation [18–22]. According to the DSM-5, stress can cause negative moods, dissociative manifestations, hypervigilance, problems with concentration, and impairment in functioning. From a cognitive standpoint, people experiencing chronic stress perceive stress for a more prolonged period, causing poor cognitive performance, as indicated by reduced memory capacity [3,22,23], attention span, inhibition control, and problem-solving skills [24]. For example, persistent nervousness or anxiety can make it complicated for individuals to remember things or concentrate on tasks.

The impact of stress on cognitive factors, particularly attention [5,10,25,26], and inhibitory control [27] which regulates behavior, emotions, and thoughts, has been extensively studied through numerous experiments and research conducted by scholars worldwide, aiming to establish theories on how various stress levels and types affect cognitive function.

Most existing research has focused on healthy participants exposed to simulated stressors, such as noise or temporary stressors, during experiments [18,24,28–30]. Some studies have also explored populations with traumatic brain injuries [31]. However, research on these populations is not enough yet to investigate these domains in clinical populations diagnosed by standardized clinical assessment and by a clinician, specifically patients experiencing high levels of perceived stress as a chronic factor. Based on this criterion, our research aims to examine the impact of high perceived stress levels on our participants' attention and inhibition.

### *1.1. Hypothesis*

In the present study, we put forth three hypotheses to investigate the influence of stress levels on three response measures: reaction time (RT), correct response rate (CrrR), and inhibition. Specifically,

1.1.1. We hypothesized that individuals experiencing higher stress levels would show impaired performance on cognitive tasks compared to those with lower stress levels. Specifically, we predicted that the high-stress group would exhibit prolonged reaction times (RT), decreased correct response rates (CRR), and reduced inhibition on the cognitive tasks compared to the low-stress group.

1.1.2. Furthermore, we hypothesized that introducing an audio stimulus in the form of noise would exacerbate the negative effects of stress on cognitive performance. We predicted that presenting task-irrelevant noise would lead to even slower RTs and lower CRRs in the high-stress group than in the low-stress group.

1.1.3. Finally, we hypothesized that presenting irrelevant video stimuli would adversely affect participants' attentional processes and inhibitory control. We predicted that irrelevant video clips would have a greater negative impact on RT, CRR, and inhibition in individuals with higher stress levels than in those with lower stress levels.

## 2. Experiment 1

### *2.1. Methods*

#### *2.1.1. Participants*

For this study, 91 participants were recruited from July 2022 to December 2022, in collaboration with a team of clinical psychologists from city of Moscow, Russia, Moscow City, all Psychologists were certified psychologists and. The sample consisted of 40 females (44.0%) and 51 males (56.0%), with a mean age of 24.73 years (SD = 4.04). Female participants had a mean age of 24.85 years, while male participants had a mean age of 24.63 years. The inclusion criteria for participants were as follows: For the control group, we included participants with no history of diagnosed psychiatric or neurological disorders and the ability to complete online tasks and questionnaires. The exclusion criteria included individuals with a history of psychiatric conditions such as major depressive disorder, generalized anxiety disorder, or any other diagnosed condition, individuals currently taking psychotropic medications, and significant visual impairments that could interfere with task performance.

For the main group, participants were recruited from clinical populations with high perceived stress. The inclusion criteria were clinically assessed and diagnosed with high levels of perceived stress by a qualified psychologist, as well as willingness and ability to complete online tasks and questionnaires. The exclusion criteria included individuals with any other diagnosed psychiatric or neurological disorders beyond high perceived stress, individuals taking psychotropic medications for conditions other than stress, and visual impairments that would significantly impact task performance. We also excluded participants who were admitted to the clinics less than 30 days before the experiment. Due to ethical restrictions and policy regulations, we were not allowed to have access to or question the drug therapy and their medical history.

#### *2.1.2. Procedure*

We contacted three clinical psychologists to collect data. They were requested to invite their patients to complete an online perceived stress questionnaire. This method of data collection has been successfully employed in previous studies, including [20,32]. The questionnaire was administered anonymously via a web-based survey (Machform: https://www.machform.com). The project did not involve financial compensation or rewards; participants could decline or accept participation in the experiment. For the control group, we recruited students from various universities. Flyers were distributed at universities in Russia, and participation in the study was anonymous. Like the clinical group, the control group did not receive payment, credit, or access to the study results. During online registration, both groups read and signed an online consent form outlining the use of the data they provided for analysis and potential publication in scientific journals or dissemination. Those who agreed to participate were instructed to complete the Perceived Stress Questionnaire and provide demographic information, including gender and age, online through the Machform platform. No other information was collected, such as the participants' history of diagnosed stress disorders, education, or additional details. The Perceived Stress Scale (PSS) was the primary instrument for assessing stress. Although initially developed in 1983 [33], the PSS remains a widely used tool for understanding how various situations impact individuals' feelings and perceived stress levels. The scale includes questions about participants' feelings and thoughts during the last month. Participants were asked to indicate the frequency with which they experienced specific thoughts or feelings. Participants were encouraged to respond quickly, without attempting to count the exact number of occurrences, but instead providing a reasonable estimate.

Participants in this study were categorized into three groups based on their perceived stress scores [20,28]. The first group was labeled "High stressed" and consisted of participants who scored above the cut-off score of +27-40; the second group, the "Moderate Stressed," included participants who scored between 14 and 27 on the perceived stress questionnaire, and the third group, the "Low Stressed," comprised participants who scored between 0 and 13 on the same questionnaire. These categorizations enabled a more comprehensive analysis and understanding of the varying levels of perceived stress among participants in the study.

Upon confirmation of completing the online questionnaire (PSS), participants were immediately redirected to the online task. The task was designed using the Psychopy software [33,34] and made accessible via Pavlovia (https://pavlovia.org). To ensure consistency and reliable results, each participant received a unique, randomly generated code (e.g., Exp659Ed2562) during the online perceived stress questionnaire. They were instructed to enter this code later in the Psychopy experiment to allow identification and data matching. Participants were advised to perform the tasks on a computer or laptop screen using a mouse to ensure optimal task conditions.

### 2.2. Stimulus and apparatus

In this experiment, two tasks were administered to assess cognitive abilities related to attention and inhibition: the Stroop Task and the Go/No Go Task. The Stroop Task (STR) [35] evaluates cognitive flexibility and attention span by measuring participants' ability to distinguish between word- and color-naming stimuli. The task consists of three subtasks. The Stroop task is a widely used paradigm for studying attention and cognitive control. In this task, participants must name the ink color (red, blue, or green) in which words are written. The terms can be color names or objects unrelated to the colors. The words are presented in three stimulus conditions: congruent (word matching the ink color), conflict (word naming a different color), and neutral (word unrelated to color). Identifying ink colors for congruent stimuli is typically faster, resulting in shorter reaction times (RTs) than identifying colors for neutral stimuli. The task included a practice block of 12 trials with feedback, followed by the main block. In the task, at each trial, 0.5 s after the screen was shown, the stimuli appeared, and the participant had to answer using the "left", "right", and "down" arrow keys on their keyboard. The procedure of the Stroop Task is depicted in Fig. 1(a).

The Go/No Go (GNG) [36] task assesses inhibitory control. In this task, the go stimuli were green arrows pointing left or right (arrowhead size: $3 \times 3.5$ cm; base size: $3 \times 1.5$ cm). The no-go/stop stimuli were blue arrows, the same size as the go stimuli. Like the Stroop task, participants completed five familiarization trials and 32 main task trials. All stimuli were presented at the center of the screen, and a fixation cross was shown during other parts of the experiment. Participants were instructed to respond as quickly as possible. A no-go stimulus appeared in some trials, indicating that participants should refrain from responding and pressing the space button. The GNG Task procedure is depicted in Fig. 1(b). The main objective of these tasks was to establish baseline RT and CrrR ranges for participants in attention and inhibitory control. By conducting these basic tasks, we aimed to assess our participants' fundamental aspects of attention and inhibition.

### 2.3. Statistical analysis

All data were analyzed using JASP [37]. Descriptive statistics, including means and standard deviations, were calculated for all continuous variables. The normality of variables was assessed visually using histograms and Q-Q plots. For variables that were not

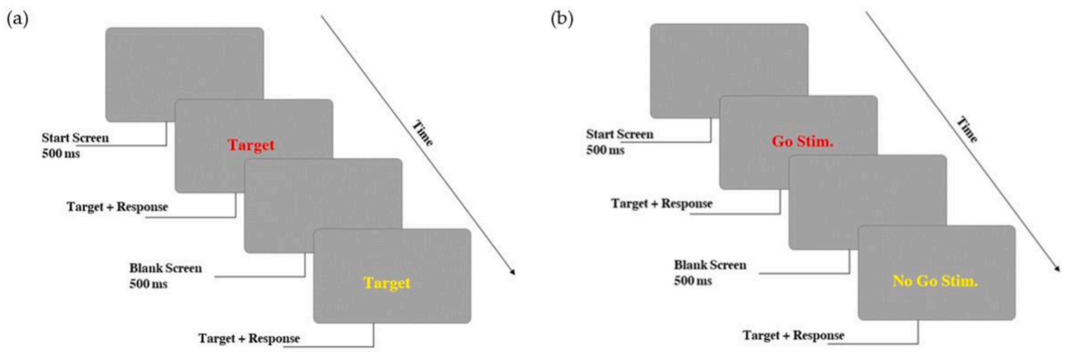


**Fig. 1.** Schematic figure of (a) the Stroop task and (b) the Go no No-Go task for experiment one.

normally distributed, appropriate transformations were applied to achieve normality prior to analysis. To compare reaction times between experimental conditions, a two-sample *t*-test was used after confirming that variances were homogeneous using Levene's test.

### 2.4. Results

#### 2.4.1. Perceived stress results

To assess participants' perceived stress level, the Perceived Stress Questionnaire was used. Table 1 presents the descriptive statistics of our participants. The distribution of participants across the perceived stress categories is as follows, as we explained in the procedure section for the PSS questionnaire. Among the participants, 30 fell into the low-stressed category, with a mean perceived stress score of 5.87 ± 3.48. There were 13 participants in the moderate stress category, with a mean score of 20.54 ± 4.74. The high-stressed group comprised 48 participants, with a mean score of 33.25 ± 3.56.

#### 2.4.2. STR and GNG results

The statistical description of Reaction Time and Correct Response for this experiment is shown in Table 2. Data shows that the High-stress group had the highest STRavg (1046.38, SD = 194.35) and GNGavg (936.42, SD = 103.27), while the Low-stress group had the lowest STRavg (987.93, SD = 188.34). The low-stress group performed best on STRCrrR accuracy (25.60, SD = 3.61), and the Moderate-stress group was most accurate on GNGCrrR (25.00, SD = 4.62). Fig. 2 shows the reaction time and correct response plots for this stage.

Based on the findings, it can be observed that participants with higher and moderate stress levels showed longer reaction times RT compared to the lower-level participants. Furthermore, the GNG task results indicate a noticeable difference in group inhibitory control. Upon observation, participants with lower stress ratings exhibited higher correct response rates across all trials, whereas the number of correct responses decreased with increasing stress levels. This phenomenon will be further discussed later. An ANOVA task was conducted to examine reaction times (RT) and correct response rates (CrrR) in the Stroop (STR) and Go/No-Go (GNG) tasks to gain further insight. The ANOVA results revealed no significant differences in RT between the groups for either task. However, there were substantial differences in correct response rates between the groups for the STR and GNG tasks. Specifically, the ANOVA results for the STR task showed a significant difference between the groups, $F(2,88) = 31.51$, $p < 0.001$, $\eta^2 = 0.42$.

Post-hoc analysis revealed that the High-stress group had significantly lower correct response rates than the Moderate-stress group ($p < 0.01$) and the Low-stress group ($p < 0.001$). This suggests that individuals in the High-stress group performed significantly worse in the STR task than those in the other stress groups.

Similarly, the ANOVA results for the GNG task demonstrated a significant difference between the groups, $F(2, 88) = 22.93$, $p < 0.001$, $\eta^2 = 0.34$. The post-hoc analysis indicated that the High-stress group exhibited significantly lower correct response rates than the Moderate-stress group ($p < 0.01$) and the Low-stress group ($p < 0.001$). This indicates that individuals in the High-stress group performed significantly worse in the GNG task than those in the other stress groups.

### 2.5. Discussion

The results revealed that participants with higher and moderate stress levels exhibited longer reaction times than those with lower stress levels. Additionally, participants with lower stress ratings demonstrated higher correct response rates across all trials, whereas the number of correct responses decreased with increasing stress levels. Although this experiment confirmed our base hypothesis that higher stress levels are associated with longer RT and poorer performance in generating correct responses, the ANOVA test shows that the higher RT is not significant for both STR and GNG. In contrast, for Correct responses, this result is significant. These findings suggest that stress negatively impacts cognitive performance, slowing reaction times and impairing inhibitory control.

## 3. Experiment 2: Stroop task and Go/No Go task with random one-beep or two-beep noise 1-3 ms before appearing their stimuli

### 3.1. Methods

#### 3.1.1. Participants

Participants in this experiment are the same as participants in the experiment 1.

**Table 1**
Descriptive statistics of the PSS task among all participants.

| | PSS | | |
|---|---|---|---|
| | High | Low | Medium |
| **N** | 48 | 30 | 13 |
| **Mean** | 33.25 | 5.87 | 20.54 |
| **Std** | 3.56 | 3.48 | 4.74 |
| **Variance** | 12.70 | 12.12 | 22.44 |

**Table 2**
Descriptive statistics for Stroop and Go/No Go tasks.

| | STRavg | | | GNGavg | | | STRCrrR | | | GNGCrrR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H | M | L | H | M | L | H | M | L | H | M | L |
| **Mean** | 1046.38 | 1023.23 | 987.93 | 936.42 | 928.92 | 935.67 | 18.96 | 22.85 | 25.60 | 21.40 | 25.00 | 27.33 |
| **Std** | 194.35 | 177.36 | 188.34 | 103.27 | 141.28 | 151.62 | 3.30 | 4.79 | 3.61 | 3.86 | 4.62 | 3.38 |

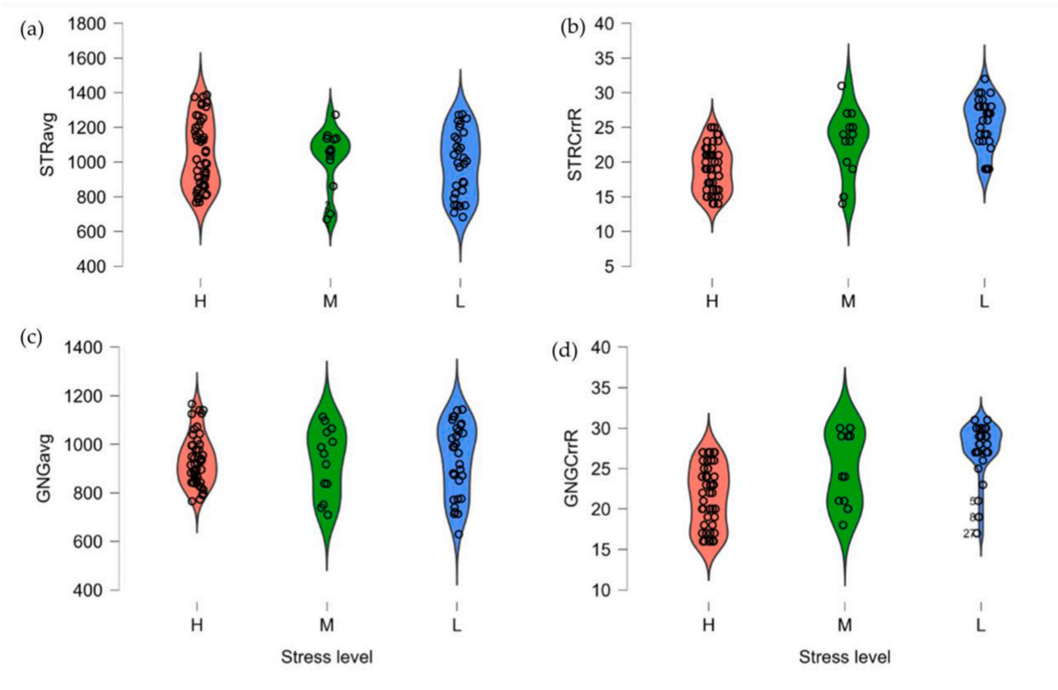


**Fig. 2.** (a) Rt for STRavg, (b) CrrR for STRavg, (c) RT for GNGavg, and (d) CrrR for GNGavg.

*3.1.2. Procedure*

Experiment 2 involved the administration of the Stroop and Go/No Go tasks, with random one- or two-beep noise occurring 1-3 ms before stimulus presentation. Before the tasks, participants were informed that the relevance rate of congruent or incongruent stimuli in both tasks was zero and that the occurrence of a single or double beep had no influence on their responses. To establish a control

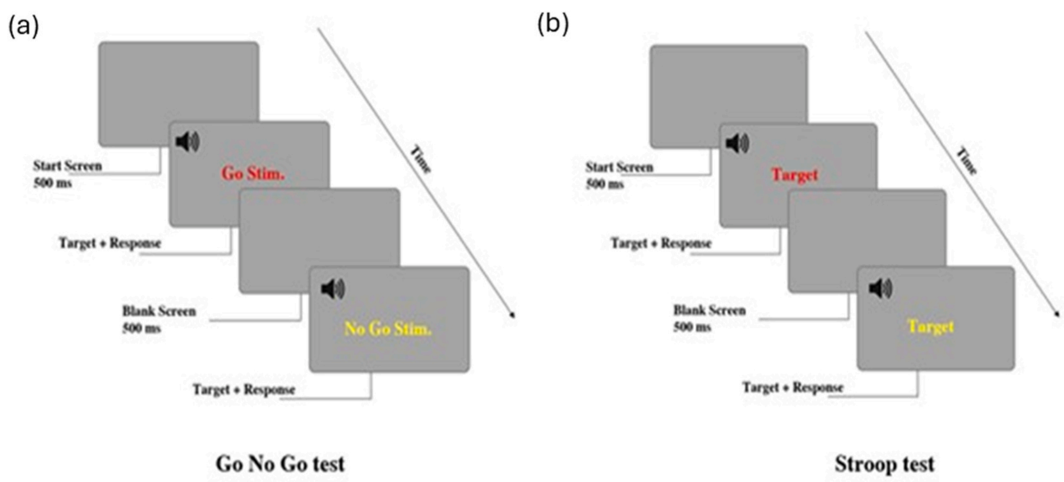


**Fig. 3.** Schematic figure of (a) the Stroop task and (b) the Go No-Go task for experiment two.

condition, participants completed 32 trials with either a single or a double beep, followed by seven additional trials in which no beep was presented (Silent trials). These silent trials were randomly interspersed after the fifth trial to assess whether participants anticipated a beep during their trials. Participants were not aware of these seven additional silent trials.

#### 3.1.3. Stimulus and apparatus

In this task, the go-stimuli were similar to the first experiment with an extra including random one-beep or two-beep noise occurring 1-3 ms before the presentation of stimuli. Fig. 3 (a, b) depicts both tasks with noise stimuli.

#### 3.1.4. Results

Participants' RT for Both STR and GNG show lower stress levels; participants have lower Reaction time, and RT increases as stress levels rise to moderate and high. Moreover, CrrR was recorded and analyzed during these tasks. Table 3 presents result for the Audio-Stimuli task in both the STR and GNG tasks, along with their correct responses. Both STR and GNG show that participants with lower stress levels have lower Reaction time, and RT increases as stress levels rise to moderate and high levels. This indicates that RT changes when an audio noise stimulus is provided. Fig. 4 also shows the box plot of RT in these experiments.

For the STRA task, the ANOVA analysis showed a significant difference in RT across stress groups, $F(2, 88) = 3.35$, $p = 0.04, \eta^2 = 0.07$. Post hoc analysis indicated a significant difference in RT between the High-stress and Low-stress groups, $p < 0.03$*. Additionally, the ANOVA revealed a significant difference in correct response rates between stress groups, $F(2, 88) = 28.48$, $p < 0.001$, $\eta^2 = 0.39$. Post hoc analysis indicated significantly lower correct response rates in the High-stress group compared to both the Moderate stress group, $p < 0.001$, and the Low-stress group $p < 0.001$. Similarly, for the GNGA task, the ANOVA analysis showed a significant difference in RT between stress groups, $F(2, 88) = 18.26$, $p < 0.001$, $\eta^2 = 0.29$. Post hoc analysis indicated significantly higher RTs in the High-stress group compared to both the Moderate stress group $p = 0.02$* and the Low-stress group $p < 0.001$***. The ANOVA also revealed a significant difference in correct response rates between stress groups, $F(2, 88) = 44.79$, $p < 0.001$, $\eta^2 = 0.50$. Post hoc analysis indicated significantly lower correct response rates in the High-stress group than in both the Moderate-stress group ($p = 0.01$*) and the Low-stress group ($p < 0.001$).

#### 3.1.5. Discussion

This experiment highlights our hypotheses that introducing an audio stimulus would further impair the effects of stress on RT and CrrR. We anticipated that individuals in the stressed group would perform worse than those in the lower-stressed group during the task associated with the first set of hypotheses. These findings contribute to our understanding of stress's influence on cognitive functioning and underscore the importance of managing stress levels for optimal cognitive performance.

4. Experiment 3: Stroop task and Go/No Go task with random visual noise 1-3 ms before appearing their stimuli.

### 3.2. Methods

#### 3.2.1. Participants

Participants for this experiment are the same as participants for experiments 1 and 2.

#### 3.2.2. Procedure

The conditions and execution of this task were the same as in the second task. However, instead of having an audio stimulus, we presented our participants a video stimulus during both tasks, assessing whether our participants paid attention to the irrelevant video stimuli or ignored them. Like the other tasks, we measured our participants' RT and CrrR.

#### 3.2.3. Stimuli and apparatus

The stimulus and apparatus in this experiment are the same as those presented in Experiments 1 and 2; we introduced an additional Silent trial without visual stimuli to determine whether participants anticipated the presence of stimuli or successfully suppressed any response to the task. Furthermore, the presence of a flash did not coincide with the presentation of another primary stimulus. Fig. 5(a and b) shows the schematics of this experiment. In both Task Two and Task Three, we incorporated a conditioning component to ensure that silent trials did not occur consecutively, thereby minimizing potential learning effects associated with their presence.

#### 3.2.4. Results

Descriptive statistics, including STRV and GNGV RT, and CrrR, are provided in Table 4. As shown in this table, RT for the higher-level group is more than moderate, and for the low-level group, it is also more than moderate. The same result is confirmed for the

**Table 3**
Descriptive statistics of the second experiment (Aavg = Audio-stimuli average).

| | STRAavg | | | GNGAavg | | | STRACrrR | | | GNGACrrR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H | M | L | H | M | L | H | M | L | H | M | L |
| **Mean** | 1065.44 | 985.23 | 938.90 | 1211.13 | 1036.62 | 927.27 | 18.56 | 23.23 | 24.53 | 17.85 | 20.69 | 24.60 |
| **Std** | 234.69 | 251.38 | 153.74 | 216.53 | 272.54 | 144.28 | 3.31 | 4.64 | 3.42 | 1.37 | 4.39 | 4.18 |

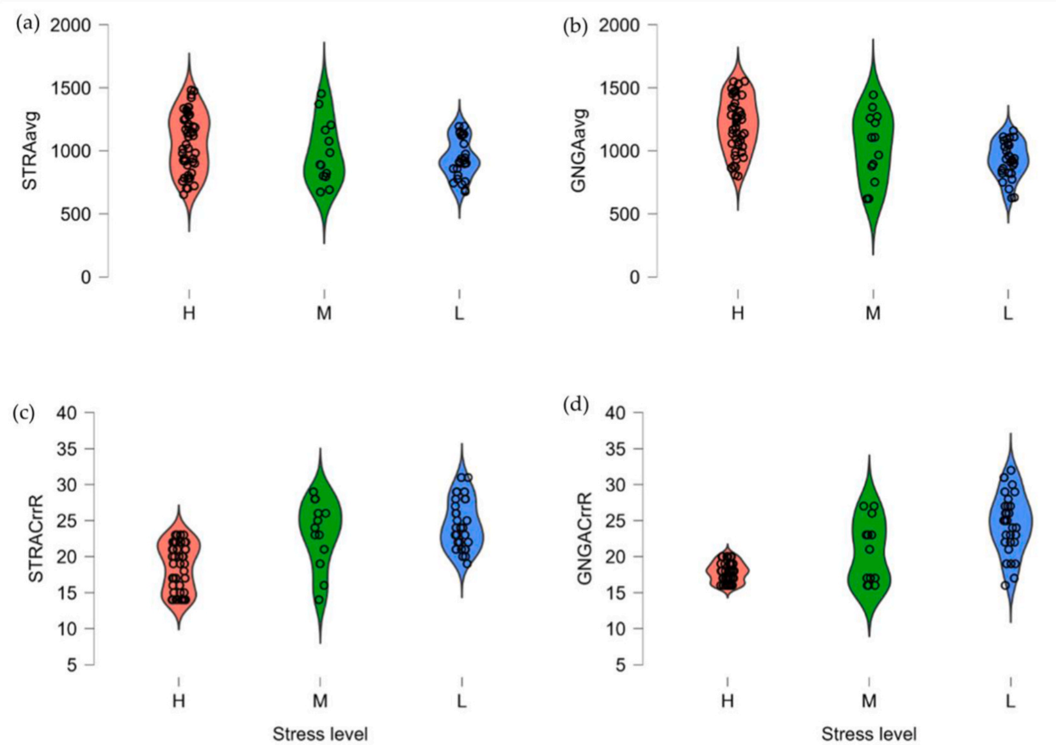


**Fig. 4.** Rt for STRAavg, (b) CrrR for STRAavg, (c) RT for GNGAavg, and (d) CrrR for GNGAavg.

CrrR, which in both STRV and GNGV, reduces the number of correct responses by increasing the stress rate. Also, Fig. 6 shows a box plot of the data obtained in this stage.

An ANOVA task was conducted to investigate the effects of stress level on reaction time and correct response rates in the Stroop task with Video stimuli (STRV) and the Go/No-Go task with Video stimuli (GNGV). The results revealed significant differences in reaction time and correct response rates between the stress groups for both tasks. For the STRV task, the ANOVA analysis showed a significant difference between the stress groups in both reaction time, $F(2,88) = 10.85$, $p < 0.001$, $\eta2 = 0.20$, and correct response rates, $F(2,88) = 101.72$, $p < 0.001$, $\eta^2 = 0.70$. Post hoc analysis indicated that the Low-stress group had significantly higher reaction times compared to both the High-stress group, $p < 0.001$, and the Moderate stress group, $p = 0.01$*, for reaction time. Similarly, the Low-stress group had significantly higher correct response rates than both the High-stress group ($p < 0.001$) and the Moderate stress group ($p < 0.001$***), while the Moderate stress group had significantly higher correct response rates than the High-stress group ($p < 0.001$***). For the GNGV task, the ANOVA results showed a significant difference between the stress groups in both reaction time, $F(2,88) = 15.96$, $p < 0.001$, $\eta2 = 0.27$, and correct response rates, $F(2,88) = 100.41$, $p < 0.001$, $\eta^2 = 0.70$. Post hoc analysis indicated that the High-stress group had significantly higher reaction times compared to both the Moderate stress group $p < 0.003$* and the Low-stress

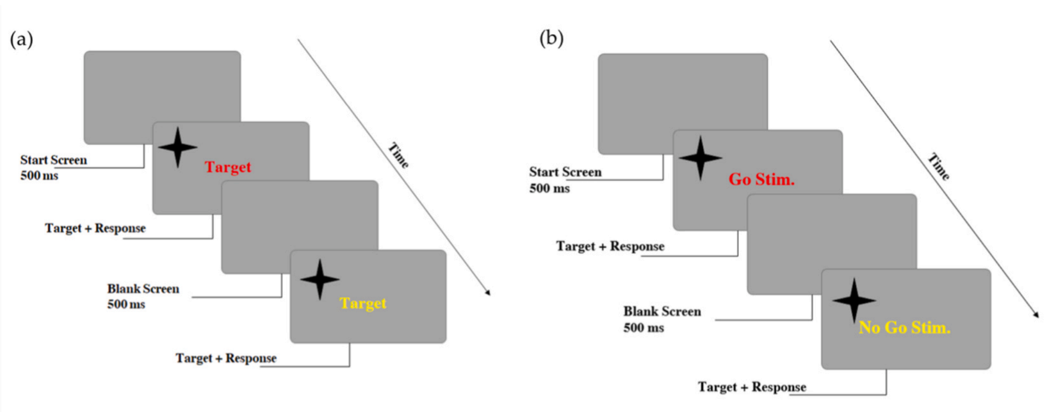


**Fig. 5.** Schematic of (a) the Stroop task with video-noise and (b) the GNG with video-noise for experiment three.

**Table 4**
Descriptive statistics of the second experiment (Vavg = Video-stimuli Average).

| | STRVavg | | | GNGVavg | | | STRVCrrR | | | GNGV CrrR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H | M | L | H | M | L | H | M | L | H | M | L |
| **Mean** | 1065.50 | 1053.08 | 889.87 | 1084.94 | 947.38 | 863.20 | 13.81 | 21.54 | 26.23 | 13.79 | 22.38 | 27.10 |
| **Std** | 168.51 | 175.27 | 160.01 | 168.42 | 198.60 | 164.05 | 2.86 | 6.85 | 3.35 | 2.92 | 7.38 | 3.88 |

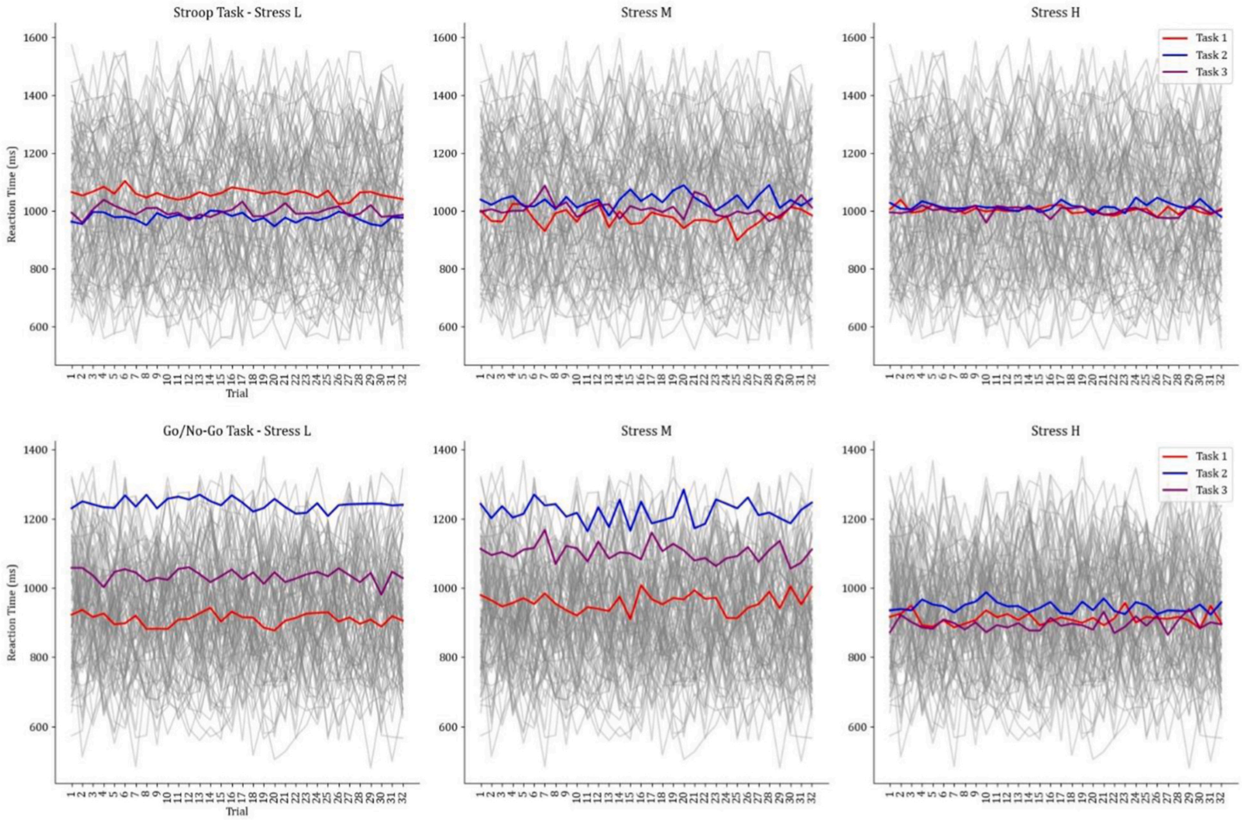


**Fig. 6.** Exploratory Analysis graph.

group $p < 0.001$***. Additionally, the Low-stress group had significantly higher correct response rates than both the High-stress group ($p < 0.001$) and the Moderate stress group ($p < 0.001$***), while the Moderate stress group had significantly higher correct response rates than the High-stress group ($p < 0.001$***).

### *3.2.5. Discussion*

As we hypothesized, the presentation of irrelevant video stimuli would adversely affect participants' attentional and inhibitory processes. We also posited that this negative impact would be more pronounced in individuals with higher levels of stress; the result of experiment 3 confirms our hypothesis.

## 4. Exploratory analysis

In addition to our primary analyses, we conducted an exploratory analysis examining reaction times (RTs) across groups in the Stroop and Go/No-Go tasks. Fig. 6(top) shows the distribution of RTs for the Stroop task across groups in the three experiments. Visual inspection of these distributions indicates minimal differences in Stroop RTs between groups within each experiment. In contrast, Fig. 6(down) reveals apparent between-group differences in RT distributions for the Go/No-Go task. Although we cannot draw definitive conclusions about these RT patterns from these exploratory analyses alone, the results suggest potential between-group RT differences on the GNG task but not on the Stroop task. Given our hypotheses, the lack of apparent Stroop RT differences between groups is somewhat unexpected. Further research examining RTs across a broader range of tasks will be needed to better understand these patterns. Nonetheless, these analyses provide preliminary evidence that group differences in RTs may depend on specific task demands. More targeted RT analyses should be considered in future work to systematically investigate this possibility.

## 5. General discussion

The study aimed to investigate the impact of high perceived stress levels on attention and inhibition in individuals. The study utilized two tasks, the Stroop Task and the Go/No Go Task, to assess attention and inhibition abilities in participants with varying levels of perceived stress. Many research studies discuss stress, its various aspects, and its impact on our behaviors, emotions, and performance, such as [21,23,28,31,38,39]. Studies on different aspects of stress have been introduced, including investigations of corticosteroid levels [40]. Stress is a complex psychological phenomenon, and even when it is not chronicized as a temporary situation, many studies have sought to investigate the different impacts of stress on cognitive functions, including attention and inhibition [26,41]. The impact of stress on cognitive function has been controversial in many studies [28]. showed that increased stress levels independently connect with a decline in cognitive function. Similar results have been observed in studies by Refs. [19,23,42], which showed that chronic stress affects cognitive functions differently in cognitively normal subjects and individuals with mild cognitive impairment (MCI). Other studies [19,38,43,44] have also shown that stress is an essential factor in the decline of cognitive functions. Our first experiment showed differences among three different groups of participants. This finding contradicts the study conducted by Ref. [27], which suggested that stressors can lead to improved inhibition and the suppression of irrelevant information. In their study [27], used white noise as a fake stressor in healthy participants. This disparity in results aligns with the research by Refs. [41,43], which demonstrated that attentional biases differ between psychological or mental stress and normal cognitive functioning. Our ANOVA results for STR and GNG correct responses align with research by Ref. [24], and [26], highlighting the difference in attentional biases between psychological stress and normal cognitive functioning. Additionally, the GNG task results showed a significant difference in inhibitory control between the control and stressed groups, indicating impaired inhibitory control among stressed participants. The study results showed that participants with higher and moderate stress levels exhibited longer reaction times in the tasks than those with lower stress levels. This finding suggests that stress may impair attentional processes and slow cognitive performance. Additionally, the study found that participants with lower stress ratings had higher correct response rates, indicating better inhibitory control, while the number of correct responses decreased with increasing stress levels. The analysis of the data using ANOVA revealed significant differences in correct response rates between the stress groups in both tasks. Specifically, the high-stress group performed significantly worse in the Stroop and Go/No Go tasks than the moderate and low-stress groups. These findings suggest that high levels of perceived stress can harm attention and inhibition, leading to decreased cognitive performance in these tasks. The results of this study are consistent with previous research [19,39,42,43] that has demonstrated the negative impact of stress on cognitive function. Chronic, high-level stress can disrupt brain regions that regulate the stress response, impairing cognitive abilities such as attention, inhibition, and memory. Stress-related changes in cognitive performance are due to individual differences in cortisol response and the task's cognitive load [2]. Performance deficits of chronic stress patients relative to the performance of controls were found for some but not all cognitive tasks, indicating a selective deficit. Repeated restraint stress might induce cognitive impairments dependent on the task and stress intensity [45]. The effects of stress on cognitive performance depend on the primary brain areas responsible for cognitive functions, such as the prefrontal cortex and hippocampus, as well as the time elapsed between the cessation of exercise and the evaluation of these functions [46]. Acute psychological stress increases general alertness and promotes attentional control in selective attention processes [10]. It also alters the response-inhibition process by reducing early, selective attention and enhancing cognitive control. Mild acute psychological stress dissociates the neural subprocesses of attention [6]. It is also essential to consider the participants' subjective experience, as [47] shows that the immediate effects of acute psychosocial stress on attention are highly dependent on it, which, in turn, can mediate stress-related physiological changes. Another factor to consider in this study is the impact of working memory, as attention and inhibition are key components. The roles of attention and inhibition are essential, as shown in a study by Ref. [48], which demonstrated that long-term stress impacts attention and the initiation of the updating process in working memory. Overall, these changes show that stress has a complex effect on participants' cognitive abilities, including attention and inhibition. However, some studies suggest that stress can improve cognitive function. However, as mentioned, the impact has been considered for studies involving regular participants facing environmental stress, not chronic stress. As we can see in this section, research that discusses chronic stress, such as [23], mentions that chronically stressed individuals' cognitive abilities, including attention and inhibition, may be impacted differently than those of individuals with normal mental health facing stressors. Furthermore, these tests can also be helpful in clinical populations for assessing attentional and clinical performance, as demonstrated by research studies [49–51].

## 6. Limitations

This study has several limitations that need to be acknowledged. First, using an online data collection method limits our control over participants' testing environments. Participants were instructed to use laptops or computers and avoid distractions, but compliance could not be directly monitored, potentially introducing variability in results. This uncontrolled environment might have affected participants' ability to concentrate, influencing their reaction times and correct response rates during both the Stroop and Go/No Go tasks. Second, participants were categorized into high-, moderate-, and low-stress groups solely on the basis of self-reported data from the Perceived Stress Scale (PSS). While the PSS is a well-validated tool, self-reported measures are inherently subject to biases such as social desirability and recall inaccuracies, which may have affected the precision of stress level classification. Future studies could incorporate physiological stress markers, such as cortisol levels, to complement the PSS and provide a more objective measure of stress. Third, the study's cross-sectional nature prevents us from drawing causal inferences about the impact of perceived stress on cognitive abilities. While we observed associations between higher stress levels and impairments in attention and inhibition, a longitudinal design would be needed to confirm causality. Additionally, given the relatively young age (mean age 24.73) and limited diversity of our sample, caution is required when generalizing these findings to broader populations, such as older adults or individuals from different cultural backgrounds. Lastly, the auditory and visual stimuli introduced during the experiments to assess the impact of distractions on cognitive performance may have variable effects based on the participants' tolerance to sensory interference, which was not explicitly measured. Future research should include assessments of individual differences in sensory sensitivity to understand how these factors interact with stress to impact cognitive performance.

## 7. Conclusion

The present study provides evidence for the detrimental effects of high perceived stress on key cognitive functions, specifically attention and inhibitory control, assessed through the Stroop and Go/No Go tasks. Across both tasks, individuals reporting higher perceived stress exhibited prolonged reaction times and reduced accuracy, indicating impairments in cognitive flexibility and inhibitory control that are consistent with accounts of chronic stress–related disruption of executive function. These results align with the existing literature, which suggests that chronic stress negatively affects cognitive functioning, particularly in attention, inhibition, and executive function. Moreover, the inclusion of auditory and visual interference in the later experiments showed that individuals experiencing high stress were especially vulnerable to external distractions, with interference disproportionately exacerbating their performance deficits compared with low-stress participants, underscoring reduced resilience to environmental distractors under chronic stress. This pattern has important implications for both clinical and non-clinical contexts that demand sustained attention in distracting environments. Taken together, these findings demonstrate that chronic perceived stress is associated with measurable impairments in attention and inhibitory control, particularly when additional distractions are present, and they highlight the importance of interventions aimed at reducing stress and supporting cognitive functioning in everyday life.

## CRediT authorship contribution statement

**Mohammad Ahsan Khodami:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Methodology, Funding acquisition, Formal analysis. **Giulio Contemori:** Writing – review & editing, Visualization, Validation. **Luca Battaglini:** Writing – review & editing, Visualization, Validation. **Maryam Jansarvatan:** Writing – original draft, Visualization, Software.

## Ethical approval

All subjects provided informed consent before participating in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee under Approval Code 1-40007/19/01. All participants have read and signed a digital version of the consent form before starting the experiments by checking two boxes to ensure a clear understanding of the experiment and consent to participate.

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## Declaration of competing interest

Authors declare no conflict of interest.

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## Data availability

The data obtained from this experiment were stored in a CSV file format. The data were processed, analyzed and visualised using JASP, a statistical software package. The data and related materials can be accessed at the following link: https://osf.io/ndp83.

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