Examination of the Relationship Between Smartphone Dependency and Driving Behaviour in Young Drivers: Preliminary Analysis

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Abstract: The smartphone has emerged as one of the important necessities in our daily lives. However, smartphone dependency can have negative as well as positive impacts on our overall well-being. Young adults are likely to demonstrate particularly problematic dependency on smartphone use. This is also the age group with a disproportionate contribution to road deaths in Australia (approximately 25% for 17-25 year olds), for reasons such as lack of experience and road awareness, resulting in bad choices or poor assessment of a road situation. The current study aimed to examine the relationship between smartphone dependency and driving behaviour in young people provided with the basic (control group) and extended (intervention group) features of an in-car telematics device. Participants aged between 18-30 were invited to complete the self-reported questionnaires, and an in-car telematics device with basic features was then activated over a 30-day period in their vehicles. At the start of the second 30-day period, half of the participants had their telematics installation extended. A linear mixed model analysis was conducted to allow for the hierarchical structure of the telematics data, with trips nested within drivers. The results suggest that in-car telematics devices can be adopted to improve the driving behaviour of young drivers.

1 INTRODUCTION

1.1 Background

In 2020 about 12% of the Australian population (approximately 3.2 million) consisted of young adults aged 15-24 years and by 2026 this number is projected to reach 5.1 million (AIHW, 2021). In 2020-21, the reported number of road hospitalisations and deaths was dominated by those aged 15-24 years, accounting for 430 hospitalisations and 6.9 deaths per 100,000 young people in this age group (AIHW, 2022). Globally, young drivers have emerged to be over-represented in accident deaths partly due to lack of driving experience and developmental factors (Arnett, 2022).

Smartphone ownership is gaining popularity in Australia. In 2019, almost all Australians aged 18 and above owned a smartphone (Granwal, 2022a). The number of smartphone users in Australia is estimated to reach 23.6 million by 2026, which translates to an 87% smartphone penetration rate in 2026 compared to just under 75% in 2022 (Granwal, 2022b). A study conducted by White et al. (2010) revealed that young adults are disproportionately represented amongst the most frequent mobile phone users in Australia compared to other advanced countries. These young adults tended to engage in excessive phone use and demonstrated indications of phone addiction, such as checking their phone continuously and thinking about their mobile phone constantly. With the advancement of technology, drivers have tended to broaden their mobile phone use from traditional usage (receiving or making call and texting) to also include using social media applications, reading emails, taking photographs and videos, as well as navigation guidance. If conducted while driving these activities are likely to put these young drivers as well as other drivers in danger (Kaviani et al., 2020a). Furthermore, more screen time has been found to be significantly associated with increasingly problematic smartphone dependency in younger

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people (Kaviani et al., 2020b). Interestingly, a recent Canadian study has shed some light on the reasons for high mobile device usage during the COVID-19 pandemic. This was associated with improved social connectedness, productivity and mental well-being (Jonnatan et al., 2022).

In 2021, the World Health Organisation reported that drivers engaging in mobile phone use while driving were found to be four times more likely to be involved in an accident than those drivers without such engagement (WHO, 2021). Additionally, mobile phone use while driving was found to affect drivers' response time to braking and traffic signals (WHO, 2021; Strayer & Johnston, 2001), also influencing their ability to maintain lateral vehicle control (Caird, et al., 2014). Existing literature has revealed that the main factors associated with young driver deaths on the roads included mobile phone use while behind the wheel (Li et al., 2016), internal factors (e.g. lack of concentration), driver's behaviour and driver's gender (Koppel et al., 2022). Arvin & Khattak (2020) highlighted the alarming finding that a one-second delay due to dialling or texting elevated the chance of an accident by 5.6% and 3.6%, respectively.

1.2 In-Car Telematics

In-car telematics is defined as a system capable of measuring and capturing real-time car usage. These systems can easily be installed in any car and they generally collect data for variables such as longitudinal acceleration (forwards and backwards movement), lateral acceleration (sideways movement), yaw (turning speed), global positioning system (GPS) coordinates, timestamps, vehicle speed, speed zone, revolutions per minute (RPM), engine load, mass airflow intake, and carbon dioxide ($CO2$) intake (SIRA, 2019).

Over the last decade, the use of in-car telematics has gained popularity because of evolving information and communications technology (SIRA, 2019). The existing literature has found contrasting results about the use of in-car telematics along with the effect of feedback from these devices for influencing driving behaviour. For example, the use of in-car telematics along with feedback (Wijnands et al., 2018) and related incentives for good driving (Peer et al., 2020), tended to improve driving behaviour. However, no such improvement was found in a study conducted by Stevenson et al. (2021).

Findings from a Young Drivers Telematics Trial (YDTT) conducted in Australia revealed that telematics use led to positive impacts for young driver behaviour (SIRA, 2019). However, the degree of behaviour and sociodemographic characteristics of positive impact depends on the previous driving behaviour and the sociodemographic characteristics of the driver, as well as the surrounding traffic environment. Interestingly, the young drivers reflected that the telematics devices they experienced in the study had constantly reminded them to be more aware of their driving behaviour (SIRA, 2019).

1.3 Study Objective

The present study aimed to compare the relationship between smartphone dependency and driving behaviour for participants allocated with the basic and extended features of an in-car telematics device. Both smartphone dependency and driving behaviour were assessed using self-reported measures, while the braking behaviour was investigated through telematics data.

2 METHODOLOGY

This section provides an overview of the participant characteristics, the self-reported measures used, the telematics data considered and the statistical methods used for analysis.

2.1 Participants

Participants aged between 18 and 30 years, residing in the state of Victoria in Australia and with a valid Victorian driver license were invited to join this study between January and December 2022. This naturalistic study collected data through in-car telematics devices for a 60-day driving period, with telematics data collected as described in section 2.2, and a research questionnaire as explained in section 2.3. All participants completed questionnaires before the start of the study (baseline), at the end of the first 30-day driving period (Time 1) and at the end of the second 30-day driving period (Time 2).

This study was approved by the Swinburne University Human Research Ethics Committee (SHR Project 20225945-9779).

2.2 Telematics Data

The GOFAR in-car telematics devices shown in Figure 1 were adopted for this study. All participants were asked to install an adapter to their car's diagnostic port. Next, they were required to download a GOFAR app available at the Google Play or the Apple App store on their smartphone. After that, participants needed to sync their smartphone with this adapter. The GOFAR app is capable of monitoring a car's efficiency, state of repair and performance. The combination of the GOFAR app and adapter were regarded as the basic feature of the telematics devices. The extended feature of this device, known as the ray, aimed to provide feedback to help participants to become safer and more efficient in their driving.

Figure 1: GOFAR devices.

The telematics device recorded and transferred vehicle real-time data, such as speed, braking score, GPS coordinates, timestamp, RPM, engine load, fuel consumption and emission, in two second intervals when the ignition was engaged and the driver's phone had Bluetooth switched on.

2.3 Research Questionnaire

The research questionnaire consisted of three components: 1) questions related to participant demographic characteristics and driving characteristics; 2) nomophobia severity questionnaire (NMP-Q) developed by Yildirim & Correia (2015); and 3) driving behaviour questionnaire (DBQ) established as well as validated by Lawton et al. (1997), Parker et al. (1998) and Lajunen et al. (2004).

2.3.1 Nomophobia Severity Questionnaire (NMP-Q)

Nomophobia, which is an abbreviation for "no mobile phone phobia", is defined as a collection of symptoms experienced when without a phone including 1) being unable to communicate, 2) losing connectedness, 3) not being able to access information and 4) inconvenience (Yildirim & Correia, 2015).

The Nomophobia severity questionnaire (NMP-Q) comprises 20 items across the above four symptom domains. Each item is rated using a seven-point Likert scale (1=strongly disagree and 7=strongly agree). The total score is calculated by summing item responses to produce a score ranging from 20 to 140, where higher scores indicate higher levels of nomophobia. The total score has further been categorised as "absence of nomophobia" (score less than 20), "mild level of nomophobia" (score of 20 or more to less than 60), "moderate level of nomophobia" (score of 60 or more to less than 100), and "severe level of nomophobia" (score of 100 or more) (Yildirim & Correia, 2015). In this preliminary study this categorical measure was converted into a binary measure identifying drivers with moderate to severe nomophobia levels.

2.3.2 Driving Behaviour Questionnaire (DBQ)

Globally, the Manchester Driver Behaviour Questionnaire (DBQ) can be regarded as one of the most well accepted self-reported measures of aberrant driver behaviour for the last 20 years. The extended 27-item DBQ includes items pertaining to aggressive violations, ordinary violations, errors and lapses (Lawton et al., 1997; Parker et al., 1998; Lajunen et al., 2004).

Participants were asked to respond to the 27 driving behaviour items using a six-point Likert scale (0=never and 5=nearly all the time), based on the vehicle they most frequently drove (Reason et al., 1990). The total score is obtained by summing item responses to produce a score ranging from 0 to 135, where higher scores show more aggressive driving behaviour (Ang et al., 2019).

2.4 Data Preparation

2.4.1 Data Collection

According to Figure 2, all participants were provided with a basic configuration of the device during Time 1. Half of these participants were randomly allocated to enjoy additional features of the device such as real-time driver feedback and an alert system during Time 2 (intervention group). The remaining half of the participants continued their driving during Time 2 with the basic configuration of the device (control group). The main outcome measure captured from the telematics device for each of these periods was the braking score, with higher scores indicating less aggressive braking behaviour. Nomophobia and DBQ Scores were collected at the start of Time 1 and Time 2 while average Braking Scores were computed using the Braking data collected within each of these 30-day periods. At present, the data collection for Time 2 is still ongoing for most of the participants.

2.4.2 Data Cleaning

There were challenges associated with the cleaning of the telematics data due to the volume of data.

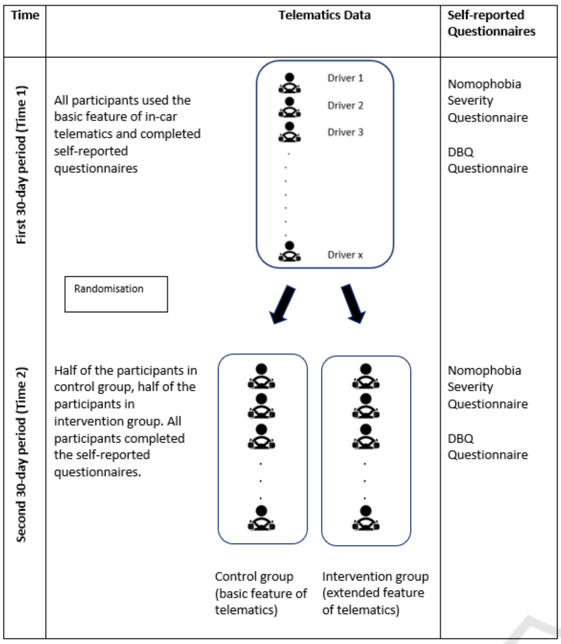

Figure 2: Data collection process.

Furthermore, the quality of data captured varied between individual participants as did the frequency of their driving. All trips without GPS coordinates, with a zero braking score and less than 1km in travelling distance were excluded from the analyses. Furthermore, zero DBQ total score were treated as missing values. Range checks were performed on the responses collected for both the NMP-Q and DBQ, and only participants with responses for all items were included in this study.

2.5 Statistical Analysis

Descriptive statistics (such as mean, standard deviation, median and range) were presented for continuous data whilst frequencies and percentages were reported for categorical data. Boxplots were used to compare the nomophobia total scores, DBQ total scores and braking scores for the control and intervention groups for Time 1 and Time 2.

Pearson's correlation coefficients were used to examine the strength of the linear relationship between nomophobia total scores and DBQ total scores, between nomophobia total scores and average braking scores, as well as between DBQ total scores and average braking scores.

Linear mixed model analyses were conducted allowing for the hierarchical structure of the telematics data, with trips nested within drivers. Separate analyses used the braking scores and the DBQ total scores as the dependent variables whilst testing the significance of the Nomophobia by Time interaction effect separately for each Group. These analyses were adjusted for age, gender and distance travelled when comparing the relationship between driving behaviour and nomophobia severity in the intervention and control groups.

Diagnostic tests were conducted for normality, linearity and multicollinearity to validate the results. A p-value < 0.05 was deemed statistically significant for all tests. The analyses were conducted using STATA Intercool version 16 (Stata Corp, College Station, TX).

3 RESULTS

3.1 Demographic Characteristics

A total of 42 participants joined this naturalistic study, but only 32 (76%) and 9 (21%) completed data collection for Time 1 and Time 2 respectively. These participants were aged between 19 to 29 years with an average age of 24 years (SD of 2.6 years). The majority of these participants were female (51%), with full driver licenses (67%), mostly residing in a major city (65%).

There was a total of 3,134 and 905 driving trips recorded for Time 1 and Time 2 respectively. The average travelled distance per trip for participants in Time 1 was found to be 13 km (SD of 19 km), with individual distances travelled per trip ranging between 1km and 499 km. On the other hand, participants in Time 2 travelled between 1 to 228 km per trip with an average travelled distance per trip of 16 km (SD of 25 km).

3.2 Parameter Characteristics

3.2.1 Nomophobia Total Score

Figure 3a showed participants from the control group had higher average nomophobia total scores (M=65, SD=0.50) compared to participants in the intervention group (Ray) (M=51, SD=1.0), demonstrating higher smartphone dependency. On the other hand, the average nomophobia total score for participants at the start of Time 1 was only slightly lower (M=63, SD=0.5) in comparison to the beginning of Time 2 (M=64, SD=1.0), showing no significant difference for smartphone dependency (Figure 3b).

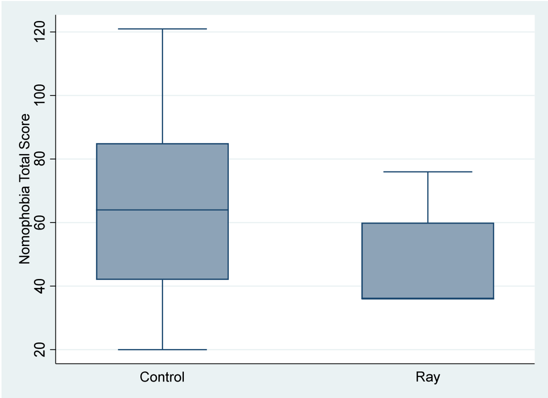

Figure 3a: Boxplot of nomophobia total score at the start of each period by Group.

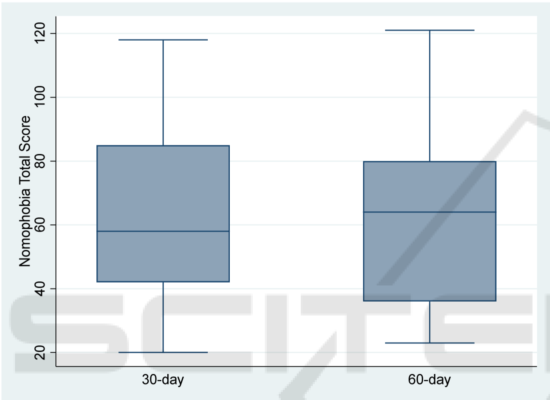

Figure 3b: Boxplot of nomophobia total score at the start of each period by Time.

3.2.2 DBQ Total Score

It was indicated in Figure 4a that the average DBQ total score for the control group (M=23, SD=0.3) was only slightly higher than the intervention (Ray) group (M=22, SD=0.6). Additionally, the average DBQ total score at the start of time 1 (M=23, SD=0.2) was similar at the beginning of time 2 (M=23, SD=0.6) (Figure 4b).

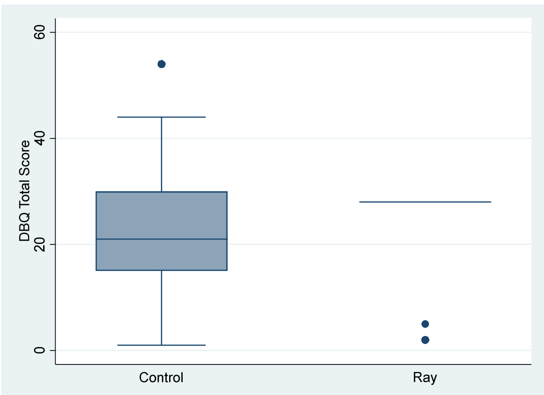

Figure 4a: Boxplot of DBQ total score at the start of each period by Group.

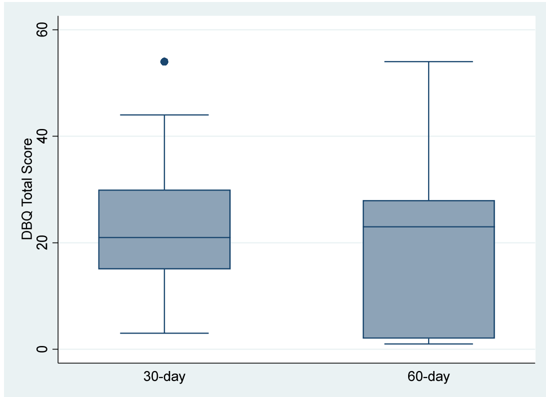

Figure 4b: Boxplot of DBQ total score at the start of each period by Time.

3.2.3 Braking Scores

Figure 5a revealed that the average braking score per trip for participants from the control group (M=76, SD=0.1) was significantly lower than for participants from the intervention (Ray) group (M=77, SD=0.4), demonstrating more aggressive braking behaviour. Furthermore, the average braking score per trip for participants for time 1 (M=77, SD=0.1) was higher than for time 2 (75, SD=0.3) (Figure 5b).

3.2.4 Correlations Between Parameters

Pearson correlation coefficients were computed to assess the strength of the linear relationship between nomophobia total scores, DBQ total scores and average braking scores. There was a weak positive correlation between the nomophobia total scores and DBQ total scores (r(3541)=0.15, p<.001), indicating

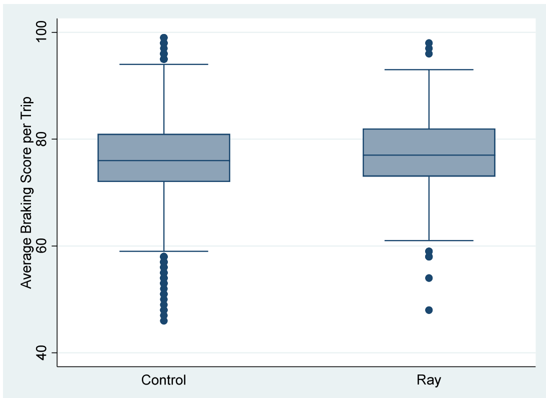

Figure 5a: Boxplot of average braking score per trip by Group.

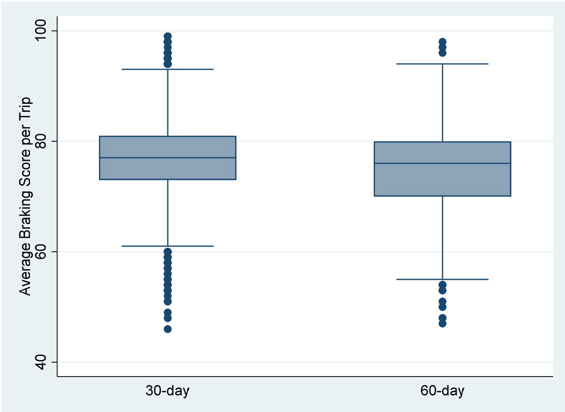

Figure 5b: Boxplot of average braking score per trip by Time.

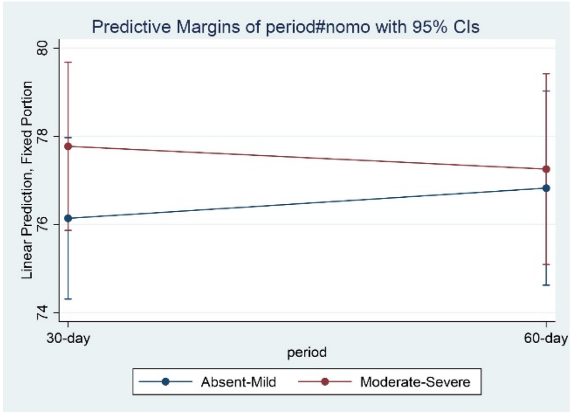

Figure 6: Daily marginal means for braking scores by nomophobia level for the intervention group.

that participants with high smartphone dependency tended to rate their driving more aggressively.

There was a weak negative correlation between nomophobia total scores and the average braking scores ($r(3513)=-0.09$, $p<.001$), showing that participants with low levels of smartphone dependency were likely to drive with less aggressive braking behaviour. On the other hand, DBQ total scores were found to have a weak negative association with the average braking score ($r(3626)=-0.04$, $p=.031$), indicating that participants who rated their behaviour more favourably tended to have less aggressive braking behaviour.

3.3 Linear Mixed Model

The linear mixed model analyses were conducted based on the complete data collected for 32 participants at Time 1 and 9 participants at Time 2. Time 2 included four (46%) and five (56%) participants allocated to the control group and intervention (Ray) group, respectively.

3.3.1 Braking Score

This preliminary analysis indicated that there was a significant Nomophobia by Time interaction effect ($Z=-2.74$, $p=.006$) for braking behaviour for participants from the intervention group, but no such finding was observed for participants from the control group ($Z=-1.61$, $p=.107$). This outcome suggested that participants who were moderately to severely reliant on their smartphone were able to improve their braking behaviour in the presence of real-time driver feedback (via the Ray) (Figure 6).

3.3.2 DBQ Total Score

In contrast, when using the self-report DBQ total score as an indicator of driving behaviour, no significant Time by Nomophobia interaction effect was found for participants from the intervention (Ray) group ($Z=1.52$, $p=.130$) nor for those in the control group ($Z=0.49$, $p=.624$). This suggests that there was no significant change in self-assessed driving behaviour that was related to smartphone dependency for either group.

4 CONCLUSIONS

This preliminary study explored the effect of smartphone dependency on driving behaviour over a period of time in a naturalistic setting.

This study showed that participants exhibited a mild to moderate level of nomophobia, meaning that they relied on their smartphones to some extent. This finding was consistent with other studies (Kaviani et al., 2020a; Yildrim & Correia, 2015). However, since nomophobia was gauged through a self-reported questionnaire, the actual prevalence of nomophobia remains unknown.

Both braking score and DBQ total score were found to be important indicators of driving behaviour. However, braking score could be regarded as the better indicator of driving behaviour because the braking score was estimated using real-time telematics data for each participant, whilst the DBQ total score was derived from self-reported responses from the participant.

Participants who received feedback from the in-car telematics device (Ray) have shown improvement in their self-reported driving behaviour over time.

This finding was consistent with the results of Wijnands et al. (2018).

Despite only a small pool of participants included in this preliminary study for Time 2, the results suggest that in-car telematics use has a positive impact on young driver behaviour. This finding aligns with a previous study conducted by SIRA (2019).

There were a few limitations in this study. Firstly, the use of self-reported questionnaires may have caused bias. Participants might not have provided accurate responses to the questionnaire designed to gauge their smartphone dependency, due to the fear that their behaviour might be judged to be socially unacceptable. Secondly, only a small sample of participants were included in this preliminary analysis for Time 2. The research team expect to show more reliable findings from this study after all 42 participants have completed their Time 2 driving period. Thirdly, most of the participants captured all their daily driving trips using the in-car telematics devices. However, a handful of participants logged a much lower driving frequency than the average, making their data less reliable. Lastly, this study commenced during the COVID-19 pandemic and the effect of the pandemic on the study findings remains unknown.

In conclusion, this study suggests that in-car telematics feedback and alarm systems have the potential to improve the braking behaviour of young drivers who exhibit moderate/severe dependency on their smartphones, reminding them to behave more responsibly when behind the wheel.

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