Multidisciplinary International Journal of Research and Development
Volume: 03 / Issue: 01 / 2023 - Open Access - Website: www.mijrd.com - ISSN: 2583-0406

# Road Traffic Noise and Its Repercussions on Working Adults' Reaction Time

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**Abstract—** Traffic Noise can affect performance by impeding the processing of information. It can also impair cognitive functions such as memory, focus, concentration, and reaction time. This study determined whether road traffic noise affects the reaction time of working individuals in order to answer the research question, "Does road traffic pollution have a significant effect on road traffic accidents?". The researchers utilized the Zoomh1n model as proposed by one of the validators to record road traffic noise, while the digital sound level meter GM1357 was used to determine the noise level range of road traffic in decibels. In getting the reaction time of the subjects, a standardized task by Psytoolkit. This standardized task was used in three stages: No background noise, non rush hour, and rush hour of recorded road traffic noise. Mann-Whitney Test, Kruskal-Wallis Test, and Friedman Test were used to analyze and interpret the collected data. After thorough data interpretation, it was revealed that the working adults had the slowest reaction time on both simple and choice reaction time tasks without road traffic noise, and they had the fastest average reaction time with road traffic noise during non-rush hour. In the Simple Reaction Time Task, there were statistically significant differences in the means of the subjects' overall reaction time. In the third stage of the simple reaction time task, statistically significant differences in reaction time were discovered when subjects were grouped according to sex. Additionally, significant differences were illustrated in the first stage of both simple and choice reaction time tasks when grouped according to their age.

**Keywords—** Choice reaction task, Commuter, Decibel (dB), Motorist, Noise level, Noise Pollution, Road traffic noise, Reaction Time, Simple reaction time, Sound-level-meter.

## 1. INTRODUCTION

Noise is an unwanted sound that poses a significant environmental risk to humans and the climate. It originates from multiple sources, including blaring music, humans conversing, dogs howling, traffic, and machinery. Due to urban development accompanied by a rise in population and an increase in the demand for mobility, traffic noise, the primary source of noise pollution, is becoming a major concern as traffic density on city roads increases. Traffic noise from roadways, railways, and airplanes causes discomfort and annoyance in several communities, especially during activities requiring careful consideration and focus. It disrupts sleep, causes annoyance, and impairs job performance. Noise can affect performance by impeding the processing of information. In addition, noise can hinder learning and increase mental activity-related errors (Anees et al., 2017). This results in human error and an increase in road accidents. Human error is widely recognized as the primary cause of automobile accidents. It is linked to inattention, acceleration, poor turning, and miscalculation, with inattention being the most significant contributor. Due to having to process a great deal of information, such as road signs, traffic signals, vehicles, and pedestrians, motorists and commuters may choose the incorrect response or choose the correct answer but fail to execute it. A traffic index revealed that Manila had the fourth worst traffic in the world, while Moscow had the worst. Manila had a 53% congestion rate, meaning that an average of 53% of additional travel time is required due to traffic. The study by TomTom (2020) was conducted during the remote working at home arrangement, which reduced unnecessary travel during quarantine by 18% compared to 2019. The purpose of this experimental study is to test the theory of Trimmel and Poelzl (2006) that background noise lengthened the reaction time.

## 2. LITERATURE REVIEW

### *2.1 Road Traffic Noise Pollution*

Grubesa & Suhanek (2021) state that the three elements affect how loud traffic is on the roads: the kind of motor vehicles, vehicle tires, road surface contact friction, and driving habits and mannerisms. According to Subramani & Kavitha & Sivaraj (2012), more vehicles, faster speeds, and more enormous traffic volumes result in more traffic noise. The sounds of the engine, exhaust, and tires make up vehicle noise. Defective mufflers and other faulty car parts can also make traffic noise louder. Traffic noise levels will rise in response to any circumstance that makes motor vehicles' engines work harder, like a steep hill. The traffic noise level is also influenced by other, more complex causes. For instance, distance, terrain, vegetation, and other natural and artificial barriers can all help minimize traffic noise as one walks away from a roadway.

It is a well-known and acknowledged fact that traffic noise contributes significantly to the overall noise pollution issue. The neighborhood may experience disturbances from highway noise, mainly when many automobiles are nearby. A wide range of vehicles, including big and medium trucks, buses, cars, and two-wheelers, worsen the issue of vehicular traffic noise. Traffic noise will continue to worsen due to population growth, urbanization, and the corresponding rise in the use of automobiles. From an observer's perspective, highway noise is the total noise produced by all moving vehicles on the roadway. This makes the noise that each vehicle makes, which varies depending on the type of vehicle and how it is operated, a crucial factor. The features of the vehicle flow and the proportional distribution of the different vehicle types within the flow also impact the total noise. To explain the characteristics of highway noise and then predict the appropriate noise level in the immediate area, it is essential to be aware of these factors. As a result, the complexity of the highway noise model will be determined by the noise descriptor used. Vehicle traffic noise is a well-known source of community annoyance, particularly close to busy highways. Many people believe that the main offender is truck noise. Various noise sources contribute to overall truck noise (Subramani & Kavitha & Sivaraj, 2012).

### *2.2 Effects of Road Traffic Noise on Humans*

According to Wang & Yu & Feng & Zou & Zhang & Huang (2016), environmental noise has turned into a risk problem that could cause depressive disorder, cognitive decline, and neurodegenerative disorders as cities and businesses continue to expand. It has been demonstrated that noise exposure affects the central nervous system, resulting in emotional distress, anxiety, cognitive decline, and memory problems. Exponential traffic expansion and expeditious urbanization have exasperated road traffic noise. Working adults who are employed and living

MIJRD Multidisciplinary International Journal of Research and Development

Multidisciplinary International
Journal of Research and Development

Volume: 03 / Issue: 01 / 2023 - Open Access - Website: www.mijrd.com - ISSN: 2583-0406

near busy traffic lanes are exposed to sound levels that are higher than permitted, which has a direct impact on human performance. The decrease in a person's productivity at their specific workplaces due to the rapidly expanding vehicular traffic is the root of road traffic noise pollution. Additionally, traffic noise influences adults' work efficiency in residential areas and workplaces beside busy main roads (Pal & Bhattacharya, 2012). Numerous sources have been utilized to investigate how noise affects non-auditory performance factors such as information processing, reaction time, attention, and memory of working adults. Road noise affects performance by impairing the processing of information or by causing changes in strategic reaction. Both types of stress effects are supported by evidence. Noise, in particular, raises all-around alertness or activation levels and attentional selectivity. Although it does not affect performance speed, it affects performance accuracy and working memory (Szalma & Hancock, 2011).

The impact of noise on non-auditory task performance has not been determined, with various research finding that noise either increases or decreases task performance. The auditory transmission of information, such as speech, warning signals, etc., can be disrupted by noise, which may reduce task performance. The human hearing system can distinguish between signals and background noise (Mishra & Rathore, 2012).The World Health Organization's European Centre for Environment and Health developed a guideline for assessing the health effects of environmental noise. Health issues were taken into consideration annoyance, sleep disturbance, cognitive impairment, particularly in children, and cardiovascular illness. The Environmental Protection Agency has estimated that traffic noise has contributed to at least 10,000 premature deaths annually (Jamalizadeh, 2018). In many decades of attempts to control environmental noise or environmental noise intervention led by the WHO, a conceptual framework of interventions and health outcomes was developed. Evidence of how these interventions affect human health should primarily be based on studies that have been synthesized, where the outcome of the intervention has been directly linked to a change in health. Variations in exposure can be assumed to alter the course of one's health.

### *2.3 Reaction time*

According to Fang & Davis (2017), reaction time is simply the amount of time between a stimulus and a response. A reaction is a deliberate, voluntary response to an external stimulus. The reaction time is the interval of time between the onset of a stimulus from the outside environment and the appropriate motor response to that input (Balakrishnan & Uppinakudru & Singh & Bangera & Raghavendra & Thangavel, 2014).

Milliseconds are a frequent unit of measurement. It tracks the speed with which stimuli acting on a person's sensory system cause neurophysiological, cognitive, and informational processes to be activated. Reaction time comprises the sequential processes of taking in information (visual or aural), processing it, choosing a course of action, and executing the motor act. (Baayen, 2010). As per Alimohammadi & Zokaei & Sandrock (2015), Reaction time is a complex activity that is impacted by many different factors. Mental processing time and movement time are components of reaction time. The period between perceiving a stimulus and deciding how to respond to it is known as mental processing time. Mental processing time is estimated to be 500 to 800 milliseconds. Movement time is the amount of time it takes for the respondent to move his or her muscles in order to execute the selected response.

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## 3. METHODOLOGY

In order to determine the reaction time of the working adults concerning the level and exposure to noise. The researchers used the Simple and Choice Reaction Time Task by Psytoolkit, considered a standardized test. This instrument was also analyzed and validated by an expert, and used in previous studies for its reliability. The researchers used the Zoomh1n model to record road traffic noise in EDSA. At the same time, the digital sound level meter GM1357 was used to determine the noise level range of road traffic in decibels. The points for measuring noise were chosen at 1.5 meters above the ground and 2 meters from the edge of the streets.

The recorded traffic noise was emitted in an enclosed area, and the three stages of the examination are separated by a week. Subjects were not exposed to road traffic in the first stage of the test; in the second stage, they were exposed to recorded traffic noise when it was not rush hour, and after a week, they were exposed to background noise during rush hour while completing the online task.

In the simple reaction time task, subjects must wait until they see a black cross on the white square. When that happens, subjects need to press the spacebar as soon as possible. Thus, one stimulus (black cross) and one response (pressing the spacebar) exist. In the choice reaction time task, on the other hand, subjects must wait until they see a black cross on one of the four white squares (e.g., there are four different black cross positions, which count as four different stimuli).

When that happens, they need to press the corresponding key (x, c, b, and n) as soon as possible; if they press the wrong key, it will be counted as an error; 1 error is equivalent to a 5% error percentage. Thus, there are four stimulus-response associations. When the experiment is finished, the response time is sent back to the PsyToolkit server, and subjects will see their average response speed for the simple and choice reaction time tasks at the end.

### *3.1 Participants*

The simple and choice reaction time tasks were administered to the working individuals drawn from Malate, Manila, using purposive sampling. Instead of examining who was available, the researchers relied on their best judgment to select samples based on prior knowledge. The researchers specifically targeted Malate, Manila,due to exponential traffic growth, noise, and various business firms. Also, public corporations in Malate are likely to have more employees and are highly exposed to road traffic noise.

The participants must be of a certain age, have active senses, work on-site, and exposed to road traffic noise for nearly the same amount of time. These subjects were identified based on their demographic characteristics, including age, sex, whether they were commuters or motorists, and the length of time they were exposed to noise during their workdays.16 individuals or 53% of the study's subjects were females, while only 47% or 14 were males, comprising thirty (30) working subjects.

According to their age, the subjects are categorized as ten (10) young adults aged 18-34 or 33.3%, ten (10) early middle adults aged 35-44 account for 33.3% of the total sample, and ten (10) late middle adults aged 45-64 account for 33.3%. Eight subjects (26.7%) were exposed to road traffic noise for less than an hour on working days, seven

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(23.3%) for an hour, three (10%) for an hour and a half, and twelve (40%) for two hours, assuming an equal distribution of vehicles and commuters based on their mode of daily travel.

## 4. RESULTS AND DISCUSSION

***4.1. The statistical differences in subjects' reaction time in Simple Reaction and Choice Reaction Time Task under three traffic noise levels.***

**Table 1: The overall differences and percentage of Subjects' Reaction Time in Three different levels of road traffic noise**

| Descriptive Statistics | | | | |
|---|---|---|---|---|
| **Reaction Time** | **N** | **Percentiles** | | |
| | | **25th** | **50th (Median)** | **75th** |
| **While not hearing the road traffic noise'.** | 30 | 319.75 | 377.50 | 520.25 |
| **While hearing the road traffic noise of Manila when it is not rush hour.** | 30 | 282.50 | 337.00 | 399.00 |
| **While hearing the road traffic noise of Manila when it is rush hour.** | 30 | 329.00 | 381.00 | 478.75 |
| **N=30** | Chi-square=10.067 | df=2 | | P value= 0.007 |

According to the level of road traffic noise, there was a statistically significant difference in reaction times for the Simple Reaction Time Task (test statistic value: 10.067; p = 0.007). With the application of the Bonferroni correction, Wilcoxon signed-rank tests were used in post hoc analysis, and the significance level was established at p 0.017. For the first, second, and third stages of the Simple Reaction Time Task, the subjects' median (IQR) reaction times were 377.50 (319.75 to 520.25), 337.00 (282.50 to 399.00), and 381.00 (329.00 to 478.75), respectively.

**Table 2: The differences in subjects' reaction time in Simple Reaction Time Task under three levels of road traffic noise**

| Test statistics | | |
|---|---|---|
| **Reaction Time** | **Z** | **P value** |
| **While not hearing the road traffic noise' - While hearing the road traffic noise of Manila when it is not rush hour.** | -3.435 | 0.001 |
| **While hearing the road traffic noise of Manila when it is not rush hour.- While hearing the road traffic noise of Manila when it is rush hour.** | -2.612 | .009 |
| **While hearing the road traffic noise of Manila when it is rush hour. - While not hearing the road traffic noise'.** | -.864 | .388 |

As shown in the preceding tables (Table 1 & Table 2 ), the study's hypothesis is accepted in Simple Reaction Time Task, indicating a statistically significant difference between the subjects' reaction times under the three traffic noise levels.

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**Table 3: The overall differences in subjects' reaction time in the Choice Time Task under three levels of road traffic noise.**

| Test Statistics | | | |
|---|---|---|---|
| **N=30** | Chi-square=2.067 | df=2 | p value=.356 |

There was no statistically significant difference in subjects' reaction time depending on the level of road traffic noise in the Choice Reaction Time Task, test statistic value = 2.067, p = 0.356. Median (IQR) reaction times for the first, second, and third stages of the Choice Reaction Time Task were 661.50 (511.75 to 863.75), 569.00 (483.75 to 729.50) and 602.50 (522.75 to 710.75), respectively. While the hypothesis of the study is rejected in Choice Reaction Time Task. The study's hypothesis suggests that there is a significant difference between the subjects' Choice Reaction Time under the three levels of road traffic noise, which is supported by Schlittmeier, Feil, and Hellbrück's (2015) findings that loud noise, in particular, is more detrimental to cognitive functions than moderate noise. Sensory stimulation is believed to reduce attention span by increasing arousal. It has been demonstrated that loud noise causes performance-related changes in attentional functions. According to their findings, performance was better under moderate (50 dBA) traffic noise than under high (70 dBA) traffic noise. According to Szalma and Hancock (2011), noise increases overall alertness or activation levels and attentional selectivity.

### *4.2. Statistical difference in average reaction time among subjects when grouped according to their demographic profile*

#### *4.2.1 Difference in the subjects' Average Reaction Time based on Sex.*

**Table 4: The average reaction time of the subjects in the Simple Reaction and Choice Reaction Time Task when grouped according to their Sex**

| Reaction time Task | Variables | Sex | Mean rank | P - value |
|---|---|---|---|---|
| **Simple Reaction** | While not hearing the road traffic noise'. | Male | 14.29 | 0.480 |
| | | Female | 16.56 | |
| | While hearing the road traffic noise of Manila when it is not rush hour. | Male | 13.39 | 0.220 |
| | | Female | 17.34 | |
| | While hearing the road traffic noise of Manila when it is rush hour. | Male | 11.86 | 0.034 |
| | | Female | 18.69 | |
| **Choice Reaction** | While not hearing the road traffic noise. | Male | 16.39 | 0.603 |
| | | Female | 14.72 | |
| | While hearing the road traffic noise of Manila when it is not rush hour. | Male | 16.43 | 0.589 |
| | | Female | 14.69 | |
| | While hearing the road traffic noise of Manila when it is rush hour. | Male | 13.29 | 0.197 |
| | | Female | 14.44 | |

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The table 4 showed that males had a mean rank lower than females during the third stage. Consistent with the study's hypothesis, the third stage concludes that loud traffic noise influences subjects' reaction times, showing a significant difference. Because both men and women may be sensitive to noise, it is generally true that noise degrades performance. Females are more bothered by commotion than males, and their threshold for discomfort is higher (Alimohammadi & Zokaei & Sandrock, 2015). According to Kandil, Olk, and Hilgetag (2017), the results revealed a significant difference between male and female responses to stimuli, with males responding faster than females when identifying traffic light signals. In contrast, the second and third stages did not demonstrate a significant difference, which is consistent with Silverman's (2010) study, which found evidence that the male advantage in visual reaction time is decreasing (mainly outside the United States), possibly as a result of an increase in the number of women who participate in driving and fast-action sports. Additionally, females had lengthier movement times than males, but there was no significant difference in reaction times (Alimohammad et al., 2015).

As seen in the table, there is no significant difference in the overall average reaction time of males and females in the Choice Reaction Time Task, which contradicts the study's hypothesis. Numerous studies support the study's hypothesis, particularly Bellis (2012), who discovered that men's and women's average time to light was 220 milliseconds and 260 milliseconds, respectively. According to Spierer & Raz & Benezra & Herzog & Cohen & Karshai & Benezra (2010), males responded faster to visual and auditory stimuli than females. They claimed that the use of visual cues increased the male advantage. Despite missing a statistically significant difference in the table, males have quicker reaction times at all stages than females. These results are consistent with those of Alimohammadi, Zokaei, and Sandrock (2015), who found no significant difference between male and female reaction times. However, males move and react more quickly than females. Other researchers who examined the difference in visual reaction time found that females had a slower reaction time than males (Karia et al., 2012).

***4.2.2 Average reaction time of the subjects based on Age***

**Table 5. The average reaction time of the subjects in the Simple Reaction and Choice Reaction Time Task when grouped according to their Age**

| Reaction time Task | Variables | Age | Mean rank | P - value |
|---|---|---|---|---|
| **Simple Reaction** | While not hearing the road traffic noise. | Young Adult | 11.40 | 0.006 |
| | | Early Middle Adult | 12.30 | |
| | | Late Middle Adults | 22.80 | |
| | While hearing the road traffic noise of Manila when it is not rush hour. | Young Adult | 10.90 | 0.089 |
| | | Early Middle Adult | 16.10 | |
| | | Late Middle Adults | 19.50 | |
| | While hearing the road traffic noise of Manila when it is rush hour. | Young Adult | 13.25 | 0.399 |
| | | Early Middle Adult | 18.45 | |
| | | Late Middle Adults | 14.80 | |
| **Choice Reaction** | While not hearing the road traffic noise | Young Adult | 8.25 | 0.002 |
| | | Early Middle Adult | 16.30 | |
| | | Late Middle Adults | 21.95 | |

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| | | | | |
|---|---|---|---|---|
| | While hearing the road traffic noise of Manila when it is not rush hour | Young Adult | 12.00 | 0.150 |
| | | Early Middle Adult | 14.90 | |
| | | Late Middle Adults | 14.60 | |
| | While hearing the road traffic noise of Manila when it is rush hour | Young Adult | 15.30 | 0.716 |
| | | Early Middle Adult | 14.00 | |
| | | Late Middle Adults | 17.20 | |

Based on the data presented in Table 5, late middle-aged adults had the highest mean rank (22.80), followed by young adults with the lowest mean rank (11.40), indicating that young adults had the quickest reaction time compared to early and late middle-aged adults. In the second stage of the Simple Reaction Time Task with 80 to 85 dBA of road traffic noise, the mean rank of late middle-aged adults is 19.50, while the mean rank of young adults is 10.90. Young adults and late middle-aged adults had the lowest mean rank (13.25, 14.80) during the third stage of the Simple Reaction Time Task, with road traffic noise of 90 to 95 dBA.

According to the results, the subjects' reaction time in the first stage of the Choice Reaction Time Task differs significantly by age group (p=0.002). The second and third stages of the Choice Reaction Time Task do not differ substantially by age group (p=0.150 and p=0.716, respectively). The first stage post hoc analysis revealed no significant differences in reaction time between young adults and early middle-aged adults (p = 0.123), nor between early middle-aged adults and late middle-aged adults (p = 0.454). There was, however, a statistically significant difference (p = 0.002) between the reaction times of young adults and late middle-aged adults.

**Table 6. Differences in subjects' reaction time in the first stage of the Simple Reaction and Choice Reaction Time when grouped according to their age**

| Reaction time Task | Age | Test Statistic | Sig. | P- value |
|---|---|---|---|---|
| **Simple Reaction** | Young Adult - Early Middle Adult | -900 | .819 | 1.000 |
| | Young Adult - Late Middle Adult | -11.400 | .004 | .011 |
| | Early Middle Adult - Late Middle Adult | -10.500 | 0.008 | .023 |
| **Choice reaction** | Young Adult - Early Middle Adult | -8.050 | .041 | .123 |
| | Young Adult - Late Middle Adult | -13.700 | .001 | .002 |
| | Early Middle Adult - Late Middle Adult | -5.650 | .151 | .454 |

As seen in the table 5, the average reaction time of subjects in the first stage of the Simple Reaction time task differed significantly by age group (p=0.006). In contrast, the average reaction time of subjects in the subsequent stages did not differ significantly (p=0.89, p=0399). The first stage posthoc analysis revealed significant differences in reaction time between young adults and late middle-aged adults (p = 0.011) and between early middle-aged adults and late middle-aged adults (p = 0.023). There was no statistically significant difference between young and early middle-aged adults regarding reaction time (p = 1.000).(Eppinger, Nystrom, & Cohen, 2012) found that senior adults exhibited more delayed responses than younger adults. In contrast, Martin et al. (2010) conducted a study that measured reaction time. Their findings suggest that although older adults may require more time to initiate a response, they do not require more time to execute it. No significant physical slowing with age was demonstrated, but perceptual slowing was implied (Table 5).

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Results of the first stage show that evidently, there is a significant difference on the first stage as the complex task can influence the reaction time of working adults due to the presence of multiple stimuli and minimal noise (Table 6). In contrast, the outcomes of the second and third stages indicate otherwise since noise may negatively impact cognitive abilities such as reaction time regardless of age group (Jafari & Mohammadian, 2019).Wood et al. (2015) found that the average reaction time of subjects under choice reaction time had similar results to the first stage, with delays in response selection and motor execution accounting for a small number of older age groups having slower visual Choice Reaction Time latencies than younger age groups (Table 6). Moreover, the result reported by Woods & Wyma & Yund & Heron & Reed (2015) is comparable to previously documented age-related increases in CRT latencies. The effects of aging were quite significant: the mean CRT latencies of participants aged 59 to 65 increased by more than 120 ms (1.8 standard deviations) compared to the earliest participant group. Further research revealed that age did not affect the duration between movement preparation and initiation (Haith, 2016).

## 5. CONCLUSIONS AND RECOMMENDATIONS

According to the findings of this study, working adults have the slowest reaction time on both Simple and Choice Reaction Time during the first stage or when there is no road traffic noise, while they have the fastest reaction time during the second stage or when there is road traffic noise during non-rush hour. The mean error percentage between the simple and choice response time tasks showed a clear difference, indicating that choice reaction time causes errors to increase. In the Simple Reaction Time Task, there was a statistically significant difference between the first and second stages, as well as between the second and third stages. In contrast, there were no statistically significant differences in all stages of the Choice Reaction Time Tasks. In the third stage of the Simple Reaction Time Task, there was a significant difference based on sex. There was a statistically significant difference in the first stage when the Simple and Choice Reaction time tasks were grouped by age. Finally, there were no significant differences when they were grouped according to whether they were daily travelers or how long they were exposed to road traffic noise on working days. It is recommended for working adults to consider alternative transportation like public transit, which can reduce time spent on noisy roads, using headphones or earplugs to avoid noise exposure, creating a noise-controlled workspace, and raising awareness about noise pollution. These measures can help reduce exposure and improve focus and productivity. More studies on the role of the length of exposure of the subjects to other types of noise and their personality attributes are suggested.

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