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Factors considered by light vehicle drivers when changing lanes around heavy vehicles

Sajani Siriwardene[1*], Mahmud Ashraf[1], Ashim Kumar Debnath[1]

[1]Safe Future Mobility Research Lab, School of Engineering, Deakin University, Victoria, Australia

*Email for correspondence (presenting author): s.siriwardene@deakin.edu.au

Abstract

Lane changing is a complex task, which can be more challenging to perform around heavy vehicles (HVs) due to higher risk of crashes and differences in vehicle manoeuvrability characteristics. Even though lane changing behaviour of light vehicle (LV) drivers have been studied using observational and simulation data, the LV drivers' knowledge, and their views on changing lanes around HVs are yet to be comprehensively studied. To address this important gap in the literature, using data collected from an online survey among 455 drivers, this paper presents an analysis of LV driver behaviour and their views on the factors they consider when changing lanes around HVs. The results showed that driving experience is a significant factor when selecting the lane changing position around HVs. Further, it was found that LV drivers prefer changing lanes behind a HV when the HV is closer to the lane closure location. By thematically analysing qualitative comments given by LV drivers on the factors they consider when changing lanes around HVs, 15 factors were identified related to what drivers look for, what drivers assess, and what drivers do before lane changing. Observing speed and the presence of other surrounding vehicles and judging the speed and movements of HVs were the most commonly reported factors.

1 Introduction

Heavy vehicles (HVs) travel long distances regularly on highways (Van der Beek 2012). Maneuvering a HV in order to change lanes is a challenging task due to the size and weight of the vehicle, especially on high speed roads (Moridpour et al. 2012; Debnath et al. 2015). Most HV drivers are familiar with their routes and can adjust their speed and position based on upcoming road conditions. However, HVs often need to change lanes unexpectedly in work zones, near incidents like crashes or breakdowns, or to overtake slower vehicles. While HVs perform these actions around LVs, the higher stopping distance (Moridpour et al. 2015) and larger blind spots of HVs (Pyykonen et al. 2015), can contribute to crashes.

Australia's vast land area and reliance on HVs for long-distance transport mean that LV drivers often share the road with HVs. Although LV drivers are advised to be cautious around HVs, there's limited understanding of what factors they actually consider in these situations. This study seeks to fill this knowledge gap by examining LV drivers' considerations when changing lanes around HVs. An online survey of 455 drivers was conducted to analyse their lane-changing behavior and the factors they take into account. The findings aim to identify potential improvements in communication, infrastructure, and regulations to enhance road safety.

2 Research context

The injury severity of crashes involving HVs are higher than that of only LVs (e.g., Cantor et al. 2010; Weng et al. 2015b; Daud et al. 2019). Weng et al. (2015b) also noted that the highest increment in rear-end crash risks at work zone merging areas is when the merging lead vehicle

is a HV. These results show that lane changing is not only challenging for HVs, it is also a challenging task for LVs to find a suitable gap when changing lanes around HVs.

Interviews with HV drivers (Gray 2019) noted that the driving behaviour of LVs when driving around HVs can also increase the crash risk. Majority of HV drivers noted that the most common unsafe action performed by LVs is passing HVs and cutting back into the lane too soon. Further 20 actions of LV drivers were categorised in to three categories which include purposely taking risks, not paying attention, and lack of knowledge of risks. Therefore, LVs should also be aware of the challenges and limitations of a HV to perform a safe lane change, and to assess the knowledge and risk perception of LV drivers it is evident that gathering views and opinions of LV drivers are also equally as important as HV driver inetrviews done over the years (e.g., Walton 1999; Cherry and Adelakun 2012; Anderson et al. 2017).

An attempt was made by Moore et al. (2005) in the US to investigate the motorists perception of HVs on highways using a national phone survey. The survey results showed that over 80 percent of respondents noted the dangerous conditions created by HVs when driving in the rain. While to the best of the author's knowledge all respondents had a predominantly positive or negative opinion of HV drivers, more frequent drivers had a positive perception on HV drivers when compared to less frequent drivers. With this outdated study being the only study available which analyse LV driver views on driving around HVs, there is a need to futher understand the opinions of LV drivers on driving around HVs in Australia, especially, with respect to lane changing manouvres.

3 Methodology

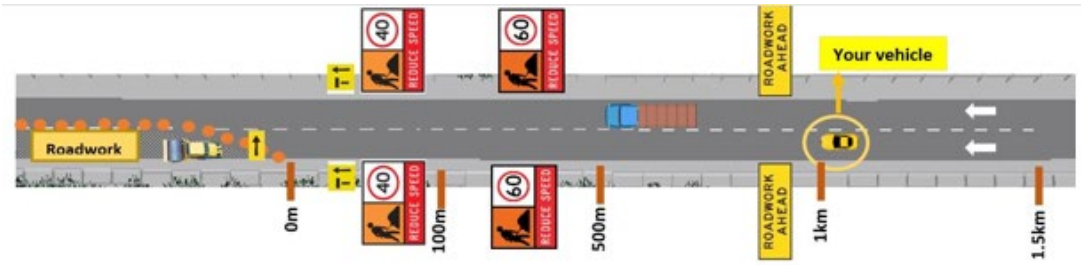
The factors considered by LVs when sharing the road with HVs were studied using an online survey followed by a qualitative analysis of driver comments provided in the survey. Surveys are commonly used to collect driver perception data on factors such as driver safety (Siriwardene et al. 2023), mode choice (e.g., Sekhar 2014), impact from other road users (e.g., Moore et al. 2005), etc. Participants can be more relaxed and open in an anonymous online survey when compared to in-person interviews. Therefore, this study adopted the online survey approach to gather insights on factors considered by drivers when driving and changing lanes around HVs.

3.1 Study design and data analysis

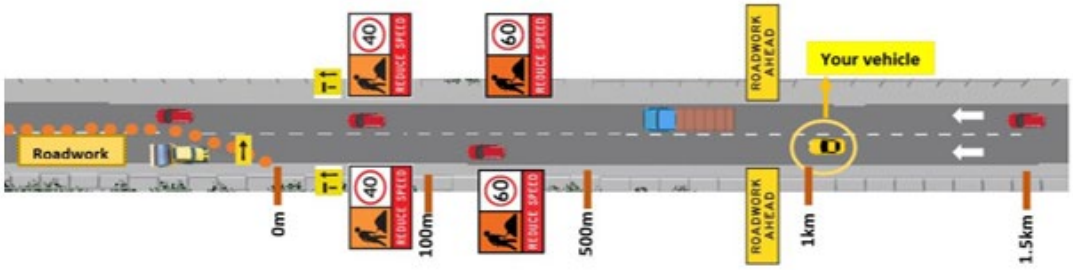
The online survey was created in the Qualtrics platform and was structured in to three parts. The survey design and the data collection process received Deakin University ethics approval (SEBE – 2022 – 63).

First, participants' demographic characteristics such as age, gender, driving experience, license type, and high-speed road use were recorded using a set of structured questions with categorical response options. In the second part of the survey, participants were presented with four figures of scenarios where they would have to change lanes due to a lane closure with a HV travelling on the targeted lane, as shown in Figure 1. The four scenarios included changing lanes when (1) there are no other vehicles around, (2) when there are some other LVs around, (3) the HV is close to the lane closure, and finally (4) two HVs are presented. For these scenarios, the participants were asked to indicate whether they would merge in front or behind (or in between for scenario 4) the HV. To further analyse the influence of demographic characteristics on the choice of merging location, binary logistic regression models were developed using the data obtained from the first three scenarios. To maintain the comparability around results, scenario 4 was excluded from the model. The model was calibrated using STATA/BE 17.0.

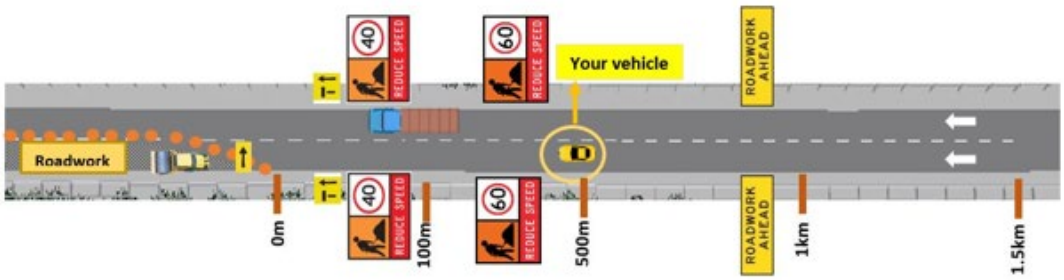
Figure 1: Scenarios presented in survey, part 2



(a) No other vehicles around



(b) With other vehicles around



(c) The HV close to roadworks

(d) Two HVs present

In the third and final part of the survey, a non-mandatory open-ended question was presented to the participants to mention the factors they would consider when changing lanes around HVs. The main aim of the open ended question was to give the respondent an opportunity to note any factors that they immediately thought of when completing the second part of the survey. The valuable comments provided by the respondents were evaluated individually and grouped in to themes to analyse the factors considered by LV drivers when changing lanes around HVs.

3.2 Data collection

The survey was distributed through both online and offline platforms. Social media applications such as Facebook and LinkedIn were utilised to reach various social groups, further, distributed physical handouts and posters in public areas. To ensure unbiased sampling, the survey was openly accessible to all members of the public without any restrictions. Additionally, an incentive was offered to attract participants and improve response rates.

This survey was aimed at participants aged 18 or above who holds a valid driving license (full or probationary) and have driven in Australia for more than 6 months. Participation was voluntary and collected data was deidentified and anonymous. A total of 455 responses were collected for the first and second parts of the survey. As the third part was an optional open question, out of the 455 respondents 184 provided a valid descriptive answer for the open question. The distribution of the survey sample and the percentage of respondents who completed the third part (open question) are presented in Table 1.

The survey sample was representative of the Australian population (Australian Bureau of Statistics 2022), encompassing participants evenly distributed across all age groups. Notably, 27% and 39% of respondents fell within the 18-25 years and 26-35 years age brackets, respectively. However, there was a lower representation of older drivers aged 45 years and above compared to the general population statistics (Australian Bureau of Statistics 2022), suggesting a potentially lower proportion of drivers in that age group. Similarly, while around 60% of the survey respondents were male drivers, the Australian population statistics show a slightly higher proportion of females when compared to males. The survey sample had a good distribution of drivers with all categories of experience from 6 months to over 5 years. Most of the drivers (about 78%) were full license holders. As HVs mostly travel on highspeed roads, the respondents were asked how frequently they would use highspeed roads. More than 50% of the drivers noted using highspeed roads 2 days a week or more regularly.

From 184 participants who answered the non-mandatory open question on factors considered when driving and changing lanes around HVs, the highest number (32.5%) of respondents were the participants holding a full license. Around 26% of the male participants provided a valid descriptive response for the third part of the survey which was the second highest category of responses. Around 14% of the female drivers completed this part of the survey. The least amount of responses (only about 5%) were given by the drivers who do not use highspeed roads frequently.

4 Results

4.1 Choice of merging location around HVs

The results from Table 1 shows that most drivers (over 60%) would prefer to change lanes behind a HV when only a single HV is available around them. However, this rate dropped (to 52%) when two HVs are available around them, with 33% of drivers selecting the gap between the two HVs to change lanes. While more than 20% of drivers chose to overtake the single HV, 14% of drivers preferred overtaking both HVs from the left to get ahead of the HVs. Further, a chi-squared test was performed to identify if the independent variables influence the lane changing position of LVs around HVs.

To further analyse this behaviour, binary logistic regression models were employed to model the choice of merging location (in front of the HV or behind the HV). Three models were developed for scenario 1 - 3. To maintain the comparability of the results, scenario 4 was not included in the models.

A pairwise correlation test, log linearity and a log normality test were done to identify variables with significant levels of correlation and to confirm the data set is suitable for a regression model. As these tests provided satisfactory outcomes, the modeling was undertaken. The results of the models are presented in Table 2.

Table 1: Survey sample and responses

Description	%(n)	Scenario 1 (S1) %Front (n)	Scenario 1 (S1) %Behind (n)	Scenario 2 (S2) %Front (n)	Scenario 2 (S2) %Behind (n)	Scenario 3 (S3) %Front (n)	Scenario 3 (S3) %Behind (n)	Scenario 4 (S4) %Front (n)	Scenario 4 (S4) %Between (n)	Scenario 4 (S4) %Behind (n)	Chi-square test results x^2(p-value)	%completed survey part three (open ended question)
Age												
18 – 25 years	26.6 (121)	38.0 (46)	62.0 (75)	37.2 (45)	62.8 (76)	24.8 (30)	75.2 (91)	14.9 (18)	36.4 (44)	48.8 (59)	**S1**: 10.3 (0.016)	10.6 (48)
26 - 35 years	39.3 (179)	30.2 (54)	69.8 (125)	30.7 (55)	69.3 (124)	22.3 (40)	77.7 (139)	12.8 (23)	41.3 (74)	45.8 (82)	**S2**: 5.7 (0.127)	12.3 (56)
36 - 45 years	20.0 (91)	40.7 (37)	59.3 (54)	44.0 (40)	56.0 (51)	27.5 (25)	72.5 (66)	19.8 (18)	24.2 (22)	56.0 (51)	**S3**: 2.5 (0.481)	10.1 (46)
Over 45 years	14.1 (64)	18.8 (12)	81.3 (52)	29.7 (19)	70.3 (45)	17.2 (11)	82.8 (53)	14.1 (9)	17.2 (11)	68.8 (44)	**S4**: 18.4 (0.005)	7.5 (34)
Gender												
Male	59.8 (272)	35.3 (96)	64.7 (176)	37.5 (102)	62.5 (170)	27.2 (74)	72.8 (198)	14.7 (40)	30.1 (82)	55.1 (150)	**S1**: 2.0 (0.158) **S2**: 1.9 (0.163)	26.2 (119)
Female	40.2 (183)	29.0 (53)	71.0 (130)	31.1 (57)	68.9 (126)	17.5 (32)	82.5 (151)	15.3 (28)	37.7 (69)	47.0 (86)	**S3**: 5.8 (0.016) **S4**: 3.3 (0.191)	14.3 (65)
Driving experience												
6months – 1 year	19.3 (88)	22.7 (20)	77.3 (68)	22.7 (20)	77.3 (68)	15.9 (14)	84.1 (74)	10.2 (9)	46.6 (41)	43.2 (38)	**S1**: 10.7 (0.014)	7.2 (33)
1 - 3 years	22.4 (102)	44.1 (45)	55.9 (57)	39.2 (40)	60.8 (62)	27.5 (28)	72.5 (74)	18.6 (19)	39.2 (40)	42.2 (43)	**S2**: 8.7 (0.034)	6.4 (29)
3 -5 years	24.4 (111)	34.2 (38)	65.8 (73)	41.4 (46)	58.6 (65)	34.2 (38)	65.8 (73)	18.9 (21)	36.9 (41)	44.1 (49)	**S3**: 14.6 (0.002)	9.7 (44)
Over 5 years	33.8 (154)	29.9 (46)	70.1 (108)	34.4 (53)	65.6 (101)	16.9 (26)	83.1 (128)	12.3 (19)	18.8 (29)	68.8 (106)	**S4**: 33.0 (<0.001)	17.1 (78)

License type											
Full license	78.2 (356)	33.4 (119)	66.6 (237)	30.6 (109)	69.4 (247)	19.1 (68)	80.9 (288)	12.9 (46)	29.5 (105)	57.6 (205)	**S1**: 0.3 (0.558) **S2**: 13.5 (<0.001) **S3:** 16.1 (<0.001) **S4**: 21.5 (<0.001)	32.5 (148)
Probationary/ Learner permit	21.8 (99)	30.3 (30)	69.7 (69)	50.5 (50)	49.5 (49)	38.4 (38)	61.6 (61)	22.2 (22)	46.5 (46)	31.3 (31)		7.9 (36)
Highspeed road use												
Daily	13.8 (63)	39.7 (25)	60.3 (38)	36.5 (23)	63.5 (40)	20.6 (13)	79.4 (50)	15.9 (10)	33.3 (21)	50.8 (32)	**S1**: 5.8 (0.213) **S2**: 2.8 (0.585) **S3**: 3.8 (0.437) **S4:** 24.6 (0.002)	18.9 (86)
4 - 6 days	23.3 (106)	28.3 (30)	71.7 (76)	36.8 (39)	63.2 (67)	25.5 (27)	74.5 (79)	9.4 (10)	39.6 (42)	50.9 (54)		8.1 (37)
2 - 3 days	24.8 (113)	32.7 (37)	67.3 (76)	35.4 (40)	64.6 (73)	23.9 (27)	76.1 (86)	20.4 (23)	42.5 (48)	37.2 (42)		8.4 (38)
Once a week	21.5 (98)	38.8 (38)	61.2 (60)	37.8 (37)	62.2 (61)	27.6 (27)	72.4 (71)	17.3 (17)	24.5 (24)	58.2 (57)		2.2 (10)
Occasionally	16.5 (75)	25.3 (19)	74.7 (56)	26.7 (20)	73.3 (55)	16.0 (12)	84.0 (63)	10.7 (8)	21.3 (16)	68.0 (51)		2.9 (13)
Total	**100 (455)**	**32.7 (149)**	**67.2 (306)**	**34.9 (159)**	**65.1 (296)**	**23.3 (106)**	**76.7 (349)**	**14.9 (68)**	**33.2 (151)**	**51.9 (236)**		**40.4 (184)**

Table 2: Merging location selection of drivers when changing lanes around HVs

		Odds ratio		
Characteristics	**Description**	**Scenario 1**	**Scenario 2**	**Scenario 3**
Age	18 - 25 years	Ref	-	-
	26 - 35 years	1.5	-	-
	36 - 45 years	1.0	-	-
	Over 45 years	2.8**	-	-
Gender	Male	Ref	-	Ref
	Female	1.3	-	1.6*
Experience	6months - 1 year	Ref	Ref	Ref
	1 - 3 years	0.3**	0.4**	0.5*
	3 -5 years	0.6	0.3**	0.3**
	Over 5 years	0.6	0.3**	0.7
License type	Full license	Ref	Ref	Ref
	Probationary/ Learner permit	1.6	0.4**	0.4**
Highspeed road use		-	-	-
Summary statistics				
	Constant	1.96	1.09	5.20
	Log-likelihood (at model)	-287.73	-294.43	-246.99
	Log-likelihood (at zero)	-274.35	-273.28	-229.08
	Akaike Information Criteria (AIC)	568.70	558.56	472.15
	Likelihood ratio test results	26.76 (*df 9*)	42.3 *(df 5)*	35.83 *(df 6)*

- Did not remain in the most parsimonious model; ** Significant at 95% confidence interval;

* Significant at 90% confidence interval

Firstly, for scenario 1, driver age, gender, experience and license type variables remained in the model. From the variables retained, gender and license type were not significant at 90% confidence interval. With regards to driver age, when compared to young drivers, older drivers preferred merging behind the HV. Further, when compared to drivers with less than 1 year of driving experience, drivers with 1 – 3 years of experience preferred merging in front of the HV.

Secondly, for scenario 2, driver experience and license type were found to be significantly influencing (at 95% confidence interval) the merging decision of drivers. Drivers with more experience preferred merging in front of the HV when compared to drivers with less experience. Surprisingly, drivers with learner permits also preferred merging in front of a HV when compared to drivers with full license when other vehicles are in vicinity.

Finally, for scenario 3, gender, driving experience and license type remained in the most parsimonious model. When compared to male drivers, female drivers prefer merging behind a HV. Similar to scenario 1 and 2, drivers with more experience prefer merging in front of the HV when compared to less experienced drivers and drivers with probationary license would prefer merging in front of a HV when compared to drivers with full license.

4.2 Model results Discussion

The model results showed that driver age only remained in scenario 1. For scenario 1, except for the over 45 years category, is not a significant factor at 95% confidence interval when considering the choice of lane changing location. Drivers over 45 years of age preferred merging behind a HV. This behavior can be explained by the findings of Freire et al. (2021) on crash risk between young drivers and HVs, where it was noted that due to maturational limitations in neurocognitive functions of young drivers, they are unaware of the mental workload required for tasks such as overtaking. Therefore, crash risk can significantly be increased when overtaking HVs.

Even though most of the current literature show that a significant difference between male and female drivers in their overall driving behaviour does not exist (e.g., Baxter et al. 1990; DeJoy 1992; Aronsson and Bang 2006; Özkan and Lajunen 2006), some studies (e.g., Rhodes and Pivik 2011; Cordellieri et al. 2016; Jing et al. 2023) reported male drivers are involved in more risky behaviour than female drivers. Bener and Crundall (2008) noted from a Qatar study that male drivers have a higher degree of risk acceptance and prone to crashes than female drivers. From the analysed models, it is evident that gender is only a significant variable for scenario 3, where the HV was closer to the lane closure and which involves a higher level of risk taking to change lanes in front of the HV.

Driving experience remained in all three models. Compared to drivers with experience of 6 months – 1year, drivers with more experience were found to change lanes in front of a HV. Contrastingly, drivers with learner permits or probationary license were found to be changing lanes in front of a HV. Despite the license type, a phone survey done by McCartt et al. (2003) on self-reported crashes and penalties, it was reported that the crash risk of drivers during the first month or the first 800kms driven after obtaining the license was were higher than the next 11 months.

The frequency of highspeed road use did not retain in the most parsimonious model for any scenario. It was also noted by Moore et al. (2005), that drivers who do not frequently use highspeed roads might not be familiar around driving HVs and can be nervous around them.

While scenario 4 was not included in the model some interesting insights were noted from the descriptive statistics. When there are two HVs (scenario 4), the percentage of female drivers changing lane in front and in between HVs slightly increased compared to male drivers. Since the risk perception on risky behaviour was found to be significant for female drivers (Jing et al. 2023), it can be assumed that the level of risk is not perceived by female drivers in this scenario with two HVs. Further, 47% of the drivers with lesser driving experience selected to change lanes between the HVs with 10% preferring to overtake both HVs.

For this analysis, it was assumed that other factors such as the weather, road geometry, etc. were similar across the four scenarios. To further understand what other factors affect LV drivers when making lane changing related decisions around HVs, the third part of the survey was presented to the respondents.

4.3 Factors considered when driving around HVs

From the results of the third part of the survey, 15 different factors they would consider when changing lanes around HVs were noted by LV drivers. The most commonly noted factors include their observation of surrounding vehicles (67 comments), the speed and movement of HVs (56 comments), the distance to the lane closure (33 comments) and controlling the LV speed (25 comments). These identified 15 factors were categorised under four themes: (i) what drivers look for before changing lanes, (ii) what LV drivers assess before changing lanes, (iii) what LV drivers do before changing lanes, and (iv) other factors. These factors are discussed in detail in the following sections.

4.3.1 What drivers look for before lane changing

The factors drivers look for before making decisions related to changing lanes around HVs are categorised under this theme.

Four factors were identified under this theme: (i) other road signs to be informed of speed limits and any changes to the road condition ahead, (ii) the speed and location of the surrounding vehicles, (iii) other hazards such as debris on road or people working close to the edge of the road and finally, (iv) the number of trucks around. The number of drivers commented on each of these factors is presented in Table 3.

Table 3: Number of participants commented on what drivers look for before lane changing

Characteristics	Description	Number of participants commented on			
		Other road signs	Surrounding vehicles	Other hazards on road	Number of trucks
Age	18 - 25 years	2	28	3	1
	26 - 35 years	6	18	6	2
	36 - 45 years	0	14	3	0
	Over 45 years	2	7	2	1
Gender	Male	5	46	7	3
	Female	5	21	7	1
Experience	Less than 3 years	1	33	6	1
	3 - 5 years	3	16	1	2
	Over 5 years	6	18	7	1
License	Full	7	40	11	4
	Probationary	3	27	3	0
Highspeed road use	Daily	3	30	7	3
	4 - 6 days	3	13	3	1
	2 - 3 days	2	18	1	0
	Once a week or less	3	6	3	0
Total		10	67	14	4
(%)		(5.4)	(36.4)	(7.6)	(2.2)

Looking for surrounding vehicles were found to be the most commonly noted factor by the majority of participants (67, 36.4%) across all categories. Around 58% (28) of young drivers aged 18 – 25 years look for surrounding vehicles before changing lanes close to HVs. As noted by Weng et al. (2015a) the speed and location of the target lane lead and lag vehicles as well as merging lane lead and lag vehicles are important to perform a safe merging manoeuvre. Some respondents noted that they would observe and consider the speeds of other vehicles. Overall, drivers were more aware of the vehicles following them as well as the leading vehicle's actions when a HVs are presented:

> "*Vehicles speeding behind me*" A male participant aged between 18 – 25 years with 3 – 5 years of driving experience who use highspeed roads 4 – 6 days a week.
>
> *"Consider whether traffic ahead will change lanes"* A female participant of 26 – 35 years of age with 1 – 3 years of driving experience and use highspeed roads daily

Further, supporting the comments made by LV drivers on being aware of other hazards and debris on road, studies shows that the crash risk increase with debris on road after major weather events (Meyer et al. 2015), and even from objects fell from other vehicles on road (Tefft 2016).

4.3.2 What LV drivers assess before lane changing

After observing the surrounding environment, LV drivers reported assessing different factors before changing lanes around HVs. Four factors were identified as 'assessed before changing lanes' by the LV drivers: (i) distance to the HV from LV (33 comments), (ii) distance remaining to the lane closure (10 comments), (iii) HV speed and movement (65 comments), and (iv) the load of the HV (8 comments). The number of responses received for each of these factors are presented in Table 4.

Table 4: Number of participants commented on what LV drivers assess

Characteristics	Description	% participants commented on			
		Distance to the HV	Distance remaining to the lane closure	HV speed and movement	HV load
Age	18 - 25 years	8	3	12	2
	26 - 35 years	11	4	21	1
	36 - 45 years	4	3	17	3
	Over 45 years	10	0	15	2
Gender	Male	20	7	41	4
	Female	13	3	24	4
Experience	Less than 3 years	9	2	17	1
	3 - 5 years	3	2	12	2
	Over 5 years	21	6	36	5
License	Full	32	9	62	8
	Probationary	1	1	3	0
Highspeed road use	Daily	16	5	35	2
	4 - 6 days	8	3	8	3
	2 - 3 days	3	1	12	2
	Once a week or less	6	1	10	1
Total		33	10	65	8
(%)		(17.9)	(5.4)	(35.3)	(4.3)

From the factors assessed by drivers, the most popular was the HV speed and movement. This factor was mostly mentioned by drivers with over 5 years of driving experience. Unlike LVs, HVs usually travel and change lanes at a constant speed with lower applied acceleration or deceleration (Aghabayk et al. 2011). Therefore, it is important to assess and be aware of the speed of a HV and adjust the LV speed accordingly.

Around 18% (33) of the drivers would judge the distance to a HV. When required to make the decision of changing the lane in-front or behind the HV, participants were found to prefer speeding to get in front of a HV rather than decelerating to get behind a HV.

> *"Would consider if I would need to brake heavily to get behind the trucks. In that case I would accelerate and end up in front of the trucks"* A male participant 26-35 years of age with 6 months – 1 year of experience using highspeed roads 4 -6 days a week.

The distance remaining to the lane closure was mentioned by 5.4% (10) of the respondents. Despite the low number of comments, the study done by Weng and Meng (2011) shows that the remaining distance is an important factor when merging. While the current literature has limited studies, based on how the load of a HV influence a LV driver behaviour around HVs, it was noted by respondents.

> "*If their load looks dangerous I may keep distance behind them"* A female participant 18 – 25 years of age with more than 5 years of driving experience and using highspeed roads daily

4.3.3 What LV drivers do before lane changing

Five factors were identified as actions taken prior to changing lanes around HVs: (i) changing the LV speed (25 comments), (ii) being more cautious of head checks or the blind spot checks (6 comments), (iii) avoiding driving beside a HV for a longer period of time (7 comments), (iv) warning the HV ahead of time on their intention to change lanes (5 comments), and finally (v) alerting the HV drivers of their presence by sounding the horn or flashing lights (3 comments). The responses received for each of these categories are presented in Table 5.

Table 5: Number of participants commented on what LV drivers do

Characteristics	Description	% participants commented on				
		Changing LV speed	Blind spot checks	Driving beside HVs	Warning ahead of time	Sound the horn/ flash the lights
Age	18 - 25 years	3	0	1	0	1
	26 - 35 years	11	2	3	2	0
	36 - 45 years	7	3	3	2	2
	Over 45 years	4	1	0	1	0
Gender	Male	15	4	6	3	3
	Female	10	2	1	2	0
Experience	Less than 3 years	6	1	2	2	0
	3 - 5 years	7	1	1	1	2
	Over 5 years	12	4	4	2	1
License	Full	23	6	7	5	3
	Probationary	2	0	0	0	0
Highspeed road use	Daily	9	3	4	3	3
	4 - 6 days	7	0	1	2	0
	2 - 3 days	5	3	0	0	0
	Once a week or less	4	0	2	0	0
Total (%)		25 (13.6)	6 (3.3)	7 (3.8)	5 (2.7)	3 (1.6)

When changing lanes with HVs, the LV drivers are more aware of their speeds. Around 14% (25) of drivers across all driver categories commented on adjusting their speeds when changing lanes around HVs. Drivers adjust their speeds to either overtake a HV, to avoid higher deceleration rates after changing lanes in front of a HV or to accommodate the needs of the surrounding vehicles;

> "*I would prefer to be behind the truck because I would want to slow to 40 km/h (the speed limit) and I don't want a truck driver that wants to speed sitting behind me. And if they don't want to speed, then I can sit behind them happily at 40 km/h without worrying if the person behind me wants to go faster."* A female participant over 45 years with over 5 years of experience who travel on highspeed roads daily.

The importance of blind spot checks and the importance of not being in a HV's blind spot were mentioned by more than 3% (6) of the drivers. Interestingly, none of the participants on probationary license highlighted the need for blind spot checks or the fact that the LV should avoid being in the blind spot of a HV. Freire et al. (2021) noted that even though Australian road user manuals (e.g., TfNSW 2021) provide an overview of HV blind spots, young drivers in Australia have little awareness of the limitations of HV visibility due to blind spots.

Further, 1.6% (3) male participants with full license noted that they would use the flashing headlights and/or the sound of the horn to warn HV drivers before overtaking them. This behaviour can be received as aggressive behaviour by the surrounding vehicles.

> *"Sound the horn in advance to warn the truck before overtaking"* A male participant, 18 – 25 years of age with more than 5 years of experience who use highspeed roads daily.

4.3.4 Other factors

From the commented factors, (i) the impact of weather and visibility (12 comments) and (ii) the road inclination (6 comments) were two other factors (see Table 6) mentioned by some drivers as important to consider when driving around HVs. While these factors cannot be controlled, the driving behavior can be adjusted accordingly to ensure safety.

Commenting on weather and visibility was common around drivers, especially drivers over the age of 45 with over 5 years of driving experience. Drivers from all categories except drivers with 3 – 5 years of experience have commented on considering visibility when changing lanes around HVs. Karali et al. (2017) noted that it can be more difficult for older drivers to drive in foggy weather due to lesser reaction speeds to avoid crashes.

Unlike weather and visibility, the observation of road inclination and adjusting the LV behaviour accordingly was not a popular opinion. Attempting to overtake HVs on uphill roads can be risky as noted by (Arellano et al. 2015), also the LV speed might drop after changing lanes in front of a HV. From the survey respondents, only around 9% of mature drivers who are less frequent in using highspeed roads commented on road inclination;

> "*I would consider whether the approach is uphill or downhill. If uphill I would aim to be in front of trucks"* A male participant 36 – 45 years of age with more than 5 years of experience and use highspeed roads 2 -3 days a week.

Table 6 Number of participants commented on other factors

		% participants commented on	
Characteristics	**Description**	**Weather and visibility**	**Road inclination**
Age	18 - 25 years	2	0
	26 - 35 years	3	0
	36 - 45 years	2	3
	Over 45 years	5	3
Gender	Male	8	5
	Female	4	1
Experience	Less than 3 years	1	0
	3 - 5 years	0	0

	Over 5 years	11	6
License	Full	11	6
	Probationary	1	0
Highspeed road use	Daily	4	0
	4 - 6 days	2	1
	2 - 3 days	3	3
	Once a week or less	3	2
Total		12	6
(%)		(6.5)	(3.3)

5 Conclusions

This paper presents results from an analysis of drivers' perceptions when driving and changing lanes around HVs. Using data collected from 455 drivers in an online survey, LV drivers' lane changing behaviour around HVs were analysed using a regression model. The factors considered by LV drivers before changing lanes were also analysed thematically using qualitative comments provided by drivers in the survey. For this study, it was assumed that drivers make decisions regarding lane changing based on the positioning of the HV when all other factors remain unchanged.

The results showed that when only one HV is available around a LV driver, most drivers prefer changing lanes behind the HV. Drivers over the age of 45 years and female drivers prefer merging behind HVs, whereas young and male drivers preferred merging in front of HVs. Experienced drivers preferred merging in front of HVs.

Analysis of the qualitative comments provided by drivers identified 15 factors that drivers consider before changing lanes around HVs. These factors were broadly categories into what drivers look for before changing lanes, what LV drivers assess before changing lanes, what LV drivers do before changing lanes and other factors. The two most commonly reported factors were observing surrounding vehicles and judging the speed and the movement of the HV before making a decision on changing lanes. The important factor of blind spot checks and minding and avoiding the blind spot of HVs were only mentioned by a few participants. Further, behaviour such as sounding the horn or flashing the lights was also mentioned by some drivers.

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