

# The Effects of Intermittent Noise and Whole-Body Vibration on Cognitive Performance

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## ABSTRACT

Work environments involving noise and whole-body vibration are known to affect human cognitive performance, particularly selective attention. The aim of this study is to identify and analyse the impact of noise level and whole-body vibration exposure duration on cognitive performance using a controlled laboratory experiment and the Stroop Task. Cognitive performance was measured by total response time and accuracy under two intermittent noise levels (65 dBA and 85 dBA) and two whole-body vibration exposure durations (5 minutes and 10 minutes). Multivariate analysis indicated that intermittent noise significantly reduced response accuracy, while longer whole-body vibration exposure slowed response time. No significant interaction between noise and vibration was observed, suggesting that each factor affects cognition through different mechanisms. This study presents novel empirical evidence on the combined cognitive effects of intermittent noise and whole-body vibration exposure assessed via the Stroop Task, an approach rarely used in prior research. This study contributes to provide a better understanding of how physical environmental stressors influence selective attention in occupational settings. From a scientific perspective, controlling noise intensity and the duration of whole-body vibration exposure are essential to minimise adverse cognitive effects at work. Future research should investigate the long-term and combined effects of exposure under more complex cognitive task conditions.

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## 1. Introduction

Cognitive performance refers to an individual's capacity to process, store, and utilise information through core functions such as attention, memory, decision-making, and response control (Bufano et al., 2024). Optimal cognitive functioning is therefore fundamental to effective task execution, particularly in work settings that require sustained attention and accurate information processing. Nevertheless, exposure to excessive noise and vibration has been consistently reported to impair cognitive functions and disrupt concentration during task performance (Grenzebach & Romanus, 2022; Mesa et al., 2021). Prolonged exposure to such conditions may further contribute to long-term cognitive decline (Jafari et al., 2019).

Selective attention is a critical component of cognitive performance, referring to the ability to focus on goal-relevant stimuli while suppressing irrelevant information in complex environments (Knudsen, 2018). This ability is highly dependent on environmental conditions, as supportive work environments promote effective attentional control, whereas distracting or uncomfortable conditions

can impair cognitive performance (Jahncke & Hallman, 2020). In occupational settings, noise and whole-body vibration are among the most prominent environmental stressors known to adversely affect cognitive performance.

Exposure to occupational noise has been associated with adverse health effects, including auditory impairment, elevated blood pressure, heightened stress responses, headaches, and diminished cognitive performance (Pretzsch et al., 2021). Intermittent noise is characterised by unpredictable, fluctuating intensity and tends to be more disruptive than continuous noise because it increases cognitive load and impairs the brain's ability to filter distractions (Zeng et al., 2024; Zhang et al., 2024). A previous study found that individuals with noise-induced hearing loss show measurable declines in attention and visuospatial memory (Nadri et al., 2022).

A recent experimental investigation found that intermittent noise at 60 dBA reduced participants' arithmetic accuracy and increased discomfort (Mesa et al., 2021). Furthermore, individuals exposed to intermittent noise conditions exhibit decreased accuracy and vigilance in visual tasks, indicating that unpredictable noise fluctuations disrupt sustained attention and task performance (Carter & Beh, 1989). According to the Indonesian Ministry of Manpower's Regulation on Occupational Safety and Health in the Work Environment, the permissible exposure limit for noise is 85 dBA for an eight-hour workday.

Whole-body vibration (WBV) has been shown to affect cognitive functions, particularly when exposure is prolonged or occurs at specific intensities. These impairments are linked to disruptions in neural signalling and increased cognitive load from mechanical stimulation, which can interfere with the brain's ability to sustain focus and recall information effectively (Yang et al., 2025). In a controlled study, exposure to whole-body vibration at 16 Hz for several minutes led to a significant decline in short-term memory performance, as shown by slower reaction times and increased attentional lapses during memory scanning tasks, demonstrating that both duration and frequency are critical factors in cognitive impairment (Seok et al., 2025).

Additionally, according to Yang et al. (2025), exposure to whole-body vibration has been linked to detrimental physiological effects, including musculoskeletal disorders, impairments in the circulatory and neurological systems, and reduced cognitive performance, particularly in attention and focus. Other studies have found that, particularly in industrial environments characterised by continuous, acoustically complex noise, exposure to such noise disrupts cognitive function, reduces concentration, increases mental fatigue, lowers task accuracy, and elevates stress levels (Mesa et al., 2021). According to the Indonesian Ministry of Manpower's Regulation on Occupational Safety and Health in the Work Environment, the permissible exposure limit for whole-body vibration is  $0.87 \text{ m/s}^2$  over an eight-hour workday.

Several previous studies have analysed the effects of noise levels and vibration exposure on cognitive performance. These studies generally demonstrate that both environmental stressors independently and jointly influence cognitive performance under occupational conditions. Mohammadian et al. (2015) assessed the link between workplace noise exposure (35, 75, and 85 dBA) and whole-body vibration (0, 0.8, and  $1.1 \text{ m/s}^2$ ) on mental performance. The results indicated that both factors had significant effects on task completion time and error rates, with their interaction having a powerful impact on more complex tasks.

Additionally, Rahmani et al. (2021) explored the effects of noise exposure ( $79.50 \pm 3.51 \text{ dBA}$ ) and whole-body vibration ( $0.62 \pm 0.16 \text{ m/s}^2$ ) on cognitive performance, measured by error frequency and reaction time. The findings indicated that both factors substantially impaired cognitive performance; however, the interplay between these two factors requires further examination. Notably, existing studies predominantly employ continuous noise exposure and assess general cognitive performance indicators, without explicitly addressing the characteristics of intermittent noise or isolating selective attention as a primary cognitive outcome. Therefore, additional research is needed on the effects of noise and whole-body vibration exposure, as well as their interaction, on cognitive performance.

This study utilised the Stroop Task, a widely used neurocognitive tool that assesses selective attention, cognitive control, and processing speed by evaluating how individuals manage conflicting stimuli under time pressure (Smolker et al., 2022). The Stroop Task commonly uses total response time (TRT) and accuracy rate (correct score) as the performance metrics, allowing researchers to simultaneously assess processing speed and cognitive control during tasks involving selective attention and response inhibition (Asbee et al., 2022).

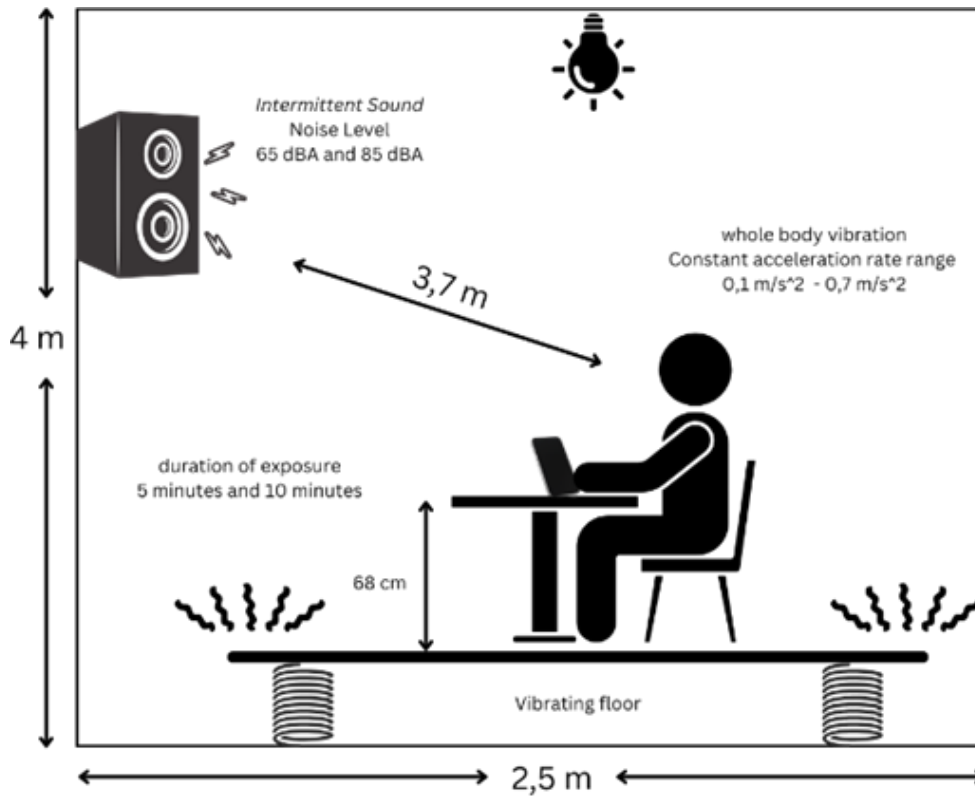
This study employs intermittent noise at two exposure levels: 65 dBA (low) and 85 dBA (high). Exposure to intermittent noise has been shown to disrupt cognitive performance. These effects are particularly pronounced when noise sharpness is high, indicating that both intensity and spectral qualities contribute to cognitive disruption (Zhang et al., 2024). Meanwhile, whole-body vibration exposure in this study was applied at constant acceleration levels ranging from 0.10 m/s<sup>2</sup> to 0.70 m/s<sup>2</sup>, with two duration levels: 5 minutes for the short-duration level and 10 minutes for the long-duration level. The selection of these treatment conditions is also supported by previous studies, which indicate that 5 minutes of vibration exposure can increase blood flow velocity, potentially increasing the risk of hypertension (Needs et al., 2023; Waldstein, 2003).

Despite extensive evidence that occupational noise and whole-body vibration impair cognitive performance, most studies focus on continuous noise and overall mental performance, leaving the effects of intermittent noise and its interaction with whole-body vibration on selective attention underexplored. In particular, experimental investigations that simultaneously combine intermittent noise exposure with whole-body vibration while targeting selective attention as a specific cognitive function remain limited. This study addresses this gap by experimentally examining the combined effects of intermittent noise and whole-body vibration duration on selective attention using the Stroop Task, assessed through total response time and accuracy.

The Stroop Task enables a focused assessment of attentional control under conflicting stimuli, making it particularly suitable for examining subtle cognitive disruptions induced by environmental stressors. The novelty of this study lies in the integrated examination of the effects of intermittent noise and controlled whole-body vibration on selective attention in a laboratory setting, using the Stroop Task as a targeted cognitive measure. Given the increasing prevalence of intermittent noise and vibration in industrial and transportation workplaces, this study provides urgently needed evidence to support occupational safety.

## 2. Method

This quantitative experimental study investigated the effects of intermittent noise and the duration of whole-body vibration on cognitive performance using the Stroop Task. A total of 12 participants were recruited using convenience sampling. Although this sample size is limited, the study was designed as a controlled, within-subject experimental investigation, in which each participant was exposed to all experimental conditions. Such designs reduce between-subject variability and can provide sufficient sensitivity to detect systematic effects in exploratory research (Lakens, 2022). Small sample sizes can be justified in studies employing tightly controlled experimental designs with clearly defined research objectives (Kelley, 2010). To enhance internal validity and minimise variability, participants were selected based on strict criteria, including normal colour vision and DASS-21 scores, a BMI between 18.50 and 24.90, and an age range of 19–22 years. The experiment was conducted from March 10 to March 17, 2025, in the Ergonomics Laboratory's climate-controlled room. Fig. 1 shows the experimental design illustrating the intermittent noise exposure levels, whole-body vibration duration conditions, and the sequence of Stroop Task administration.



**Fig. 1.** Layout of the climate-controlled room illustrating the experimental setup

This research encompasses two independent variables that induce change in the dependent variable:

- Intermittent Noise Level (65 dBA and 85 dBA)
- Duration of Whole-Body Vibration Level (5 minutes and 10 minutes)

Cognitive performance as the dependent variable was measured using the Stroop Task and comprised the following :

- TRT (reaction time)
- Correct score (accuracy rate)

The experimental design is shown in [Table 1](#).

**Table 1.** Experimental design

Noise Level	Vibration Duration	Replication	TRT (s)	Correct Score (%)
65 dBA (A1)	5 Minutes (B1)	1	(A1, B1) <sub>1</sub>	(A1, B1) <sub>1</sub>
		2	(A1, B1) <sub>2</sub>	(A1, B1) <sub>2</sub>
		3	(A1, B1) <sub>3</sub>	(A1, B1) <sub>3</sub>
65 dBA (A1)	10 Minutes (B2)	1	(A1, B2) <sub>1</sub>	(A1, B2) <sub>1</sub>
		2	(A1, B2) <sub>2</sub>	(A1, B2) <sub>2</sub>
		3	(A1, B2) <sub>3</sub>	(A1, B2) <sub>3</sub>
85 dBA (A2)	5 Minutes (B1)	1	(A2, B1) <sub>1</sub>	(A2, B1) <sub>1</sub>
		2	(A2, B1) <sub>2</sub>	(A2, B1) <sub>2</sub>
		3	(A2, B1) <sub>3</sub>	(A2, B1) <sub>3</sub>
85 dBA (A2)	10 Minutes (B2)	1	(A2, B2) <sub>1</sub>	(A2, B2) <sub>1</sub>
		2	(A2, B2) <sub>2</sub>	(A2, B2) <sub>2</sub>
		3	(A2, B2) <sub>3</sub>	(A2, B2) <sub>3</sub>

The hypotheses presented in this study are as follows.

1. Hypothesis on the effect of intermittent noise levels on cognitive performance:
  - a.  $H_{0a}$  : There is no significant difference in cognitive performance across different levels of intermittent noise.
  - b.  $H_{1a}$  : There is a significant difference in cognitive performance across different levels of intermittent noise.
2. Hypothesis on the effect of whole-body vibration exposure duration on cognitive performance:
  - a.  $H_{0b}$  : There is no significant difference in cognitive performance across different durations of whole-body vibration exposure.
  - b.  $H_{1b}$  : There is a significant difference in cognitive performance across different durations of whole-body vibration exposure.
3. Hypothesis on the interaction effect of intermittent noise levels and whole-body vibration exposure duration on cognitive performance:
  - a.  $H_{0c}$  : There is no significant difference in cognitive performance across different levels of interaction.
  - b.  $H_{1c}$  : There is a significant difference in cognitive performance across different levels of interaction.

Fig. 2 shows a schematic overview of the experimental procedure, including the participant's position, the Stroop Task presented via a mobile interface, and intermittent noise delivered through an external sound source.

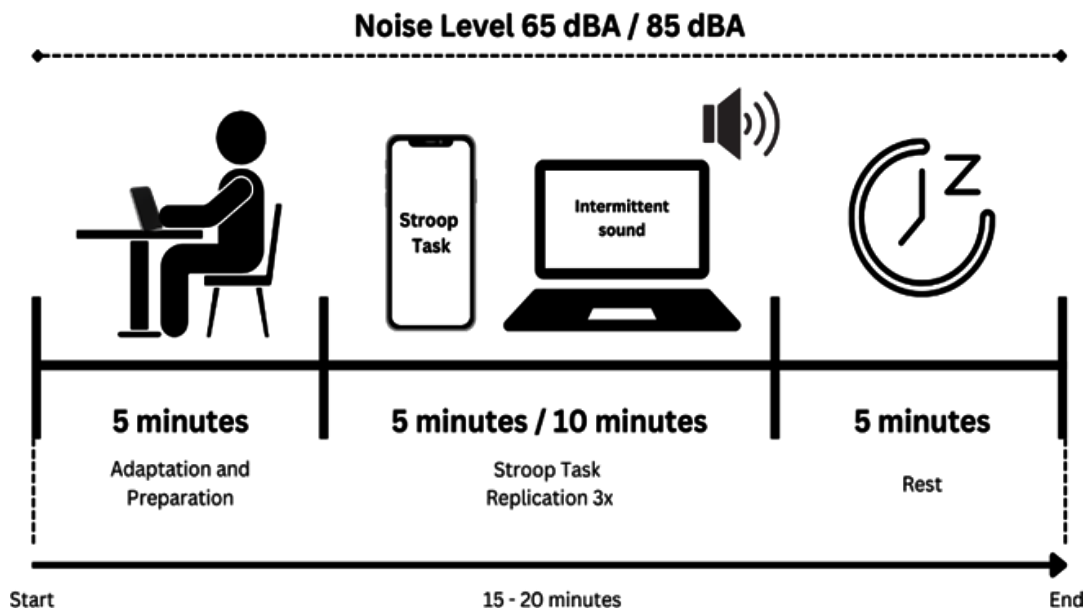


Fig. 2. Experimental procedure, showing the participant setup, Stroop Task interface, and intermittent noise exposure

The experiment was conducted over four days. Each participant completed one session per day across different combinations of intermittent noise (65 dBA or 85 dBA) and whole-body vibration duration (5 minutes or 10 minutes), yielding a total of 6 unique treatment conditions. Subsequently, participants completed a full session of the Stroop Task, consisting of 50 items, attempting to respond to as many as possible until the provided whole-body vibration exposure ended. A 5-minute intermission was provided following each session, and the outcomes were documented and examined. The Stroop Task was administered using the “get meaning, put color” mode of the Stroop Effect Test application, as illustrated in Fig. 3. In the example displayed, the word 'Blue' appears in orange ink. Under this mode's rules, the correct score is to select the button for the color blue (i.e., respond to the word's meaning, not its ink color).

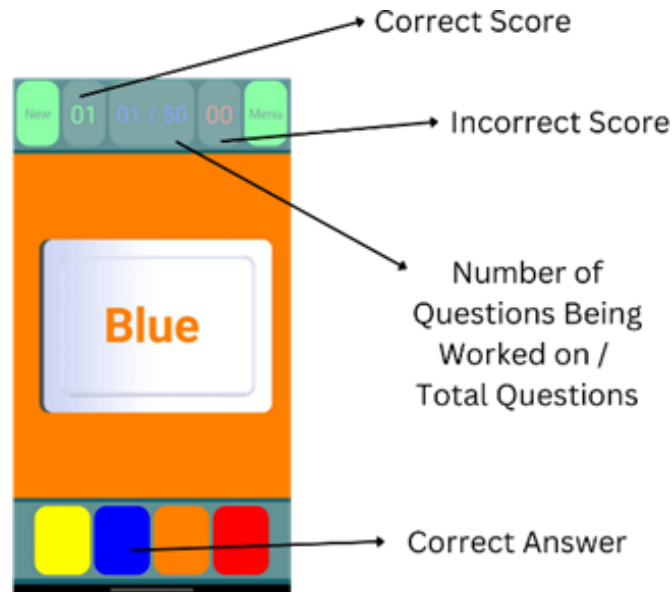


Fig. 3. Stroop Task interface illustrating the “get meaning, put color” mode.

To control for potential Stroop learning effects, participants received a brief explanation of the procedure session before data collection. This study was conducted in accordance with ethical research principles. All participants were informed of the study objectives, procedures, and their rights as research subjects, and written informed consent was obtained before participation.

### 3. Results and Discussion

This study involves the collection, processing, and analysis of data from an experimental design investigating the impact of intermittent noise levels and the duration of whole-body vibration on cognitive performance, specifically TRT and correct score.

#### 3.1. Data Collection

Participants were excluded if they had a Body Mass Index (BMI) outside the normal range, exhibited symptoms of depression, anxiety, or stress, or had diagnosed colour vision deficiencies. The characteristics of the 12 participants who participated in this study are presented in Table 2.

Table 2. Participants characteristics

Respondents	Age	Gender	BMI	Color Blind Test	DASS-21
1	22	Male	20.10	Normal	Normal
2	21	Male	24.70	Normal	Normal
3	20	Male	22.90	Normal	Normal
4	21	Male	24.80	Normal	Normal
5	21	Female	21.60	Normal	Normal
6	22	Male	22.10	Normal	Normal
7	20	Female	20.80	Normal	Normal
8	21	Male	24.50	Normal	Normal
9	21	Female	22.70	Normal	Normal
10	21	Female	21.50	Normal	Normal
11	22	Female	20.80	Normal	Normal
12	22	Female	23.20	Normal	Normal

Based on Table 2, the respondents have an equal gender distribution: six males (50%) and six females (50%). The majority of respondents were 21 years old, accounting for six individuals (50%), followed by four individuals aged 22 (33%), and two individuals aged 20 (17%). All participants had a Body Mass Index (BMI) within the normal range, normal vision as confirmed by a color blindness test, and showed no indications of depression, anxiety, or stress based on the DASS-21 questionnaire.

The results of the work for TRT and correct score from the Stroop Task at two intermittent noise levels (65 dBA and 85 dBA) and two durations of whole-body vibration levels (5 minutes or 10 minutes) are presented in Table 3 and Table 4.

**Table 3.** TRT and correct score from the Stroop Task for 65dBA

Noise Level	Subjects	Vibration Duration			
		5 Minutes		10 Minutes	
		TRT (s)	Correct Score (%)	TRT (s)	Correct Score (%)
65 dBA	1	47.81	0.99	44.86	0.97
		47.67	0.94	41.54	0.96
		48.53	0.97	42.05	0.97
	<b>Average</b>	<b>48.00</b>	<b>0.96</b>	<b>42.82</b>	<b>0.97</b>
	2	41.03	0.98	44.49	0.97
		41.13	0.97	44.08	0.97
		40.18	0.98	48.16	0.96
	<b>Average</b>	<b>40.78</b>	<b>0.98</b>	<b>45.57</b>	<b>0.97</b>
	3	41.59	0.99	45.83	0.96
		41.51	0.99	45.42	0.98
		41.51	0.97	45.61	0.98
	<b>Average</b>	<b>41.54</b>	<b>0.98</b>	<b>45.62</b>	<b>0.97</b>
	4	41.12	0.97	47.17	0.97
		40.63	0.98	47.08	0.96
		40.51	0.99	43.44	0.98
	<b>Average</b>	<b>40.75</b>	<b>0.98</b>	<b>45.90</b>	<b>0.97</b>
	5	40.07	0.97	40.00	0.96
		42.21	0.97	39.54	0.95
		38.92	0.90	44.15	0.96
	<b>Average</b>	<b>40.40</b>	<b>0.94</b>	<b>41.23</b>	<b>0.96</b>
	6	35.21	0.93	43.54	0.93
		40.68	0.93	40.20	0.96
		40.28	0.92	40.91	0.96
	<b>Average</b>	<b>38.72</b>	<b>0.93</b>	<b>41.55</b>	<b>0.95</b>
7	46.20	0.95	50.15	0.96	
	47.51	0.99	55.14	0.95	
	47.50	0.99	45.51	0.95	
<b>Average</b>	<b>47.07</b>	<b>0.97</b>	<b>50.27</b>	<b>0.95</b>	
8	35.86	0.97	41.02	0.97	
	35.79	0.95	39.46	0.97	
	36.76	0.96	39.69	0.96	
<b>Average</b>	<b>36.14</b>	<b>0.96</b>	<b>40.06</b>	<b>0.97</b>	
9	39.28	0.96	36.02	0.97	
	35.02	0.97	33.73	0.96	
	35.40	0.95	36.02	0.96	
<b>Average</b>	<b>36.56</b>	<b>0.96</b>	<b>35.25</b>	<b>0.97</b>	
10	41.65	0.98	41.26	0.99	
	41.77	0.98	44.63	0.98	
	41.92	1.00	44.20	0.97	
<b>Average</b>	<b>41.78</b>	<b>0.99</b>	<b>43.36</b>	<b>0.98</b>	
11	42.80	0.98	44.17	0.98	
	41.29	0.95	40.95	0.98	
	41.42	0.98	40.59	0.98	
<b>Average</b>	<b>41.84</b>	<b>0.97</b>	<b>41.91</b>	<b>0.98</b>	
12	41.25	0.96	45.37	0.94	
	42.12	0.97	46.05	0.95	
	40.57	0.98	45.04	0.95	
<b>Average</b>	<b>41.31</b>	<b>0.97</b>	<b>45.49</b>	<b>0.94</b>	

**Table 4.** TRT and correct score from the Stroop Task for 85dBA

Noise Level	Subjects	Vibration Duration			
		5 Minutes		10 Minutes	
		TRT (s)	Correct Score (%)	TRT (s)	Correct Score (%)
85 dBA	1	41.28	0.97	48.59	0.98
		36.18	0.97	44.57	0.91
		36.33	0.95	48.68	0.94
	<b>Average</b>	<b>37.93</b>	<b>0.96</b>	<b>47.28</b>	<b>0.94</b>
	2	45.25	0.90	47.94	0.97
		46.17	0.96	44.49	0.95
		46.64	0.97	46.29	0.96
	<b>Average</b>	<b>46.02</b>	<b>0.94</b>	<b>46.24</b>	<b>0.96</b>
	3	41.15	0.94	40.48	0.97
		41.33	0.97	43.95	0.97
		41.86	0.95	44.46	0.97
	<b>Average</b>	<b>41.45</b>	<b>0.95</b>	<b>42.96</b>	<b>0.97</b>
	4	40.80	0.97	47.72	0.95
		40.53	0.98	44.23	0.93
		40.85	0.96	47.97	0.96
	<b>Average</b>	<b>40.72</b>	<b>0.97</b>	<b>46.64</b>	<b>0.95</b>
	5	39.10	0.93	47.48	0.93
		39.97	0.96	43.35	0.95
		40.56	0.86	44.05	0.93
	<b>Average</b>	<b>39.88</b>	<b>0.92</b>	<b>44.96</b>	<b>0.93</b>
	6	35.35	0.97	39.84	0.97
		35.83	0.97	46.73	0.93
		35.59	0.96	43.90	0.90
	<b>Average</b>	<b>35.59</b>	<b>0.97</b>	<b>43.49</b>	<b>0.93</b>
7	46.34	0.99	42.09	0.94	
	54.56	0.94	43.02	0.94	
	55.92	0.93	43.15	0.93	
<b>Average</b>	<b>52.27</b>	<b>0.95</b>	<b>42.75</b>	<b>0.94</b>	
8	45.12	0.91	43.37	0.96	
	39.80	0.98	44.06	0.95	
	40.91	0.98	44.25	0.94	
<b>Average</b>	<b>41.94</b>	<b>0.96</b>	<b>43.89</b>	<b>0.95</b>	
9	32.16	0.98	44.51	0.97	
	32.02	0.95	41.23	0.95	
	32.15	0.95	44.61	0.96	
<b>Average</b>	<b>32.11</b>	<b>0.96</b>	<b>43.45</b>	<b>0.96</b>	
10	47.93	0.98	48.11	0.97	
	41.10	0.99	48.31	0.99	
	41.21	0.99	48.54	0.98	
<b>Average</b>	<b>43.41</b>	<b>0.99</b>	<b>48.32</b>	<b>0.98</b>	
11	41.08	0.99	43.58	0.96	
	36.26	0.99	44.15	0.95	
	36.40	0.95	42.53	0.95	
<b>Average</b>	<b>37.92</b>	<b>0.98</b>	<b>43.42</b>	<b>0.95</b>	
12	46.93	0.94	44.75	0.97	
	40.61	0.96	46.73	0.93	
	47.66	0.96	46.25	0.86	
<b>Average</b>	<b>45.07</b>	<b>0.95</b>	<b>45.91</b>	<b>0.92</b>	

### 3.2. Normality Test

The Shapiro-Wilk test was chosen for the normality test because the sample size was less than 50 (Ghasemi & Zahediasl, 2012). The residual values are normally distributed, as indicated by the significance value below. Table 5 shows the result of the normality test for TRT.

**Table 5.** Normality test of TRT

Noise Level	Whole-Body Vibration Duration	Statistic	Shapiro Wilk (df)	Sig.
65 dBA	5 Minutes	0.89	12	0.14
	10 Minutes	0.95	12	0.70
85 dBA	5 Minutes	0.98	12	0.99
	10 Minutes	0.91	12	0.20

Based on [Table 5](#), the results for the TRT data in each treatment condition are not significant ( $p > 0.05$ ), indicating that the TRT data have normally distributed residuals. For the correct-score data, the results of the normality tests are shown in [Table 6](#).

**Table 6.** Normality test of correct score

Noise Level	Whole-Body Vibration Duration	Statistic	Shapiro Wilk (df)	Sig.
65 dBA	5 Minutes	0.90	12	0.15
	10 Minutes	0.94	12	0.57
85 dBA	5 Minutes	0.94	12	0.55
	10 Minutes	0.99	12	1.00

Based on [Table 6](#), the results for the orrect score in each treatment condition are not significant ( $p > 0.05$ ); hence, the residuals are normally distributed.

### 3.3. Homogeneity Test

Testing the homogeneity hypothesis is fundamental in statistics to assess whether multiple samples originate from populations with identical characteristics or distributions ([Rahmani & Razmkhah, 2019](#)). The basis for decision-making guidelines in the homogeneity test is the significance value, as follows. [Table 7](#) shows the result of the homogeneity test for TRT and the correct score.

- If the significance value is  $> 0.05$ , the variance of the data population is homogeneous.
- If the significance value is  $< 0.05$ , the variance of the data population is heterogeneous.

**Table 7.** Homogeneity test

Test of Homogeneity of Variances (TRT)					
TRT	Based on Mean	Levene	df1	df2	Sig.
		Statistic			
		1.70	3	44	0.18
Test of Homogeneity of Variances (Correct Score)					
Correct Score	Based on Mean	Levene	df1	df2	Sig.
		Statistic			
		0.49	30	44	0.69

The results of the homogeneity test presented in [Table 7](#) indicate that both the TRT and correct-score datasets yielded p-values greater than 0.05, indicating homogeneous population variances.

### 3.4. Two-Way MANOVA Test

The Two-Way MANOVA significance test is applied to the dependent variables, namely TRT and correct score. The basis for decision-making in the Two-Way MANOVA test is if the significance value  $< 0.05$ , which means there is an influence ( $H_0$  is rejected), and if the significance value  $> 0.05$ , which means there is no influence ( $H_0$  is accepted). [Table 8](#) presents the result of the Two-Way MANOVA test.

The Two-Way MANOVA test in [Table 8](#) indicates that the significance value for the dependent variable TRT with respect to noise levels is 0.458, leading to the rejection of  $H_0$  and suggesting a significant effect of noise level variations on TRT. The dependent variable, representing the proportion of accurate responses relative to noise levels, yields a p-value of 0.013, leading to the rejection of  $H_0$  and indicating a substantial effect of varying noise levels on the correct score. The

results also indicate that the dependent variable TRT is significantly associated with duration of exposure to whole-body vibration ( $p=0.012$ ), leading to the rejection of  $H_0$  and confirming a significant influence of varying exposure durations on TRT. The dependent variable, representing the correct score based on exposure duration to whole-body vibration, has a p-value of 0.208; thus,  $H_0$  is accepted, indicating that varying exposure durations do not significantly affect the correct score

**Table 8.** Two-Way MANOVA test

Test of Between-Subject Effects						
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	TRT	116.741 <sup>a</sup>	3	38.914	2.701	0.057
	CR	.002 <sup>b</sup>	3	0.001	3.037	0.039
Intercept	TRT	87342.084	1	87342.084	6062.005	0.000
	CR	44.186	1	44.186	172470.479	0.000
Noise Level	TRT	8.085	1	8.085	0.561	<b>0.458</b>
	CR	0.002	1	0.002	6.726	<b>0.013</b>
Whole-Body Vibration	TRT	99.590	1	99.590	6.912	<b>0.012</b>
	CR	0.000	1	0.000	1.630	<b>0.208</b>
Noise Level * Whole-Body Vibration	TRT	9.065	1	9.065	0.629	0.432
	CR	0.000	1	0.000	0.756	0.389
Error	TRT	633.957	44	14.408		
	CR	0.011	44	0.000		
Total	TRT	88092.783	48			
	CR	44.200	48			
Corrected Total	TRT	750.698	47			
	CR	0.014	47			

\* R Squared = .156 (Adjusted R. Squared = .098)

\* R Squared = .172 (Adjusted R. Squared = .115)

### 3.5. Descriptive Statistics Test

The mean is analysed in the descriptive statistical test results to determine which level exerts the greater influence on each independent variable. [Table 9](#) displays the descriptive statistics for the TRT and the percentage of accurate responses from the Stroop Task trial.

**Table 9.** Descriptive statistics

			Mean	Std. Deviation	N
TRT Results	65 dBA	5 Minutes	41.241	3.514	12
		10 Minutes	43.252	3.759	12
		Total	42.247	3.704	24
	85 dBA	5 Minutes	41.192	5.255	12
		10 Minutes	44.942	1.879	12
		Total	43.067	4.309	24
	Total	5 Minutes	41.217	4.372	24
		10 Minutes	44.097	3.032	24
		Total	42.657	3.996	48
Correct Score Results	65 dBA	5 Minutes	0.966	0.017	12
		10 Minutes	0.964	0.011	12
		Total	0.965	0.014	24
	85 dBA	5 Minutes	0.958	0.018	12
		10 Minutes	0.948	0.017	12
		Total	0.953	0.018	24
	Total	5 Minutes	0.962	0.018	24
		10 Minutes	0.956	0.016	24
		Total	0.959	0.017	48

According to [Table 9](#), the mean TRT during a whole-body vibration length of 5 minutes is lower (41.217) than at 10 minutes (44.097). This indicates that, when subjected to a shorter duration of whole-body vibration, the research participants completed one trial of the Stroop Task more quickly than when exposed to a longer duration. The mean of the correct score indicates that the 65 dBA noise level (0.965) surpasses the 85 dBA noise level (0.953). This suggests that, under reduced noise exposure, the research participants achieved more accurate responses on a single trial of the Stroop Task than when exposed to increased noise.

### 3.6. Effect of Whole-Body Vibration Duration on TRT

Total Response Time is one of the indicators in the Stroop Task cognitive test that can test how the level of selective attention an individual works, especially in the aspect of speed in completing a task with a state of full attention. In this study, the Total Response Time (TRT) value was measured by calculating the time required by the research subjects to complete one trial of the Stroop Task as many as possible during the two levels of the work duration, namely 5 minutes and 10 minutes which were then recapped and averaged based on the results of three replication of the work.

The analysis shows that longer whole-body vibration exposure (10 minutes) significantly increased total response time compared to shorter exposure (5 minutes) ( $p = 0.012$ ), indicating slower cognitive processing under prolonged vibration conditions. This indicates that although vibrational acceleration is in the low to medium range, the duration factor is the main determinant of neurophysiological fatigue. The brain requires greater effort to integrate disrupted sensorimotor signals, thereby slowing down cognitive efficiency in executing tasks. The results indicate that longer whole-body vibration exposure significantly increased total response time, suggesting slower cognitive processing under prolonged vibration conditions. This finding can be interpreted through the lens of sensory interference and neurophysiological fatigue, where sustained mechanical stimulation disrupts sensorimotor integration and increases cognitive effort during task execution. Prolonged vibration induces a specific type of fatigue where the effort required to maintain postural stability and process incoming sensory data increases significantly. This "perception of effort" can manifest as slower reaction times and reduced attention spans.

Previous studies have reported similar effects, showing that extended vibration exposure leads to delayed reaction times and reduced processing efficiency ([Jazani et al., 2012](#); [Marelli et al., 2023](#)). The present study supports and extends these findings by demonstrating that even relatively short differences in exposure duration (5 vs. 10 minutes) can meaningfully affect processing speed during selective attention tasks. This suggests that exposure duration is a critical parameter in vibration-related cognitive impairment, independent of accuracy outcomes. The results of this study prove that in ergonomics studies, the time factor (duration) is often more dangerous than the intensity (acceleration) if the intensity is at the intermediate level. A 10-minute exposure creates a condition of "covert cognitive fatigue" that is not visible on short exposure.

### 3.7. Effect of Intermittent Noise on Correct Score

The correct score percentage is one of the indicators in the Stroop Task cognitive test which can test how the level of selective attention of an individual at work, especially in the aspect of accuracy and accuracy when carrying out a task with a state of full attention. In this study, the value of the percentage of the correct score was measured by adding up the correct score that the research subjects were able to obtain in doing one trial of the Stroop Task as many as possible during the two levels of the duration of the work, namely 5 and 10 minutes, which were then calculated to calculate the average percentage during three replications of the work. The representation of cognitive tasks of the Stroop Task type with real work in the industry lies in the ability of workers to overcome distractions, process information quickly and accurately, and deal with complex and diverse tasks.

The results indicate that higher intermittent noise levels (85 dBA) significantly reduced response accuracy compared to lower noise levels (65 dBA) ( $p = 0.013$ ). This finding demonstrates that increased noise intensity impairs selective attention performance, as reflected by a lower correct score in the Stroop Task. The present findings demonstrate that higher intermittent noise levels are associated with reduced response accuracy, indicating impaired selective attention under elevated

noise exposure. From a cognitive perspective, intermittent noise introduces unpredictable auditory fluctuations that increase attentional load and disrupt inhibitory control mechanisms, which are critical for resolving stimulus conflict in the Stroop Task. This aligns with the attentional resource theory, which posits that environmental stressors consume limited cognitive resources, thereby reducing task accuracy. This proves that high-intensity noise acts as a powerful distraction that drains selective attention resources. The intermittent nature of the sound impairs the inhibition control mechanism, which is crucial in completing tasks with high cognitive conflict such as the Stroop Task.

According to the fight to flight theory, when the human body is exposed to harmful physical factors such as noise and vibration, physiological responses in the form of attention, stress and mental workload will appear, physiological reactions activated by the body are in response to threats or stressors that will be faced by humans. The Selective Attention Theory states that humans have limitations in the attention capacity of participants, so participants choose to focus on one particular piece of information or stimulus while ignoring others. Consistent with previous studies, elevated noise exposure has been shown to impair accuracy in attention-demanding tasks (Jafari et al., 2019; Schlittmeier et al., 2015). However, unlike many prior investigations that focused on continuous noise, the present study extends existing knowledge by demonstrating that intermittent noise at 85 dBA is sufficient to degrade selective attention performance, even when exposure duration is relatively short. This finding highlights the heightened disruptive potential of intermittent noise compared to steady-state noise, reinforcing recent arguments that noise temporal characteristics play a critical role in cognitive impairment.

Overall, this study shows a degradation of dual performance (speed and precision) due to environmental stressors. Prolonged vibration (10 minutes) attacks time efficiency, while loud noise (85 dBA) attacks the quality of work. These findings provide important implications for ergonomic design and occupational safety: in high-vibration and noisy environments, the risk of *human error* increases significantly not only due to physical factors, but also due to cognitive fatigue that arises long before physical fatigue is felt.

### 3.8. Absence of Interaction Between Noise and Vibration

Despite the independent effects of intermittent noise and whole-body vibration, no significant interaction effect was observed on either response accuracy or total response time. The results suggest that, under the exposure conditions used in this study, noise and vibration influence distinct cognitive mechanisms rather than exerting a synergistic effect. No significant interaction effect between intermittent noise and whole-body vibration suggests that the resources used to tolerate vibration are not the same as those used to fend off sound distractions. Since vibration is a tactile/kinesthetic stimulus and Stroop tasks are visual/linguistic tasks that are interrupted by sound (auditory), the brain may still be able to divide the workload without causing a complete bottleneck. This result is consistent with prior findings by Ljungberg et al. (2004), who reported that combined exposure increased subjective discomfort without significantly exacerbating performance decrements. One plausible explanation is that the exposure levels remained within regulatory and physiological thresholds, limiting cumulative overload. Additionally, the homogeneity of participants in terms of age and health status may have reduced variability, thereby constraining the detection of interaction effects.

The findings of this study demonstrate that subjects subjected to 65 dBA intermittent noise attained superior accuracy scores relative to those exposed to 85 dBA. Exposure to intermittent noise exceeding 65 dBA may detrimentally affect attention and diminish work effectiveness. These results align with those of Morihara et al. (2020), who found that noise levels above 65 dBA adversely affected cognitive functions, including reading and arithmetic computations. It is advisable to keep noise levels under 65 dBA in work areas requiring heightened concentration. Implementing noise-reduction strategies, such as soundproof walls and earplugs, is advisable, as soundproof panels can reduce noise levels by over 25 dBA (Butorina et al., 2021). The study indicated that a 5-minute exposure to whole-body vibration resulted in a lower TRT than a 10-minute exposure. Extended exposure seems to diminish reaction time and impair the capacity to eliminate distractions. This corresponds with the findings of Needs et al. (2023), who observed that vibration exposure of 5–10

minutes enhances blood flow velocity, which may influence attention and concentration. To mitigate this risk, job rotation plans are advised to restrict continuous vibration exposure to a maximum of 1 hour, incorporating 10–15 minute break periods. Moreover, vibration-dampening apparatus, such as a seat or floor suspension systems, can mitigate vibration effects by as much as 45% (Marcotte et al., 2010). It is imperative to maintain vibration acceleration below  $0.70 \text{ m/s}^2$  to prevent detrimental effects.

This study contributes novel empirical evidence by integrating intermittent noise exposure with controlled whole-body vibration duration while specifically targeting selective attention using the Stroop Task. Unlike previous research that emphasised general cognitive performance or continuous noise, this study highlights how distinct environmental stressors selectively impair accuracy and processing speed through different pathways. From a practical standpoint, the findings emphasise the importance of controlling noise intensity to preserve task accuracy and limiting vibration exposure duration to maintain processing speed, particularly in occupational settings requiring sustained attention.

This study has several limitations that should be acknowledged. First, the sample size was relatively small ( $n = 12$ ), which may limit the statistical power and generalizability of the findings. Second, the participants were a homogeneous age group (19–22 years), limiting the generalizability of the results to broader working populations with more diverse age ranges and occupational backgrounds. Third, the experiment was conducted in a controlled laboratory environment, which may not fully represent real-world workplace conditions characterised by more complex and dynamic noise and vibration patterns. The use of convenience sampling is a limitation of this study, as it limits the generalisability of the findings to broader occupational settings. Hence, the results should be interpreted as exploratory and not representative of broader occupational populations. Future research should involve larger, more diverse samples, incorporate field-based experimental designs, and better examine long-term exposure effects to understand cumulative cognitive impacts in actual occupational settings.

#### 4. Conclusion

This study examined the effects of intermittent noise levels and exposure duration to whole-body vibration on selective attention performance using the Stroop Task. The results indicate that higher intermittent noise levels significantly reduced response accuracy, while longer whole-body vibration exposure increased total response time, reflecting slower cognitive processing. No significant interaction effect was found between noise and vibration, suggesting that each environmental stressor affects selective attention through distinct cognitive mechanisms. This study contributes to the existing literature by demonstrating that intermittent noise primarily impairs attentional accuracy. In contrast, prolonged whole-body vibration predominantly affects processing speed, thereby highlighting differentiated cognitive pathways influenced by environmental stressors. These findings extend prior research that has focused mainly on continuous noise exposure and general cognitive outcomes. Future research should involve larger and more diverse participant groups, incorporate field-based experimental settings, and examine long-term or cumulative exposure effects to enhance the generalizability of the findings and further explore potential interaction effects under real-world working conditions.

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