Crash involvement during the different phases of the New Zealand Graduated Driver Licensing System (GDLS)

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Abstract

Introduction: The New Zealand Graduated Driver Licensing System (GDLS) is designed to allow novice drivers to gain driving experience under conditions of reduced risk.

Method: To examine the effectiveness of the GDLS, an analysis of how the crash involvement of novice drivers changes as drivers move through the GDLS was undertaken. Crash profiles were created by data matching the New Zealand license and crash databases, covering a time period from 1999-2006.

Results: The crash profiles show that the initial learner period of the GDLS is relatively safe and the time at which novice drivers have the highest rate of crash involvement is during the first few months of solo driving. Analysis using logistic regression also showed an effect of age and gender, with higher crash involvement associated with younger drivers and males. In addition, individuals who gained a full license within 12-18 months of holding a restricted license, due to completion of a time-discount associated educational program, had a higher level of involvement in crashes than individuals who gained a full license after 18 months.

Conclusions: The crash profiles provide an insight into the crash risk associated with different phases of the New Zealand GDLS.

Impact on Industry: Increasing the age at which drivers first begin to solo drive and the removal of the time-discount associated with completion of an educational program should be considered.

1. Introduction

Young novice drivers have an elevated level of crash involvement, which is most apparent over the first few months and kilometers of solo driving (Mayhew, 2007; Preusser & Tison, 2007). According to official police reported statistics, within New Zealand, 15 to 24 year old drivers were at fault in 127 fatal crashes, 809 serious injury crashes, and 4,086 minor injury crashes in 2007. These crashes resulted in 125 deaths, 848 serious injuries, and 4,719 minor injuries (Ministry of Transport, 2008). Research suggests that novice driver crashes are mainly due to inexperience (Mayhew, 2007). Increased driving experience is associated with drops in crash risk (Hartling et al., 2004; Senserrick, 2006; Williams, 2005), for instance the self-reported crash rates of novice drivers have been reported to drop by almost half after 250 miles driven and by almost two thirds after 500 miles (McCartt, Shabanova, & Leaf, 2003).
In addition to a lack of driving experience, a lack of maturity contributes to behaviors amongst young novice drivers that can result in an increased level of crash involvement (Hartling et al., 2004; Senserrick, 2006; Williams, 2005). Neurological research has suggested a link between risky age-related behavior and the continued maturation of the pre-frontal cortex until the age of approximately 25. This area of the brain has been linked to the inhibiting of impulses and the ability to weigh the consequences of decisions, and its underdeveloped nature in young novice drivers possibly contributes to their increased crash risk (Gogtay et al., 2004).

One intervention used to address the risks faced by young and novice drivers is a graduated driver licensing system (GDLS) such as the one that operates within New Zealand. A GDLS operates in a stepwise or graduated fashion by splitting the licensing process into several discrete license phases. Each license phase is associated with a set of restrictions on the driving behavior of the license holder that are progressively lifted as drivers move through the GDLS. The rationale behind the license restrictions is to allow novice drivers to gain experience while preventing them from driving in situations that increase the risk of a crash occurring, such as night time driving and having passengers in the car, in particular teenage passengers (Chen, Baker, Braver, & Li, 2000; Doherty, Andrey, & MacGregor, 1998; Keall, Frith, & Patterson, 2004; Preusser, Ferguson, & Williams, 1998; Ulmer, Williams, & Preusser, 1997; Williams, 2003, 2007).

The New Zealand GDLS consists of three phases; the first phase requires drivers to spend a minimum of 6 months under a learner license and is available at the age of 15 after completion of a written and oral theory exam. The learner license allows the holder to drive only when under supervision of an individual who has held their full New Zealand drivers license for more than two years. In addition, the learner license holder must display an ‘L’ plate when driving. At the end of the learner phase, the learner must pass an on-road license test in order to move on to the restricted license phase. The restricted license phase allows the holder to drive solo without passengers between the hours of 5 a.m. and 10 p.m. Driving with passengers or at other times is only allowed if the driver is accompanied by a supervisor as in the learner license phase. The restricted phase lasts for a minimum of 18 months unless the license holder completes a government approved educational course, which shortens the period by 6 months. In order to move to the final stage the restricted driver must pass another on-road test, which differs from the previous restricted phase test as it places more emphasis on testing the hazard detection abilities of the driver. This is assessed through the use of commentary driving, where those taking the test must provide a verbal account of the hazards in the driving environment. In addition, those carrying out the test are at various times
told to stop and verbally describe the hazards of a traffic situation they recently encountered during the test. In the final full license phase of the GDLS, all restrictions previously placed upon the driver are lifted. As an exception to the time frames mentioned above, individuals over the age of 25 can apply for a full drivers license after 6 months of being on a restricted license (New Zealand Transport Agency, 2007).

It has been suggested that the crash risk of young drivers can be reduced by up to 40% through the use of a GDLS (Shope, 2007). The GDLS was introduced in New Zealand in 1987 and while there was an initial marked decrease in crash involvement amongst 15 to 19 year old drivers directly after the introduction, this effect decreased in the 2 years following. However, by 1992 there was still an 8% reduction in crash involvement amongst 15 to 19 year old drivers, which could be attributed to the introduction of the GDLS (Begg & Stephenson, 2003). The initial supervised driving phase of a GDLS is especially related to a low level of crash involvement (OECD-ECMT, 2006). Conversely, the next step in the GDLS process, which allows for solo driving, is associated with the period of highest crash involvement for young novice drivers, especially in the first six months of solo driving (Hartling et al., 2004; Mayhew, Simpson, & Pak, 2003; Senserrick, 2006; Williams, 2005). This, quite large, shift in crash involvement has been illustrated using data from Victoria in Australia (White, 2005) as shown in Fig. 1.

![Crash profile of Victorian novice drivers by time and changing license status. L=Learner License, P=Provisional (Restricted in NZ) License, and F=Full License.](source)

The present paper aims to investigate the effectiveness of the New Zealand GDLS, where the minimum driving age is 15. This is one of the lowest driving ages in the OECD, although many American states also allow entry to their GDLS at this age (OECD-ECMT, 2006;
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Insurance Institute for Highway Safety, 2009). Furthermore, in New Zealand it is possible to complete an educational course during the restricted license, which grants a time discount off the period spent on the restricted license. Studies carried out in Canada have found that completion of driver education programs that offer a time discount were associated with increases in the crash rate of attendees when compared with those who did not attend such courses (Mayhew & Simpson, 1996). This was as high as a 45% increase in crash rates in the cases of studies carried out in Ontario and British Columbia (Williams & Mayhew, 2008). However, the studies carried out in Canada assessed a time discount off the learner period of their GDLS, and in New Zealand the discount applies only to the end of the longer restricted license period.

Furthermore in New Zealand there is a final Full License test that drivers must pass before graduating to the final stage of their license. This test was introduced in 1999 and since then there has been a marked increase in the number of people remaining on their restricted license longer than the required 18 month period (Ministry of Transport, 2007). This effectively means that there is a group of New Zealander drivers that could be viewed as never fully graduating through the GDLS.

This paper provides detailed New Zealand data on the crash involvement of novice drivers as they move through the GDLS. The crash involvement of drivers is examined as a function of age, time of licensure, gender, and time spent in the different licensing phases. It is predicted that in line with international findings that the learner license phase will be associated with the period of lowest crash involvement and that there will be a marked increase in crash rates as drivers move to the restricted license phase. It is also expected that there will be an effect of age and that crash involvement will decrease over time as drivers gain more experience and maturity. The effect of attaining a time-discount off the time spent on a restricted license will also be examined.

2. Method

Driver records and crash data for all New Zealand drivers who obtained a restricted license between 01/03/1999 and 31/12/2003 were examined. The details of all the drivers who obtained a restricted license in New Zealand between 01/03/1999 and 31/12/2003 were obtained from the Driver License Register (New Zealand Transport Agency, 2006); and data on police reported fatal and injury crashes between 01/01/1997 and 31/12/2005 were obtained from the Crash Analysis System (CAS) at the Ministry of Transport (2007). This enabled the analysis of crashes for a full two years after the restricted license was gained. The date of
01/01/1997 was as far back in the crash data as was available at the time of analysis.

The data obtained from the licensing database were categorized by the year the drivers gained their restricted license, and the age of the drivers at the time they gained their restricted license. Further, it was recorded if the drivers gained a full license by 25/03/2006, the last possible date available in the provided dataset. Three “license path groups” were then produced. The first was drivers who gained their full license after 12 to 18 months on their restricted license, and had therefore taken advantage of the time-discount associated with attending a specific driver education course in New Zealand. The next was drivers who gained their full license after 18 months or longer on their restricted license, and therefore did not gain their license earlier than what would be considered standard under the GDLS. The final group was drivers who had gained a restricted license but not moved on to a full license by the end of the period examined, and thus could be seen as not “graduating” fully through the system. All drivers were followed for a minimum of two years from their restricted license date. Crash data were matched to licensing data using the driver license number. The data were also limited to only examine the crashes of drivers under the age of 25 at the time they gained their restricted license. Overall the records of 206,123 drivers (92,310 females and 113,809 males) and of 10,704 crashes were available for analysis.

There is a known underlying increasing trend in crash involvement for 15-24 year olds in New Zealand over the time period examined. Therefore in order to be able to compare the crash involvement of drivers across this whole period the data were adjusted to take into account this trend. This means that, for example, the crash rate of someone who first crashed in 1999 can be compared with someone who crashed in 2004. A crash rate per 10,000 drivers was then also calculated for each month. During the first 12 months after the restricted license was gained, all drivers examined remained on a restricted license, so the license path groups are directly comparable.

In order to examine the effects of age, gender, and time on license on the number of individuals involved in crashes (i.e., crash involved vs. non-crash involved) over the time period assessed, SAS Proc Genmod was used to fit logistic regression models to the data for each license path group. To assess the effect of age within the logistic regression, the crash involvement of the under 20.5 year old age groups was compared to the crash involvement of over 20.5 year olds. Time on license was treated as a continuous variable that recorded the number of months since gaining a restricted license that preceded a crash. The experience of the groups diverges during the period of 12-18 months after the restricted license was gained, when the early licensing group can potentially gain their full licenses. A second logistic
regression model was fitted to compare the crash involvement of groups during this period. Additional examination of the data was undertaken using SPSS 17 for Mac.

3. Results

An overall profile of the per-driver crash rate of New Zealand novice drivers as they move through the GDL is provided in Fig. 2. The figure shows a low crash rate during the learner license period. There is then a large increase in crash rate at the start of the restricted phase. Over time the crash rate generally trends downward.

![Graph showing crash profile of Victorian novice drivers by time and changing license status. L=Learner License, P=Provisional (Restricted in NZ) License, and F=Full License.](image)

The average increase in crash rate between the last six months of holding a learner license compared with the first six months of holding a restricted license by the age of the driver at the time they gained their restricted license is shown in Fig. 3. Analysis using t-tests revealed that all increases were significant (t= -5.53 to -16.19, p<.01).

Furthermore, the 7.4 times increase in average crash rate for those aged 15.5 to 16.5 at the time of gaining their restricted license was significantly higher than all other age groups (t=3.57 to 6.94, p<.05) except for those aged 18.5 to 19.5 at the time of gaining their restricted license (t=2.35, p=ns). Similarly, those aged 16.5 to 17.5 at the time of gaining their restricted license had a significantly higher increase in crash rate than those aged 17.5 to 18.5 and those aged 19.5 to 20.5 (t=5.14 and 3.47, p<.05), but not those aged 18.5 to 19.5 (t=1.39, p=ns). Finally, those in the age groups higher than 17.5 did not have significantly larger increases in
crash rate between their learner and restricted stages, compared to the groups older than them (t=-.02 to .57, p=ns).

**Figure 3.** Comparison of the average crash rate per 10,000 drives in the last six months of the learner phase and the first six months of the restricted license phase by age at the time of gaining a restricted license (note – the numbers above the each pair of bars represent the increase in crash rates between the last six months of the learner and first six months of the restricted phase ** p<0.001, * p<0.01).

Fig. 4 shows how per-driver crash rate (adjusted for change in the underlying crash rate) changes over time since obtaining a restricted license, for each license path group. There is a clear increase in crash rate associated with the transition from learner (supervised) to the restricted (unsupervised) phase for all three groups. For drivers that obtained their full license in 12-18 months (the “fast track group”), there is an apparent increase in crash rate in the period just after gaining their full license. In general there appears to be a trend toward reductions in crashes per driver, over time. The decreasing trend in crash involvement is significant for all groups in the first 12 months after gaining a restricted license (R= .84 to .60, p<.05). However, after 12 months the decreasing trend for those drivers who obtained their full license after 18 months levels off (R=.14, p=ns), but the crash involvement in the other two license paths continues to significantly decrease over time (R= .64, p<.05).

Logistic regression models were fitted to each license path group, using data for the first 12 months after obtaining a restricted license. Crash involvement was modeled against
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gender, age, and time since obtaining the restricted license. Reasonable fits were obtained for all models, with no evidence of over dispersion. The results are shown in Table 1.

![Figure 4](crash_rate_per_10000_drivers_by_eventual_full_license_status.png)

**Figure 4.** Crash rate per 10,000 drivers by eventual full license status (adjusted for changes in underlying crash rate).

In all license path groups, female drivers were involved in significantly fewer crashes ($\chi^2=3.89$ to 32.95, $p<.05$) during the first 12 months after gaining their restricted license than male drivers (males had approximately 1.2 – 1.3 times the crash rate of females, depending on the license path group). No age effects were identified in the fast track group in the 12 months after gaining their restricted license. In the group who obtained a full license after 18 months, drivers under 20.5 were involved in significantly more crashes ($\chi^2=9.59 – 14.70, p<.01$) in the first 12 months after gaining their restricted license than those over 20.5. In the group that had not obtained a full license, there was a clear age gradient, with the youngest age group (15.5 to 16.5 years old when gaining a restricted license) being involved in the most crashes ($\chi^2=51.01, p<.001$). Increasing time since obtaining a restricted license, accounting for age and gender, was associated with a significant decrease in crash involvement for the full license after 18 month group and no full license within 2 years group ($p<.001$). However, there was no significant decrease in the time period examined for the fast track group.
Table 1. A Logistic regression of crash involvement in the first twelve months after obtaining a restricted license for each license path group. Taking into account gender, age, and time since gaining a restricted license.

<table>
<thead>
<tr>
<th></th>
<th>Full licence after 12-18 months</th>
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<th>Full Licence after 18 months</th>
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<th>No full licence within 2 years</th>
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<tr>
<td></td>
<td>Odds Ratio</td>
<td>95% Confidence limits</td>
<td>p</td>
<td>Odds Ratio</td>
<td>95% Confidence limits</td>
<td>p</td>
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<tr>
<td>Female vs Male</td>
<td>.87</td>
<td>.76</td>
<td>1.00</td>
<td>.83</td>
<td>.73</td>
<td>.95</td>
</tr>
<tr>
<td>Months since gaining restricted licence</td>
<td>.98</td>
<td>.97</td>
<td>1.00</td>
<td>.97</td>
<td>.95</td>
<td>.99</td>
</tr>
<tr>
<td>Age vs 20.5 plus year olds:</td>
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<tr>
<td>15.5-16.5 years old</td>
<td>.64</td>
<td>.39</td>
<td>1.12</td>
<td>1.55</td>
<td>1.24</td>
<td>1.95</td>
</tr>
<tr>
<td>16.5-17.5 years old</td>
<td>.77</td>
<td>.47</td>
<td>1.37</td>
<td>1.57</td>
<td>1.25</td>
<td>1.99</td>
</tr>
<tr>
<td>17.5-18.5 years old</td>
<td>.78</td>
<td>.46</td>
<td>1.43</td>
<td>1.48</td>
<td>1.16</td>
<td>1.91</td>
</tr>
<tr>
<td>18.5-19.5 years old</td>
<td>1.05</td>
<td>.53</td>
<td>2.11</td>
<td>1.59</td>
<td>1.21</td>
<td>2.09</td>
</tr>
<tr>
<td>19.5-20.5 years old</td>
<td>1.74</td>
<td>.72</td>
<td>3.98</td>
<td>1.31</td>
<td>.94</td>
<td>1.82</td>
</tr>
</tbody>
</table>
The increase in crash rate at the point of gaining a full license amongst the fast-track group is clearly demonstrated in Fig. 5 by examining the crash rate per-driver 6 months before and after the point at which a full license could be gained. There is a significant ($t=2.74$, $p<.05$) increase in crash rate for those who gain their license after less than 18 months on a restricted license. This increase is not apparent for those who stayed on their restricted license for at least 18 months ($t=.34$, $p=ns$).

![Figure 5](image)

**Figure 5.** Crash rate per 10,000 drivers six months before and after gaining a full license (adjusted for changes in underlying crash rate).

To investigate the differences in crash involvement between the three license path groups during the period 12-18 months after obtaining a restricted license, a logistic regression model was used to fit crash involvement to status, age, gender, and time since obtaining the restricted license. When age, gender, time since gaining a restricted license, and significant two-factor interactions were taken into account, the crash rates of the ‘full license after 18 months’ and ‘no full license within 2 years’ groups were indistinguishable, but being in the fast track group was associated with an increase in crash rate of 2.9 times that of the ‘full license after 18 months’ group ($\text{Odds ratio}=2.88$, $\chi^2=8.94$, $p<.01$).

4. **Discussion**

Overall, the results show that, as expected, the learner phase of the New Zealand GDLS has the lowest level of crash involvement. During the learner phase novice drivers are only...
allowed to drive under the supervision of an individual who has held their full New Zealand drivers license for more than two years. However, crash involvement increases when the novice driver moves to the restricted phase, where solo driving is allowed. This increase in crashes occurs despite the prohibitions that exist during the restricted phase, such as restrictions against driving at night, and driving with peers in the car (Keall et al., 2004).

In addition there appears to be an increase in crash involvement associated with gaining a full license between 12 and 18 months after restricted licensure compared to gaining a full license after 18 months, even after taking into account any underlying differences in age and gender between the groups. This suggests that despite the completion of an approved educational course for those who gained their full license between 12 and 18 months of restricted licensure, there is greater benefit in remaining on the restricted license for the full 18 month period. That is to say, that even if the driver education courses do improve on-road driver behavior, they do not appear to do so enough to warrant the associated 6 month reduction off the restricted license period. This is not surprising as the practice of offering a time reduction off licensing as an incentive for completing driver education is generally considered to be counter-productive as part of a licensing system and is not common internationally (Mayhew & Simpson, 1996, 2002; Mayhew, Simpson, & Singhal, 2005). The continued existence of the time reduction associated with driver education courses in New Zealand should therefore be reexamined.

However, a credible explanation for the increase noted for those who fast-track their full license is that these individuals are highly motivated to drive, and therefore may drive more often, which increases their risk of being involved in a crash. The potential motivational increase in driving exposure in fast tracked individuals could not be controlled for in this study. That on-road exposure could not be controlled for between the different license groups and license phases is a general limitation of this study. It is likely that a significant proportion of the increase in crash involvement associated with moving from the learner phase to the restricted license phase is caused by an increase in on-road driving. It is also possible that, in addition to any extra motivation of fast tracked individuals, the increase in crash rate for the fast track group after 12 months could be the result of an increase in driving exposure simply because of access to a full license. Also a full license allows driving in potentially risky situations, such as with passengers and at night, exposure to which is limited under a restricted license and would presumably increase once a full license has been gained. However increases in driving and exposure to potentially risky situations would also be expected to increase after gaining a full license for those who took 18 months or longer, yet there is no significant increase in crash rate at this point for these individuals. It is also possible that those who fast-tracked their
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restricted license may have also stayed on their learner license for a shorter period of time than drivers in the other two license paths. This would further reduce their time in the GDLS and perhaps dilute its effect.

In terms of a potential experience effect, it is interesting that there appears to be no significant difference in crash involvement between individuals who had not gained their full license by the end of the period assessed and those who had gained this license after 18 months. The number of individuals remaining on their restricted license for long periods of time has been increasing ever since the full license test was introduced to the GDLS in 1999 (Ministry of Transport, 2007). The increase in the number of these people is potentially concerning as they are seen as having not fully graduated through the system. The data here, however, suggests that there may be no benefit in terms of reduced crash rate associated with a driver sitting the second on-road driving test and graduating to a full license after 18 months of holding a restricted license. This brings into question the value of having a final exit test before graduating to a full license, given that the data seem to suggest the period of highest crash involvement has already past by this point. Therefore, it may be worth reverting to the previous system that used to function in New Zealand where drivers automatically transitioned to a full license after 18 months, and after paying a small fee. This would need to be further examined.

During the first 12 months after restricted licensure there are gender differences in the crash rate for all license path groups. The overall higher crash rates of young male drivers are largely thought to be due to increased risk-taking involving peers, typically at night (OECD-ECMT, 2006), factors which should be reduced during the restricted license phase. Furthermore, in general younger drivers are involved in more crash than older drivers. In particular there was a 7.4 times increase in average crash involvement between the first six months of the learner and restricted license period for those individuals who gained their restricted license when aged between 15.5 and 16.5. Crash involvement for younger drivers therefore could perhaps be lowered by increasing the age at which the restricted license can be gained, by lengthening the learner phase, by increasing the age at which individuals can enter the GDLS, or through a combination of these policy changes.

There are some other possible solutions to an overall increase in crash involvement levels at the restricted phase. Firstly, since there appears to be some reduction in crashes per driver over time, a requirement for learner drivers to complete a certain amount of hours of supervised driving could be introduced. This may address potential differences in time spent driving during the learner phase and increase on-road driving experience before the high risk
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solo driving period. Such a requirement is in place in some Australian states. For example, in July of 2007 Victoria introduced a requirement that learner license holders under the age of 21 gain 120 hours of supervised on road driving, 10 of which must occur at night. To enforce this, Victoria requires that a practice diary be kept with a declaration signed by the learner driver and a supervising driver (Arrive Alive!, 2009).

Another way to potentially increase driving exposure during the comparatively safe learner phase would be to increase the level of competency that individuals must demonstrate during the driving test required to graduate to the restricted phase. This may encourage drivers to gain more on-road experience in order to pass this test and move on through the system. For example, commentary driving, where drivers are asked to describe potential hazards as they drive, is currently part of the test requirement to graduate to the full license phase of the New Zealand GDLS. Hazard perception is known to be one of the areas novice drivers are lacking (OECD-ECMT, 2006), therefore perhaps the assessment of hazard perception via commentary driving could be shifted to become part of the earlier restricted license driving test. The assessment of hazard perception before solo driving begins could encourage novice drivers to improve this skill during the learner phase.

The conditions associated with a GDLS are designed to protect the drivers from being exposed to high risk situations and if they are not complied with this intention is undermined (Keall et al., 2004). Therefore initiatives to increase compliance amongst novice drivers with the conditions of the GDLS could also potentially reduce crash involvement during high risk driving phases. The number of individuals detected breaching the conditions of their restricted license has increased markedly over the last few years (Ministry of Transport, 2007). It may be that the current penalties for breaching the GDLS conditions are not acting as enough of a deterrent for novice drivers. It is worth noting, however, that as of the first of December 2009 the Land Transport (Enforcement Powers) Amendment Act came into effect in New Zealand. The amendment decreases the fines associated with GDLS breeches, while increasing the amount of demerits these breaches attract as well as granting additional powers to the police when dealing with GDLS breeches. The additional police powers include the ability to immobilize the vehicle and forbid those in breach of GDLS conditions to continue to drive.

Finally, it should be noted that the crash data used in this paper come from a police report based system and include only injury or fatal crashes. However, not all injury crashes are reported to the police and there may be additional biases in terms of the types of crashes reported. Therefore, the crash rates presented in this study are likely to be underestimates. However, it is likely the relative changes seen here would still remain the same, as it is unlikely
that there are significant differences in how crashes are reported for drivers with different license statuses.

The crash profiles examined in this paper provide valuable insight into the operation of the GDLS in New Zealand. The profiles especially highlight the protective nature of the initial learner phase and the importance of the initial solo driving period in terms of crash rate. They also clearly demonstrate the positive effect of experience and maturity on crash involvement.

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