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DRIVER DISTRACTION ASSOCIATED WITH MOBILE PHONE TACTILE TASKS: A DRIVING SIMULATOR-BASED STUDY

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Abstract:

The mobile phone is an extremely beneficial tool for humanity, capable of performing a multitude of functions beyond the mere transmission and reception of telephone communications. Regrettably, it has the capacity to cause significant distractions for drivers in numerous ways. The aim of the study is to measure the distraction in terms of participants' response time for different tactile tasks and driving scenarios. In this research, 54 participants executed several secondary tasks (i.e., tactile tasks) while simultaneously engaging in the DRT throughout a simulated driving environment. For the comparison of driving scenarios, three scenarios were used: free flow (40 km/h) with medium traffic volume, free flow (40 km/h) without traffic and traffic jams. For different tactile tasks, apart from the 2-character number, other tactile tasks such as 5, 9, 14, and 20 number of characters were also assessed. The study findings indicated that participants responded to lesser stimuli when dealing with more difficult tactile tasks. Besides, the results found that drivers were more distracted when dealing with more demanding tasks of using mobile phones (i.e., tactile tasks) as compared to baseline. In addition, participants attended the worst in terms of stimuli and higher response time in the traffic jam scenario as compared to other scenarios. Besides, the study discovered that the novice drivers' group was identified to respond at a significantly faster rate than the experienced drivers' group. In terms of gender, male drivers were generally faster in terms of response time than female drivers, with no significant differences.

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Keywords:

Distracted Driving; Driving Simulator; Mobile Phone; Tactile Tasks; Road Safety.

Introduction

In 2023, there were 6,473 fatalities attributed to road accidents (Royal Malaysian Police, 2024). This concerning statistic equates to an average of 17 deaths daily. Road traffic injuries rank as the eighth leading cause of death globally, with over one million persons succumbing each year due to road accidents (World Health Organisation, 2018). Human mistakes account for over 90% of road traffic accidents (Chan, 2007). Driver distraction is a significant and escalating threat to road safety. Driver distraction refers to any activity that diverts a driver's focus from the main objective of driving (Ranney, 1994). Driver distraction may hinder performance by diverting attention from the main job in perilous conditions, as drivers get engrossed in supplementary duties that compromise their capacity to operate a vehicle safely (Young & Salmon, 2012). Driver distraction is recognised as a contributing factor in at least 25% of vehicular accidents in various studies (McEvoy, Stevenson, & Woodward, 2007; Stutts, Reinfurt, Staplin, & Rodgman, 2001; Wang, Knipling, & Goodman, 1996). This figure may increase in the future due to the prevalent usage of cell phones while driving, which may distract operators.

Numerous studies throughout the globe have shown that driving distraction, including using a cell phone while driving, increases the probability of being involved in an accident (Horberry et al., 2006; Klauer et al., 2006; Redelmeier & Tibshirani, 1997). According to other research, even one hour of mobile phone usage while driving each month may raise a driver's risk of an accident by 400–900% (McEvoy, Stevenson, & Woodward, 2007; Violanti, 1998; Violanti & Marshall, 1996). Alcohol intoxication has been shown to be less disruptive than cell phone usage while driving (Strayer, Drews, & Crouch, 2006). Some research found that using a cell phone while driving has a negative impact on drivers' performance. These studies also shown that the performance of mobile phones, both hands-free and hand-held, is similar to that of driving normally, which does not include using a phone (Elvik, 2011; Stelling & Hagenzieker, 2012).

Research on the subject of driver distraction, particularly as it relates to cell phone use in Malaysia, is still lacking. In a relatively small experimental investigation, MIROS used a driving simulator to test the response time of a range of secondary activities, such as texting while driving, without revealing the character count. Mohd Firdaus, Mohd Hafzi, Abdullah, Nurulhana, and Wong (2014) found that the texting response time was 97% different from the baseline job. Furthermore, as per Aini and Sharifah (2016), a self-reported survey on mobile phone usage while driving in the Klang Valley found that 43.4% of drivers in the area used their phones while driving, 61.9% while at a red light, and 53.6% while stuck in traffic. No particular accident statistics pertaining to the kind of defect linked to driver distraction have been published in Malaysia. With a total rate of 74.81%, careless driving, hazardous driving, risky turning, unsafe overtaking, driving too close, reckless at entry or departure, and negligent signals are all somewhat connected but debatable (Royal Malaysian Police, 2015). With an estimated 176.5 million mobile phone users in 2015, Malaysia has 5.8 mobile phones for every Malaysian. Additionally, 25,856 million Short Message Services (SMS) were sent in that same year, according to estimates from the Malaysian Communications and Multimedia

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Commission (2015). Given the aforementioned statistics and the development of smartphones, it is expected that the use of mobile phones while driving in Malaysia would be affected. MIROS carried out the research and released the article that clarifies the methodology, data analysis, and research results, acknowledging the serious problems associated with using mobile phones as a distraction. Participant response times in a variety of driving situations and mobile phone tactile activities were used to gauge participant distraction.

Materials and Methods

This research used convenience stratified sampling and a mixed-method experiment. Participants were recruited via institutional mailing and phone lists, and social media platforms to form a sample of licensed drivers. Out of the fifty-four participants in the study, twenty-seven were men and twenty-seven were women. To enhance demographic representation, we used quota sampling by sex (approximately 50% women) and age (18–24, 25–39, 40–54, 55-57), mirroring selection practices used in NHTSA's DRT evaluations. Participants vary in age from 18 to 57, with a mean age of 31.47. Recruitment continued until quotas were met. Eligibility criteria included a valid driver's license, at least 1 year of active driving, and normal or corrected-to-normal vision and hearing. The subjects, all of whom are right-handed drivers, lack any particular information or experience related to the research. The participants voluntarily took part in the research after reading and signing a permission form outlining the goals and methods of the investigation. An average of 10.42 years of driving experience and 20,478.27 km of driving mileage are covered annually. Everybody involved is a licensed driver. Both the general public and MIROS employees were selected as attendees. It is required that participants be able handle an automatic gearbox. There were two participant groups in the study: inexperienced and seasoned drivers. Drivers between the ages of 18 and 24 who have fewer than four years of driving experience are considered novice drivers. According to SWOV (2008), experienced drivers are individuals who are between the ages of thirty and fifty-nine who have amassed more than 10 years of driving experience. See Table 1 for the demographic overview.

Table 1: Participant Demographics (N = 54)

Characteristic	Category/Statistic	n / value	%
Total participants	N	54	100.0
Gender	Male	27	50.0
	Female	27	50.0
Age	Mean (range), years	31.47 (18–57)	
Driving experience	Mean years	10.42	
Experience group	Novice	28	51.9
	Experienced	26	48.1
Annual driving mileage	Mean (km/year)	20,478.27	
Handedness	Right-handed	54	100.0
License status	Valid, ≥1 year	54	100.0
Vehicle transmission	Able to operate automatic	54	100.0

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Although the sample size (N = 54) is common for repeated-measures simulator studies, the use of convenience stratified sampling and a single-site cohort constrains external validity. In particular, the participants may not reflect the full heterogeneity of the broader driving population across age strata, cultural backgrounds, and habitual driving practices. Classic threats to generalizability (external validity) arise when inferences are drawn from narrow samples and settings (Shadish, Cook, & Campbell, 2002), and behavioral science has repeatedly shown that samples drawn from limited socio-cultural contexts can misrepresent population-level effects (Henrich, Heine, & Norenzayan, 2010). Cross-national work on driver behavior further indicates systematic differences in violation and error patterns across traffic cultures, underscoring those effects observed in one context may not transfer unchanged to others (Özkan & Lajunen, 2006; Bener et al., 2013). These considerations temper the generalizability of our estimates to drivers age, driving experince, and drivers from different cultural or roadway contexts.

At the same time, the within-subject design (multiple scenarios and character-length conditions per participant) increases statistical efficiency relative to between-subjects designs, helping to detect condition effects with modest sample size (Donmez, Boyle, & Lee, 2006). Many validated simulator experiments in the literature employ samples on the order of 20–30 participants. For example, Godley et al. (2002) used N = 20, and exploratory protocols have set N = 24 based on precedents, reflecting the high trial counts and repeated measures typical of simulator paradigms (Godley, Triglone, & Fildes, 2002; Iwata et al., 2019). Nonetheless, the present sample should be viewed as providing internally valid estimates under controlled conditions rather than population-representative parameters.

This study used the MIROS Fixed-base Driving Simulator Cabin (CabinDS), which was based on the second generation of the Perodua Myvi 1.3L platform. The basic components of the simulator include software for simulation, a steering wheel, pedals, a gearbox, a full car section, LCD projector and screen, a desktop computer, a video camera, and a speaker system. Figure 1 illustrates the CabinDS.

Figure 1: MIROS Fixed-base Driving Simulator Cabin (CabinDS).

This study developed three separate driving scenarios: free flow at 40 km/h with moderate traffic volume, free flow at 40 km/h in the absence of traffic, and a traffic congestion situation. Figure 2 illustrates the designated simulated driving scenarios.

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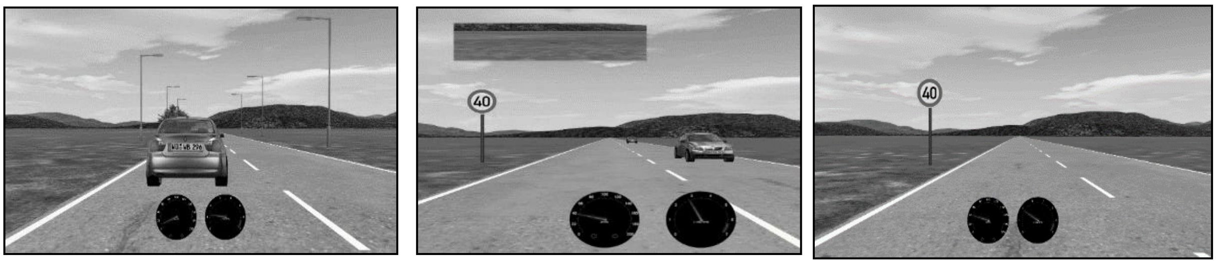

(a) Traffic jam

(b) Free-flow (40 km/h) with medium traffic volume

(c) Free flow (40 km/h) without traffic

Figure 2: Simulated Driving Scenarios

This study relied on a fixed-base driving simulator to manipulate task demand and maintain experimental control. While simulators are widely used and show behavioral and (at least) relative validity for many driving outcomes, they cannot fully reproduce real-world complexity (e.g., transient emotional states, weather, lighting, and heterogeneous traffic) that can modulate distraction effects (Godley, Triglone, & Fildes, 2002; Wynne, Beanland, & Salmon, 2019). Consequently, the present findings should be interpreted as internally valid estimates under controlled conditions rather than population-level parameters that automatically generalize to all roadway contexts.

Several strands of field and naturalistic evidence indicate why translation from simulator to road may vary. First, emotions influence driving. The anger and even positive high-arousal states (e.g., happiness) can degrade lane keeping, elevate speeds, and worsen workload, implying that affective load could magnify or attenuate distraction effects in traffic (Jeon, Yoo, & Lee, 2014; Roidl, Frehse, & Hoegg, 2014). Second, adverse weather alters exposure and driver behavior; meta-analytic and review work consistently links precipitation (and, where applicable, snow) to higher crash frequencies, which changes both baseline risk and drivers' spare attentional capacity (Qiu & Nixon, 2008; Theofilatos & Yannis, 2014). Third, large-scale naturalistic studies show elevated crash risk during real-world secondary-task engagement, underscoring the need to verify laboratory effects in situ (Dingus et al., 2016).

At the same time, simulator paradigms remain appropriate for isolating mechanisms and screening risky interfaces because they allow standardized probing of attention (e.g., ISO-recommended Detection-Response Task, DRT) with acceptable safety and repeatability. Prior reviews describe DRT use in both simulator and on-road contexts, and validation studies report that simulators often achieve absolute or relative validity for key measures, even if not universally so (Stojmenova & Sodnik, 2018; Wynne et al., 2019). Accordingly, this study inferences are best viewed as conservative, mechanism-level effects that warrant field corroboration.

Driving was done in a traffic-simulation environment, and the Detection Response Task (DRT) was used in a dynamic context. According to Young, Regan, and Hammer (2003), one technique for evaluating driver distraction is DRT. The Detection Response Task (DRT) is a standardized secondary-task method for quantifying attentional demand during driving: brief probe stimuli are presented while the driver continues the primary task, and the driver responds as quickly as possible via a button press. The two core outcomes are reaction time (ms) to detected probes and the percentages of stimuli responded (Stojmenova & Sodnik, 2018).

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According to the road conditions, the participants completed the task of driving and the secondary tasks simultaneously. The delivery of stimuli for the DRT was managed by the DRT program. Tactile DRT was used in this investigation. The stimulus was provided via the DRT at randomly dispersed, evenly spaced intervals of three to five seconds in duration. The participant replied by pressing a microswitch attached to the steering wheel's right index finger. The microswitch gave mechanical feedback, which signalled a reaction.

For every activity involving entering characters into a cell phone, such texting or entering a location, the tactile job was duplicated. For the tactile job, a cell phone was inserted into the driving simulator's windscreen utilising a suction holder. The mobile phone was equipped with a Notes application, which asked participants to repeatedly enter the designated words as many times as they could in two minutes using the set character counts. The phrases appeared on a piece of paper that was fastened to the dashboard. Table 2 provides information on the words that correspond to the character numbers.

Table 2: List of Words and Character Numbers

Number of Characters	Words
2	kg
5	taman
9	teknologi
14	jalan semenyih
20	lorong kajang raya 2

The secondary task was operationalized as mobile-phone text entry performed concurrently with a tactile Detection-Response Task (DRT). Text entry is a prototypical visual-manual interaction that degrades driving by increasing glances away from the roadway and slowing hazard responses (e.g., Hosking, Young, & Regan, 2009; Caird et al., 2014). Consistent with safety guidance, visual-manual tasks that cannot be completed with brief glances (≤ 2 seconds) and limited cumulative eyes-off-road time (≤ 12 seconds) are considered problematic during driving (NHTSA, 2013, 2016). To quantify attentional effects while preserving ecological validity, we used the ISO-standard DRT with a tactile stimulus and a 3 to 5 seconds randomized probe interval, which is recommended for assessing the attentional impact of concurrent secondary tasks in simulated or on-road driving (ISO, 2016; Stojmenova & Sodnik, 2018).

Character-length conditions (2, 5, 9, 14, and 20 characters) were selected to provide a graded manipulation of task demand anchored in prior benchmark text-entry work. NHTSA’s foundational assessment for the Visual-Manual Guidelines tested short/medium/long entries at 4/6/12 characters and showed that longer inputs elevate glance metrics (Boyle et al., 2013). Subsequent studies corroborate that increasing message length increases the number of glances, total eyes-off-road time, and the longest single glance (e.g., Peng et al., 2013; Taneja et al., 2024). The set brackets and extends these benchmarks to capture everyday interactions: 2 characters (“kg” short form for “kampung”), 5–9 characters (single-word queries such as names or places), 14 characters (two-word street names), and 20 characters (short address fragments). This design yields monotonic increases in visual-manual demand while keeping trials compatible with DRT timing (≥ 24 probes in a 2 minutes block), thereby supporting stable estimation of hit rate and reaction time (ISO, 2016; Boyle et al., 2013; Taneja et al., 2024).

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Each participant needed around one and a half hours to complete the data gathering procedures. Participants received detailed instructions before the procedures were carried out. Participants also had to fill out documents pertaining to their personal information and informed permission. Before the data gathering process started, participants received a safety briefing. Participants were then given a simulator sickness screening before the experiment began. Verifying the participants' physical and mental capacity to operate the driving simulator was the aim of the evaluation. They were then asked to lead familiarisation and training sessions for the driving simulator, secondary task, and DRT equipment. Participants in this training session were not given a time restriction, but the session ended when they were certain they could do the tasks. All tasks were to be completed within the actual data collecting period, and participants were free to quit the experiment at any time without being forced to do so. Participants also underwent post-simulator illness assessment once the actual data collection was finished. After all tasks were completed, participants were asked about their driving experiences. Following that, participants received incentives and expressions of thanks for their involvement.

To minimize adverse effects and enhance procedural clarity, the study implemented a standardized simulator-sickness protocol before, during, and after exposure. Prior to familiarization, participants completed the Motion Sickness Susceptibility Questionnaire-Short Form (MSSQ-Short) to observe individual susceptibility (Golding, 2006). Immediately before the first drive, a baseline Simulator Sickness Questionnaire (SSQ) was collected (Kennedy, Lane, Berbaum, & Lilienthal, 1993). Participants then completed a brief, self-paced familiarization until they reported comfort with the steering, pedals, and secondary task.

During data collection, symptoms were monitored continuously by the experimenter. Runs were paused if a participant reported moderate symptoms on any SSQ item (e.g., nausea, oculomotor discomfort, disorientation) or requested a break; a 5–10-minute rest was provided and the next run resumed only if symptoms subsided. Testing was terminated upon persistent symptoms or participant request, consistent with recommended SSQ-based safety practices (Kennedy et al., 1993; see also reviews in Bouchard et al., 2021). Across runs, short breaks were scheduled between blocks to mitigate accumulation of symptoms.

Immediately after the final drive, the study administered a post-exposure SSQ to quantify any change from baseline (Kennedy et al., 1993) and a NASA-TLX to characterize subjective workload for the primary or secondary task combination (Hart & Staveland, 1988; Hart, 2006). Adverse events (if any) and early withdrawal were observed in the study. This assessment package complements the ISO-17488 Detection-Response Task (DRT) outcomes by documenting tolerability and perceived workload under the same task conditions (ISO, 2016).

Results and Discussion

Figure 3 contains percentages of stimuli participants responded to in all driving scenarios across different number of characters during tactile tasks. The baseline, of course, have the highest number of stimuli participants attended. As the number of characters increases, the response percentages went decrease. There is also evident of possible interaction of traffic scenarios as traffic jam condition contained the lowest number of stimuli participants reacted to in all character conditions.

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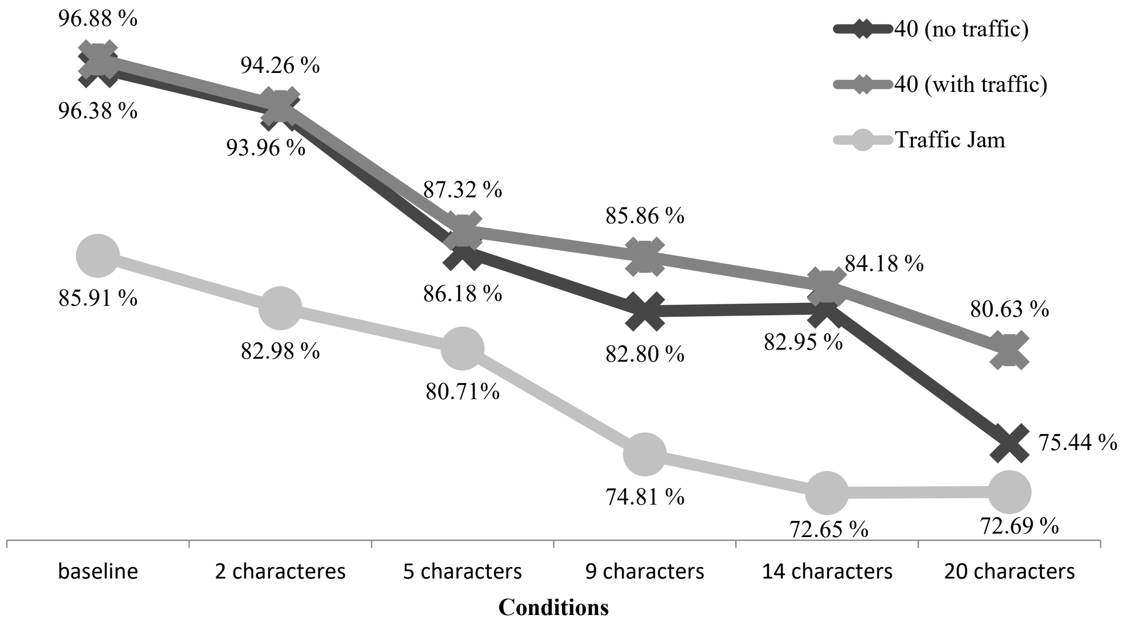

Figure 3: Proportion of Stimuli Responded to by Each Character According to Driving Scenarios

The response time findings were analysed using a mixed factorial repeated-measures ANOVA to examine mean differences in response time for different characteristics and driving conditions, as well as possible interactions. Figure 4 contains the means of response time across conditions and driving scenarios. The analysis revealed significant main effect of number of characters during tactile tasks on response time $F(3.83, 198.94) = 58.54$, $p < .001$ (Greenhouse-Geisser corrected). Further analysis using simple contrasts showed that the other characters' response times were significantly higher compared to the baseline, $F_{baseline\ vs.\ 2}(1, 52) = 75.37$; $F_{baseline\ vs.\ 5}(1, 52) = 77.41$; $F_{baseline\ vs.\ 9}(1, 52) = 92.95$; $F_{baseline\ vs.\ 14}(1, 52) = 135.39$; and $F_{baseline\ vs.\ 20}(1, 52) = 161.55$; all pairs had $p < .001$.

The main effect of traffic scenarios were also significant, $F(2, 104) = 157.52$, $p < .001$. Further, contrasted with traffic jam, the response time for the other 40 km/h traffic scenarios are significant, $F(1, 52) = 254.03$, $p < .001$; and $F(1, 52) = 152.57$, $p < .001$; for respectively without traffic and medium traffic conditions. The interaction between traffic scenarios and character conditions are marginally significant, $F(7.59, 394.70) = 2.03$, $p = .05$;

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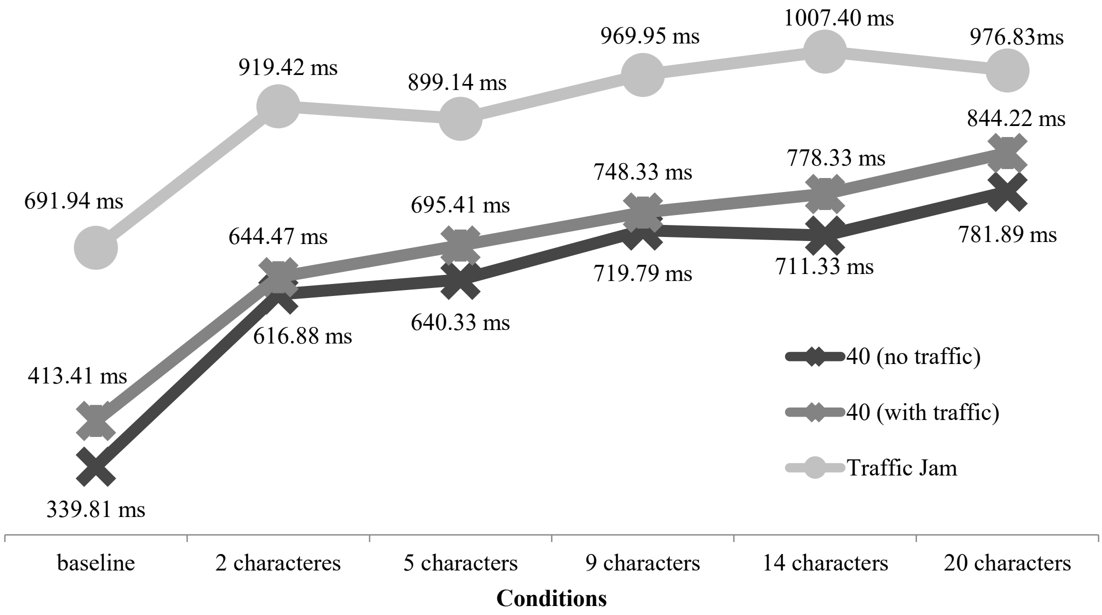

Figure 4: Response Time (Milliseconds) For Each Character According to Driving Scenarios

The study went on to examine the between-subject variables of age group and gender. The age group was divided into two categories: beginner (those aged 18 to 24 with less than 4 years of driving experience) and experienced (those aged 30 to 59 with more than 10 years of driving experience).

The investigation of response time in character tactile tasks indicated a non-significant main effect of gender regarding response time, $F(1, 51) = .61$, $p = .44$; but a significant results of age group, $F(1, 51) = 6.17$, $p = .02$. There were no interaction effects of response time during tactile tasks between gender and number of characters ($F(3.76, 191.71) = .68$, $p = .60$), between gender and traffic scenarios ($F(2, 102) = 2.55$, $p = .08$); as well as between age group and traffic scenarios ($F(2, 102) = .02$, $p = .98$). The only interaction observed was between age group and number of character conditions, $F(4.11, 209.36) = 4.96$, $p = .001$. Table 3 contains detailed means for every condition.

Table 3: Overview of Response Time Metrics by Gender and Age Group for Character Count Conditions.

Scenario	Character No.	Response Time, *M* (*SD*) milliseconds			
		Male (*N* = 27)	Female (*N* = 27)	Novice (*N* = 28)	Experience (*N* = 26)
40 km/h (no traffic)	Baseline	320.86 (141.62)	359.49 (140.59)	334.31 (154.52)	345.97 (127.29)
	2 Character	596.91 (312.88)	637.60 (343.64)	537.76 (296.26)	705.49 (340.22)
	5 Character	597.49 (323.94)	684.82 (316.98)	540.66 (237.3)	751.95 (366.93)
	9 Character	685.99 (322.46)	754.89 (363.87)	604.37 (286.49)	849.06 (357.63)
	14 Character	736.25 (355.98)	685.46 (199.2)	626.71 (219.57)	806.11 (328.77)
	20 Character	718.89 (314.71)	847.31 (296.56)	685.28 (256.01)	890.09 (333.46)
40 km/h,	Baseline	412.21 (202.78)	414.66 (190.94)	388.57 (193.22)	441.22 (197.47)
	2 Character	649.86 (346.54)	638.87 (292.50)	584.96 (331.82)	711.11 (294.37)

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	5 Character	686.02 (403.77)	705.16 (249.88)	618.98 (347.91)	781.01 (302.06)
	9 Character	714.51 (355.37)	783.45 (317.34)	655.9 (290.17)	851.85 (358.45)
	14 Character	758.43 (351.63)	798.99 (365.02)	663.9 (289.64)	906.48 (383.26)
	20 Character	835.92 (400.05)	852.85 (285.79)	714.18 (291.89)	989.87 (347.77)
Traffic Jam	Baseline	628.37 (286.57)	757.96 (344.56)	691.91 (312.26)	691.98 (334.98)
	2 Character	865.79 (394.28)	975.11 (338.04)	837.44 (383.73)	1011.23 (334.31)
	5 Character	819.54 (356.43)	981.81 (336.22)	807.1 (317.48)	1002.23 (368.2)
	9 Character	942.01 (427.83)	998.95 (328.00)	875.69 (322.09)	1075.51 (416.49)
	14 Character	996.32 (399.59)	1018.90 (336.16)	891.12 (343.45)	1137.63 (353.32)
	20 Character	930.51 (348.31)	1024.94 (251.01)	881.57 (278.48)	1083.52 (303.81)

The literature review highlights that driver can become distracted in various ways when using mobile phones while driving. This investigation employed DRT to assess the impact of driving demand and engagement in secondary tasks on driver attention. The secondary task consisted of a tactile activity that required inputting a maximum of 20 characters. This task involves replicating any activity that requires the input of characters using a mobile phone. An intriguing observation is that the quantity of characters required for input influences the degree of distraction assessed among the participants. Drivers exhibit heightened distraction levels when engaging in tactile tasks, relative to baseline measurements. This finding supports the connection between task demand and the degree of distraction identified in earlier research (Knapper, Hagenzieker, & Brookhuis, 2015). Additionally, another investigation indicated that participants' driving behaviour was negatively affected by simultaneous text messaging activities (Reed & Robbins, 2008).

A notable finding was that drivers' reaction times to stimuli increased due to their involvement in a secondary tactile task while navigating difficult driving conditions, indicating a substantial rise in distraction. Distraction among drivers was most commonly observed in traffic jams rather than in free-flowing traffic conditions. The degree of distraction resulting from mobile phone use is intensified by challenging driving situations. While a previous study did not find a correlation between the frequency of distracted driving behaviours and traffic volume (Foss & Goodwin, 2014), our findings indicate that the risk of distracted driving may be heightened under specific traffic conditions. The complexity of secondary tasks can exacerbate this risk, as demonstrated by the notable interaction effects on participants' response times.

This study compared the response times of novice and experienced drivers, revealing an intriguing finding. The novice group exhibited a significantly faster response to the stimuli compared to the experienced group. This discovery was unexpected, primarily because prior research indicated that a higher level of experience correlates with enhanced adaptation to more complex driving environments (Rudin-Brown, Edquist, & Lenne, 2014). The influence of experience on driving performance does not consistently align with the degree of distraction. The novice group may not demonstrate superior driving performance despite their faster response to stimuli, and the opposite may also be true. Prior research indicates that experience does not mitigate the safety concerns related to distracted driving resulting from dual tasking. The complexity of the primary task, such as operating a moving vehicle, is the main factor contributing to this issue (Knapper, Hagenzieker, & Brookhuis, 2015).

At first glance, the finding that novice drivers yielded faster DRT reaction times than experienced drivers appear to conflict with the general expectation that experience supports superior performance in complex traffic. This apparent contradiction is resolved by recognizing

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that the two claims refer to different constructs. The DRT primarily indexes speeded detection under dual-task load (secondary-task attentional availability), not holistic driving skill; faster responses on a speeded probe can arise from a more liberal response criterion or prioritization of the probe at the expense of primary-task control (i.e., a speed–accuracy or task-prioritization trade-off) (Heitz, 2014; Wickens, 2008). In other words, shorter DRT latencies do not necessarily imply safer or more adaptive driving.

A second, likely contributor is age-related motor speed. Our novice group was younger by design, and large epidemiological datasets show that simple and choice reaction times are generally faster and less variable, in younger adults than in middle-aged and older adults; this age effect can manifest even when task demands are modest (Der & Deary, 2006; Dykiert et al., 2012). Thus, the between-group difference in DRT latency may reflect baseline age-related speed rather than superior attentional control or safety-relevant performance.

By contrast, the experience advantage typically reported in the literature concerns perception action strategies in complex scenes (e.g., broader scanning, earlier anticipation of latent hazards, and more conservative time-sharing) rather than raw response speed. Experienced drivers exhibit wider horizontal search, shorter hazard-scene fixations, and better anticipation of conflict cues; novices show narrower search and delayed hazard recognition (Chapman & Underwood, 1998; Pradhan et al., 2005; Crundall et al., 2016). Accordingly, the data can be interpreted as follows: novices responded quickly to the probe, but this does not preclude experienced drivers having advantages in hazard anticipation and regulation under complex traffic, which are the skills most tied to crash risk.

The present findings showing robust decrements in attention (lower probe response rates and slower DRT latencies as mobile-phone text-entry demand increases and as traffic complexity rises have several actionable implications for road-safety policy and practice as follows:

a) Strengthen and enforce comprehensive phone-use laws. Jurisdictions should adopt or maintain comprehensive hands-free laws that prohibit hand-held phone use and texting for all drivers, supported by High-Visibility Enforcement (HVE) waves. Evaluations of HVE demonstrations in Connecticut and New York documented large, statistically significant reductions in observed hand-held use during enforcement waves (e.g., 6.8% to 2.9% in Hartford; 3.7% to 2.5% in Syracuse) (Chaudhary, Casanova-Powell, Cosgrove, Reagan, & Williams, 2014). Reviews likewise conclude that all-driver hand-held bans reduce hand-held use and can improve safety-relevant outcomes; more recent analyses suggest strengthened hands-free laws are associated with crash-related benefits (McCartt, Kidd, & Teoh, 2014; Reagan, 2023). Given naturalistic evidence that visual-manual phone interaction elevates crash risk several-fold, enforcement should prioritize behaviors with the highest risk (Dingus et al., 2016; World Health Organization [WHO], 2018).

b) Require safer Human-Machine Interfaces (HMIs) and app behaviors**.** Regulators and procurers can accelerate safer design by referencing established guidance. NHTSA's Visual-Manual Driver Distraction Guidelines specify glance-time and total eyes-off-road targets and recommend lock-outs for high-demand tasks; Phase 2 extends the framework to portable/aftermarket devices and driver-mode features (NHTSA, 2013, 2016). Procurement or type-approval programs can require OEMs and app developers

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to demonstrate conformance using standardized attention metrics (e.g., ISO 17488 Detection-Response Task) during design verification (ISO, 2016).

c) Institutional and fleet policies**.** Employers (public and private fleets) should implement comprehensive policies that ban all phone use while a vehicle is in motion (hand-held and hands-free), require pulling over for communication, and, where feasible, deploy phone-blocking or driver-monitoring technologies. Centers for Disease Control and Prevention (CDC) / National Institute for Occupational Safety and Health (NIOSH) guidance provides model provisions and implementation steps that organizations can adopt immediately (CDC/NIOSH, 2024). Professional societies similarly urge explicit, enforceable prohibitions within employer policies (National Safety Council, 2021).

d) Targeted programs for high-risk groups and contexts. Because young/novice drivers and congested or complex traffic conditions are especially vulnerable, effective actions should pair enforcement with behavior-change interventions (e.g., incentives/feedback through telematics) and youth-focused campaigns. Emerging evaluations indicate that smartphone-based feedback and incentive models can reduce phone interaction while driving, complementing legal measures (Ebert et al., 2022; Governors Highway Safety Association [GHSA], 2024).

Collectively, these measures translate laboratory evidence into an implementable program: reduce exposure through law and policy, redesign tasks to meet attention-safety thresholds, and verify real-world effects through enforcement and monitoring. Given converging evidence that mobile-phone distraction substantially elevates crash risk, action at regulatory, organizational, and individual levels is both warranted and feasible (Dingus et al., 2016; WHO, 2018).

With regards to the implications for theory and practice, linking tactile tasks to distraction theory specifically mobile-phone text entry during driving imposes concurrent visual-manual and cognitive demands that compete with the resources required for safe vehicle control. Capacity models posit that performance declines when total task demand exceeds limited attentional resources (Kahneman, 1973). Multiple Resource Theory further predicts interference when tasks overlap in stages (perception-cognition-response), modalities (visual, auditory, tactile), codes (spatial vs. verbal), or effectors (manual vs. vocal) (Wickens, 2008). In the study paradigm, the secondary task (tactile text entry) and the DRT response both recruit manual effectors while text entry draws heavily on visual-verbal processing; hence, resource overlap and time-sharing costs should lengthen DRT reaction time and reduce hit rate as the text-entry demand increases. Central-bottleneck accounts of dual-task performance similarly predict queuing at response selection under competing tasks, yielding longer latencies even when individual component tasks are simple (Pashler, 1994). Threaded Cognition explains these effects as contention for shared cognitive and motor processors: when two "threads" require the same processor, one must wait, producing systematic delays and/or missed probes (Salvucci & Taatgen, 2008). The ISO 17488 Detection-Response Task (DRT) operationalizes these attentional costs during driving, and prior work shows it is sensitive to secondary-task load in both simulator and on-road settings (ISO, 2016; Stojmenova & Sodnik, 2018).

With regards on how the present results extend or qualify existing theory, first, the study observed a graded, monotonic deterioration in attention as the number of characters increased. This pattern aligns with capacity and multiple-resource predictions: longer inputs require more

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visual-verbal processing, more keystrokes with the manual effector, and longer time on the secondary task, thereby compounding interference (Wickens, 2008; Salvucci & Taatgen, 2008). It also converges with text-entry/ visual-manual literature showing that longer messages produce more glances away from the road and greater eyes-off-road time (Boyle et al., 2013; Peng, Boyle, Lee, & Jenness, 2013; Caird, Johnston, Willness, Asbridge, & Steel, 2014). Second, effects were amplified under higher traffic complexity, consistent with capacity theories: when the primary task consumes more resources (dense traffic), spare capacity shrinks and interference grows (Kahneman, 1973). Third, the faster DRT latencies among novices can be reconciled with theory as reflecting age-related motor speed and/or prioritization strategies, rather than superior hazard management (Pashler, 1994; Wickens, 2008). Thus, the findings corroborate classic interference principles while highlighting that "faster probe responses" need not imply better overall driving performance.

Concerning practical applications for safer in-car systems**,** the results suggest several design levers. (i) Minimize keystrokes**:** character count is a direct driver of interference; HMIs should reduce manual input via predictive text, one-tap suggestions, and voice-to-text fallbacks, while carefully managing cognitive load (Boyle et al., 2013; Caird et al., 2014). (ii) Meet attention-safety targets**:** adopt glance-duration (less than 2 seconds) and cumulative eyes-off-road (less than 12 seconds) targets and lock out high-demand tasks while the vehicle is in motion, as recommended by United Stated guidance (NHTSA, 2013, 2016). (iii) Use DRT in verification**:** require ISO-17488 DRT testing during development and type approval; interfaces that materially increase DRT reaction time or depress hit rate relative to baseline should be redesigned before release (ISO, 2016; Stojmenova & Sodnik, 2018). (iv) Context-aware gating**:** given stronger interference under complex traffic, OEMs and app developers should implement "driver mode" behaviors that defer multi-character inputs (e.g., destination text entry) until stopped or parked.

In relation to the implications for regulation and practice, at policy level, the combination of (a) graded interference with increasing manual input and (b) amplification under complex traffic supports comprehensive restrictions on visual–manual phone interaction while driving and justifies procurement/type-approval criteria that reference DRT-based evidence (NHTSA, 2013, 2016; ISO, 2016). For fleets and public agencies, incorporating DRT-style acceptance tests into HMI safety cases can provide a transparent threshold for deployment, while hands-free policies and driver-mode enforcement reduce exposure to the highest-risk behaviors (Caird et al., 2014; NHTSA, 2016).

To enhance robustness and practical relevance, future work should employ larger, stratified, multi-site samples that explicitly balance age, sex, driving exposure, and cultural/roadway contexts; preregistered power analyses should be reported for primary outcomes (e.g., DRT hit rate/latency and glance metrics). Ecological validity can be strengthened through test-track or on-road replications using the ISO-17488 DRT alongside naturalistic measures of visual–manual interaction, lane keeping, headway, and safety-critical events, with planned manipulations of affect (e.g., stress/anger) and environment (e.g., rain/low light). Methodologically, mixed-effects models that adjust for age and experience, as well as composite speed–accuracy indices, would clarify potential task-prioritization trade-offs. Standardized simulator-sickness screening (baseline/post SSQ) and workload assessment should be reported once, in a dedicated subsection, to avoid redundancy and to document tolerability. Finally, translation to practice should be evaluated by testing specific HMI

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mitigations (keystroke minimization, context-aware “driver mode,” glance-time/ eyes-off-road targets) and by partnering with fleets or agencies to assess compliance, enforcement, and crash-relevant outcomes over time.

Conclusion

The research successfully fulfilled its goals, which included measuring distraction via participants' response times in different tactile activities and driving situations with a driving simulator. The findings of this research indicate that drivers experienced more distraction from the more challenging task of utilising a cell phone (i.e., tactile task) compared to the baseline condition. The traffic congestion simulation was the greatest challenge regarding stimuli and response times among the three driving situations seen by participants. Moreover, the novice group had a much faster response rate compared to the experienced group. This study indicates that use a mobile phone for tactile tasks while driving is categorised as a distracted activity, potentially elevating the risk of a traffic accident.

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