Transport Research Laboratory
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DRAFT PROJECT REPORT 3511

Experimental studies of factors associated with driver frustration and overtaking intentions

N Kinnear and S Helman

Prepared for: Transport Scotland

Quality approved:

Lorna Pearce (Project Manager)

Shaun Helman (Technical Referee)

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Contents amendment record

This report has been amended and issued as follows:

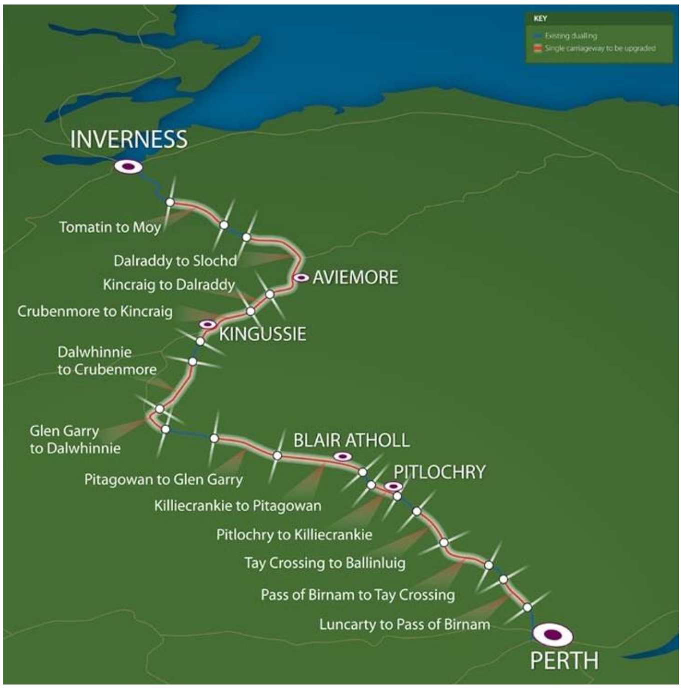
Version	**Date**	**Description**	**Editor**	**Technical Referee**
1	10/11/2015	First draft for Transport Scotland	NK	SH
2	04/02/2016	Updated report in response to client review	NK	SH
3	25/11/2016	Final report for Transport Scotland	NK	SH

Contents

1 Introduction

1.1 Background

The A9 and the A96 are two of Scotland's busiest trunk roads linking Inverness and the Highlands with the central belt and Aberdeen respectively. Both routes have been identified for dualling with the aim of delivering a number benefits including improved journey time reliability, economic growth, improved connectivity and a reduction in the rate and severity of accidents. A further aim of changes to these routes is that they will reduce driver frustration and overtaking, factors that are considered important for enhancing the driver experience, and are considered to be precursors of negative safety-related events.



The A9 between Perth and Inverness is to be upgraded along its length to dual carriageway by 2025. The A9 dualling programme between Perth and Inverness was a recommended intervention from the Strategic Transport Projects Review (2008). Interventions in advance of the dual carriageway upgrade were implemented in October 2014 and included the installation of average speed cameras (ASCs) and the raising of the speed limit for heavy goods vehicles in excess of 7.5 tonnes maximum laden weight from 40mph to 50mph.

The A96 is the trunk road linking the cities of Inverness and Aberdeen. It runs from Raigmore Interchange at Inverness to Haudagain Roundabout at Aberdeen, passing through various towns and villages along the route.

Due to the nature of the road and the surrounding landscape, dualling the A96 is a significant undertaking requiring careful, in-depth planning and design.

1.2 Driver frustration and overtaking behaviour

Driver frustration can be defined as "the psychological state that occurs when a driver is blocked from making progress towards the goals of their journey" (Kinnear, Helman, Wallbank & Grayson, 2015, p.229). It is often assumed that when this state occurs, it leads directly to an increase in overtaking behaviour. However, a review of international evidence for Transport Scotland suggests that little is known from empirical data on what variables impact on frustration and overtaking behaviour (Kinnear et al., 2015).

Drawing largely on what is known from psychology, Grayson, Kinnear and Helman (in press) put forward a simple theoretical model designed to explain the processes underlying frustration and overtaking. The model (see Figure 1) is intended as a framework in which to think about the link between frustration and overtaking, incorporating the various other factors that are likely to play a role in determining whether or not a driver feels frustrated, and whether or not they decide to overtake in a given situation.

In light of the lack of empirical work addressing the issue, Transport Scotland commissioned a study to examine directly the impact of factors associated with driving on single and dual carriageway roads (specifically length of platoon, proportion of heavy goods vehicles (HGVs), speed, and opportunities for overtaking) on self-reported frustration and overtaking intentions (Kinnear, Helman, Murphy, Casey & MacDonald, 2014). As a whole, the results of this study show that the links between traffic variables such as speed and platoon length, and behaviourally-relevant variables such as frustration and overtaking intentions, are not simple. Although there are broad and predictable effects of speed and platoon length, these are mediated by other variables, and are not equivalent for frustration and overtaking intentions. In summary, the often-held assumption that increased frustration leads to more overtaking can be said to be too simplistic.

1.3 This report

This report details two studies that were conducted to build on the work to date. One study was undertaken with users of the A9 and one was undertaken with users of the A96. Using the same methodology as that reported in Kinnear et al. (2015), these studies directly examined the impact on self-reported frustration and overtaking intentions of various parts of the frustration model (specifically time pressure, and time behind a platoon) as well as factors associated with traffic that are known to be relevant on the A9 and A96 (specifically length of platoon, proportion of HGVs, speed, and opportunities for overtaking).

The aim of the study was to identify the factors leading to driver frustration and their impact on levels of driver frustration experienced by users of the A9 and A96.

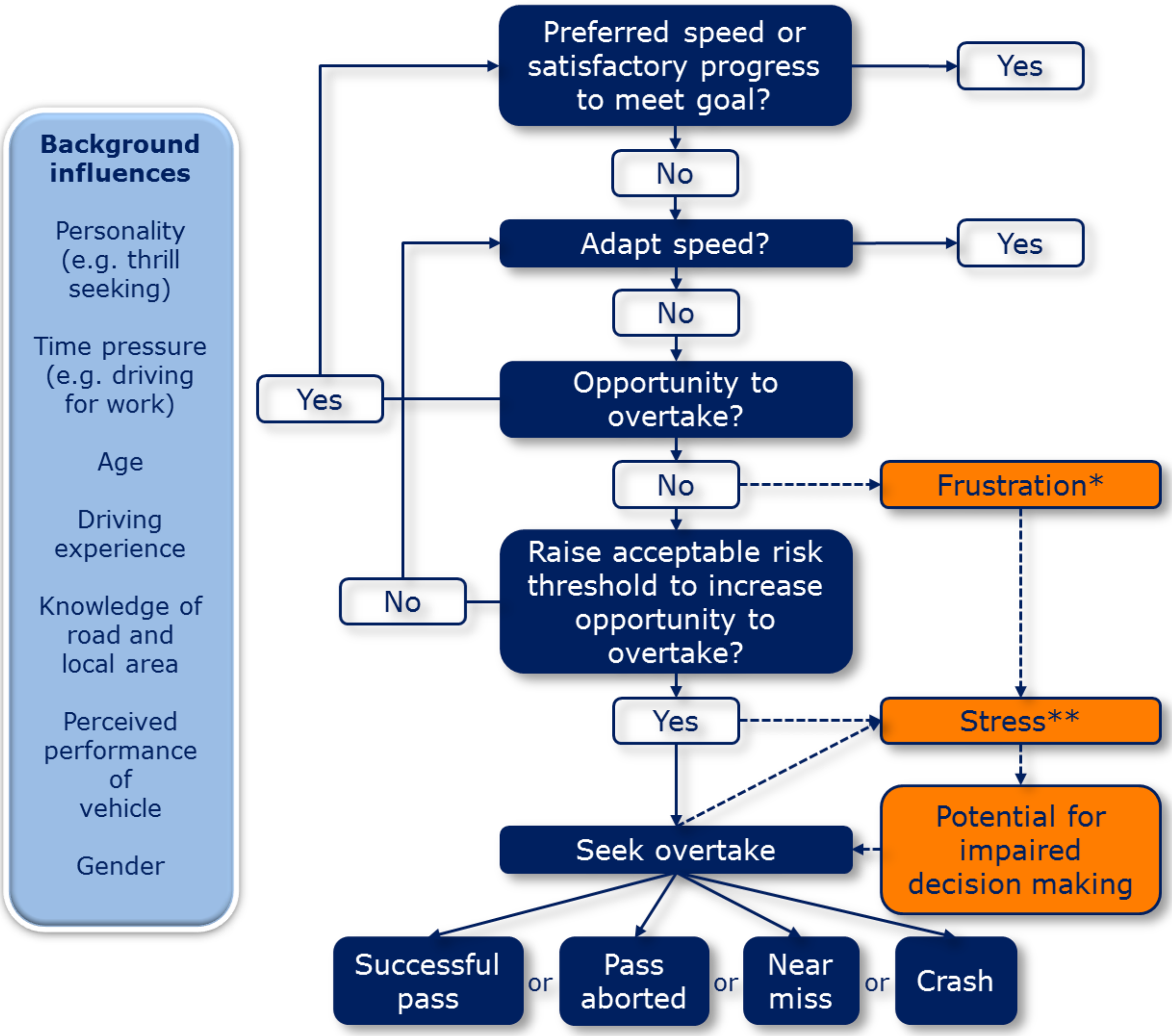
1.4 Structure of the report

The remainder of this report is structured as follows:

Section 2 describes the methods used.

Section 3 describes the results.

Section 4 discusses and summarises the key findings.



*refers to (by definition) the act of being frustrated from not travelling at the desired speed by a lack of an appropriate overtaking opportunity

**refers to a set of internal states including possibly frustration itself (arising from the act of being blocked) and others such as increased mental workload associated with planning or attempting more risky overtaking manoeuvres

Figure 1: A model of frustration and overtaking (reproduced from Kinnear et al., 2014)

2 Method

2.1 Design

The two experiments had the same methodological design except they employed different between-group variables. Each experiment had two groups: the A96 experiment compared a 'time pressured' group with a 'non-time pressured' group (via instruction from the experimenter), while the A9 experiment compared an 'ASC (average speed camera)' group with a 'no ASC' group (via manipulation of the stimuli displayed to participants). These and the within-participants independent variables tested in both experiments are listed in Table 1.

Table 1: Experimental variables in the two studies

Study	Variable	Levels
A96 (between-groups only)	Driver goal	No time pressure Time pressure
A9 (between-groups only)	Average Speed Cameras (ASCs)	No ASCs in stimuli ASCs in stimuli
A9 and A96 (within participants)	Progress speed	40mph 56mph
	Platoon length	Short (2 vehicles) Long (10 vehicles)
	Platoon type (proportion of HGVs)	No HGVS 50% HGVs
	Road type	Single carriageway Dual carriageway
	Oncoming traffic	No oncoming traffic Some oncoming traffic

The key dependent variables (self-report scored from 0 to 120 on a line scale) were likelihood of overtaking, and level of frustration.

Four stimulus orders were used, with different groups of participants seeing each order. This is a common technique in trials where participants observe multiple situations. The four orders mixed up the different combinations of variables in a systematic way to help control for any order effects (that is, any impact that earlier clips may have on responses to later clips).

2.2 Participants

521 participants in total took part in the two studies: 290 took part in the A96 experiment and 231 in the A9 experiment. Participants completed the study in groups of up to 15. The breakdown of the sample by location, date and experimental group can be seen in Table 2.

Table 2: Breakdown of participant sample by location, date and experimental group

Experiment	Location	Testing dates	Participants		
			No time pressure/ no ASCs	Time pressure/ ASCs	Total
A96 (Time pressure versus no time pressure groups)	Elgin	25-29 Aug 2015	89	87	176
	Aberdeen	1-5 Sept 2015	57	57	114
A9 (ASC versus no ASC groups)	Inverness	25-29 Aug 2015	77	60	137
	Perth	1-5 Sept 2015	43	51	94

In each of the experiments, the sample was matched as closely as possible (in terms of age and gender mix) to licence holders in the UK, based on data supplied by the DVLA (Driver and Vehicle Licensing Agency) (see Table 3). To be eligible to take part, participants needed to be a car driver and hold a full UK driving licence.

Table 3: Breakdown of sample by age and gender for the A96 and A9

	A96			A9		
	Male	Female	Total	Male	Female	Total
17-24	18	13	31	12	7	19
25-34	34	37	71	27	29	56
35-44	35	29	64	23	24	47
45-54	32	27	59	31	31	62
55-64	26	22	48	21	14	35
65-74	8	4	12	5	3	8
75-84	0	1	1	1	1	2
85+	0	0	0	0	0	0
Age and/or gender unknown			4			2
Total	153	133	290	120	109	231

Participants were recruited through adverts placed in local newspapers in and around the four locations used. Online advertising and social media were also used, with adverts placed on Facebook and Gumtree, and sponsored targeted links on Twitter and LinkedIn. Participants were given £30 for taking part in the study, to cover travel expenses and time for the session.

2.3 Materials

Thirty-six clips were generated as video files. Thirty-two of these clips covered all combinations of the variables length of platoon, proportion of HGVs in platoon, speed, road type, and oncoming traffic (2 x 2 x 2 x 2 x 2 = 32). Each clip was presented once in each of the studies. The other four clips were designed to allow participants practice with the task before the main part of the study, and also collected participants' self-reported speed intentions for single and dual carriageway roads (so that this variable could be used in the analysis if appropriate); these clips showed the single and dual carriageway roads used in other clips, at 40mph and 56mph, but with no other traffic at all. The 32 experimental clips in the A9 study were replicated with ASCs visible (for an example see pair 3 of Figure 2). All the clips are described in the first table in Appendix A, and the orders used for presentation are shown in the second table in Appendix A.

Clips were shown on a laptop computer through a high-resolution projector (image size 1920 x 1080 pixels). As participants were being tested in groups, a standard viewing distance from the projected image could not be guaranteed. At all locations the distances from the screen were similar to those in Kinnear et al. (2015).

Clips were defined into two parts for the purpose of running the sessions:

Part 1: Baseline clips (clips 1-4)

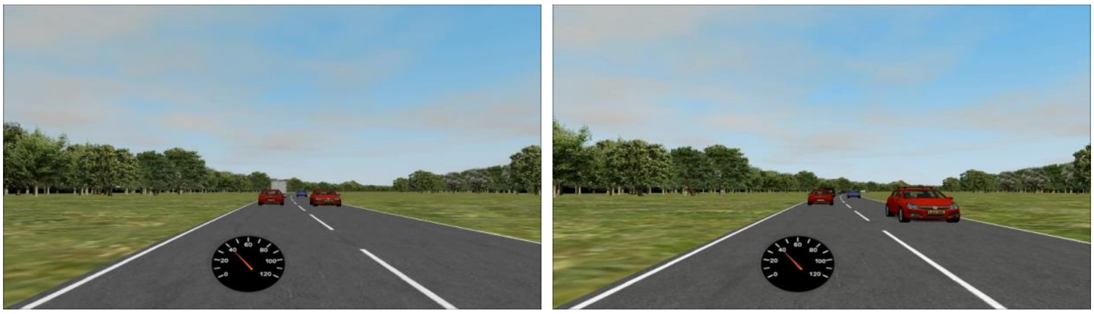
Part 2: Experimental clips (independent variables; clips 5-36)

The stimuli were created using SCANeR Studio (version 1.2) which is the software used in the TRL DigiSim car driving simulator. Each scenario was created within the SCANeR Studio software and then converted into a video file that could be played using Windows Media Player. Clips 1 to 4 (Part 1) and Clips 5 to 36 (Part 2) were edited together within Windows Movie Maker, in the four orders outlined in Section 2.1 and shown in Appendix A. The editing ensured that there was a ten-second interlude after each clip; the first five seconds of this interlude displayed a static message ('Now answer the questions for the clip') and the second five seconds displayed the name of the next clip (e.g. 'CLIP 15').

A paper-based questionnaire was used to collect data on the dependent variables for the various clips, along with demographic data and information regarding driving experience, and responses to the Driver Attitude Questionnaire (DAQ; Parker, Stradling & Manstead, 1996) which measures attitudes towards speeding, overtaking, close following and drink driving. The questionnaire is presented in Appendix C.

Pair 1

Pair 2



Pair 3

Pair 4

Figure 2: Examples of clips used in the study. All speedos show 40mph. Pairs 1 and 2 show a single carriageway road. Pair 1 shows short platoon (no HGVs) on left and long platoon (50% HGVs) with no oncoming traffic. Pair 2 shows short platoon (50% HGVs) on left and long platoon (no HGVs) with oncoming traffic. Pair 3 shows the equivalent clips as used in Pair 2 but with ASCs. Pair 4 shows the equivalent clips as used in Pair 2, but on dual carriageway.

2.4 Procedure

As participants arrived for their pre-arranged session they were given a short description of the study. The participants were told that they would be shown simulated clips of driving situations, and that they would then be asked to answer questions about how they think they would feel if driving in the situation depicted. Participants then each completed a form giving their informed consent to take part in the study. When all participants in a group had consented, the study began.

At the beginning of the study, those participants in the A96 'no time pressure' group were told that they were under no particular time pressure to be at their destination, while those in the 'time pressure' group were told to imagine that they were under some time pressure as they were running late for an appointment. In both these cases, participants were told to imagine a specific journey that they had undertaken in the past that fitted the relevant criterion (i.e. under no time pressure, or under some time pressure). The instruction to imagine a specific journey was designed to make it easier for participants to internalise the feeling of time pressure (or no time pressure) for the purpose of the stimuli they were about to be shown.

For the A9 experiment there was no difference in the instruction given as the difference between the groups was contained with the clips (no ASC visible or ASC visible).

For both groups, the instructions for Part 1 of the study (the four baseline clips) were read out by the experimenter, and the clips were played. The video was paused after each clip if necessary to allow all participants time to complete the questions for that clip.

After completion of Part 1, instructions for Part 2 were read out, and the 32 clips that formed the main part of the study were then played. Again the video was paused after each clip if necessary for survey completion, with the experimenter keeping a close eye on participants' progress through the questionnaire, and checking that all participants were keeping the correct place in the questionnaire relative to the clips being shown.

After completion of the clips participants were asked to complete the short survey on demographic data and driving experience, and the DAQ. After all participants had completed these, they were asked to complete a short stated preference survey. Details and results of the stated preference survey are reported separately.

3 Results

The frustration data and overtaking data for the single carriageway roads, and for dual carriageway roads, were analysed using parametric statistical techniques. Statistical checks suggest that the analysis used is robust[1].Complete lists of p-values associated with each individual analysis can be found in Appendix B.

3.1 A96 – main analysis

3.1.1 The participant sample

Of the 290 participants who took part in the study, there were 80 males and 64 females in the no time pressure group, and 73 males and 70 females in the time pressure group[2]. A Chi-Square test[3] confirmed that the distribution of these two groups by gender did not differ significantly. Independent samples t-tests[4] and Mann-Whitney U tests confirmed that the two groups did not differ significantly on mean age, mean number of years holding a driving licence, mean engine size of vehicle, mean annual mileage, and frequency of driving on the A96. In addition the two groups did not differ on mean speeds given to the four baseline clips shown at the beginning of the study.

In short, the two groups did not differ *a priori* on any measures that might be expected to influence their propensity to overtake or their levels of frustration independently of the time pressure conditions they were under. Four participants took part in the previous driver frustration study. The previous study was conducted two years prior to this study and it was not considered that previous participation would bias current responses. The data from these participants were therefore included in the analysis.

3.1.2 Single carriageway roads

Results from the analysis of frustration data and overtaking intention data from single carriageway roads are presented in Sections 3.1.2.1 and 3.1.2.2. The data for all experimental conditions are represented visually in Figure 4 and Figure 7 respectively.

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[1] The data were analysed using a five-way mixed Analyses of Variance (ANOVAs). Before analysis, the extent to which the dependent variables met the assumptions required for parametric analysis was checked. It was found that for almost all clips the normality assumption was not met. ANOVAs are known to be reasonably robust to the violation of the normality assumption. In addition, non-parametric tests were run on main effects to check whether they resulted in different conclusions. These supplementary analyses suggested that the analysis used is robust, as all effects were the same with non-parametric tests.

[2] Three participants failed to provide information on whether they were male or female on the survey, hence these numbers sum to less than the full sample size.

[3] A Chi-squared test is used to determine whether there is a statistically significant association between categorical variables.

[4] Independent samples t-tests are used to determine the significance of differences between the means of independent groups.

3.1.2.1 *Frustration on single carriageway roads*

Analysis of the frustration data on single carriageway roads revealed significant main effects of speed, platoon length, HGV% and oncoming traffic (all $p<0.001$[5]). The interaction between speed and HGV% was also significant ($p=0.002$), as was the three-way interaction between platoon length, oncoming traffic and time pressure ($p=0.033$). These interactions mean there is no simple relationship between any single variable and frustration; the level of frustration reported is dependent on a combination of the variables. Nevertheless, for some variables the direction of the effect on frustration is consistent (i.e. it causes frustration to either increase or decrease). The magnitude of the effect is dependent on, and mediated by, the level or levels of other variables.

Figure 3 shows the individual effects on frustration of speed, platoon length, HGV% and oncoming traffic. While these show the effect of the individual variable on frustration, they do not tell the whole story; that is, they do not show the effect that other variables have on the relationship between the individual variable concerned and frustration.

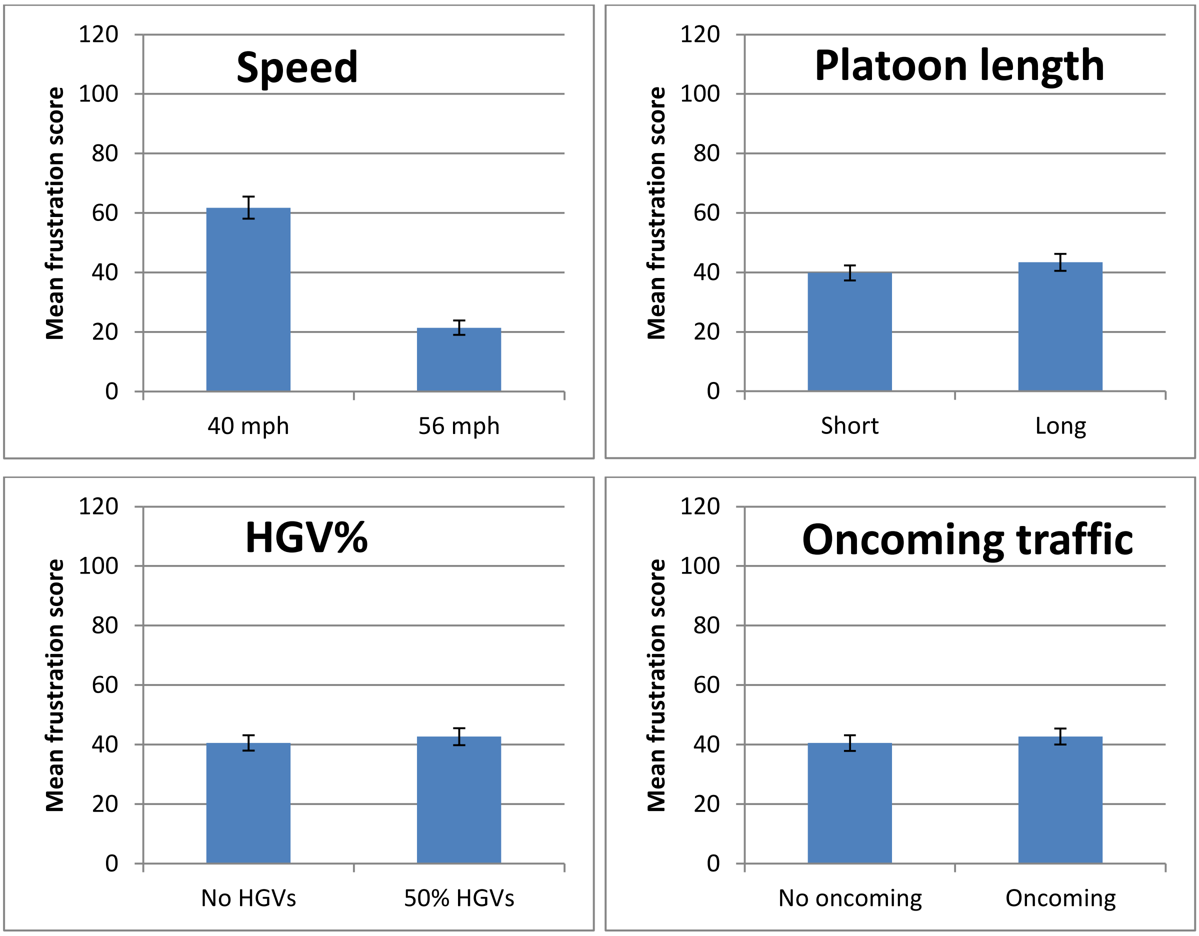

Figure 3: Mean frustration scores by speed, platoon length, HGV% and oncoming traffic[6]

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[5] Throughout this report we use the convention from the behavioural sciences in reporting p-values (the chance of a given effect having arisen purely due to random fluctuations in the data) as statistically significant if they are below 0.05 (5%)

[6] The errors bars presented on bar charts throughout this report represent the 95% confidence intervals for the reported levels of the mean value. In other words, if this study were to be repeated over and over again, the true levels of the mean would be expected to lie within this interval 95% of the time.

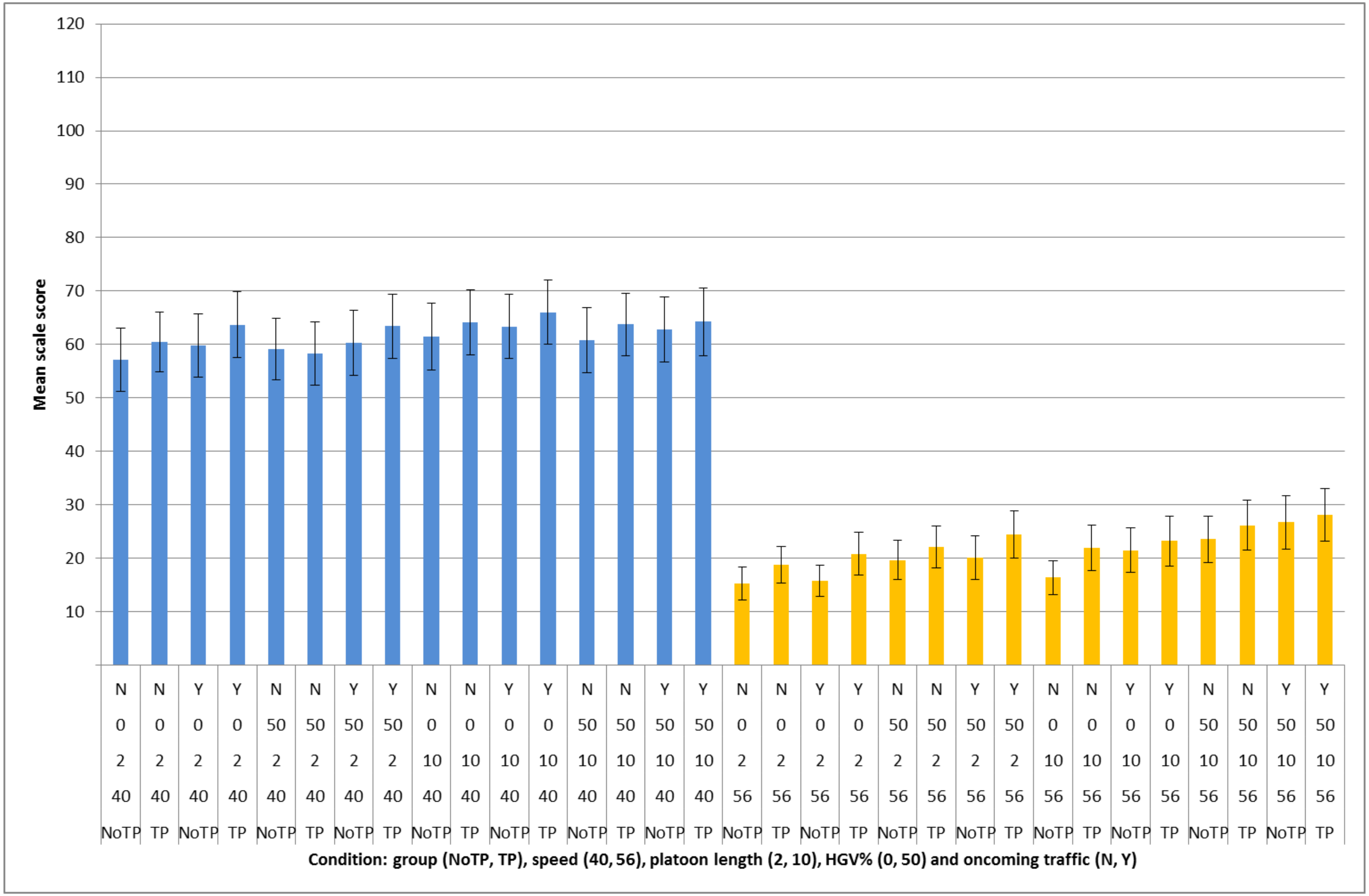

Figure 4: Mean frustration by condition on single carriageway roads (blue bars = 40mph, yellow bars = 56mph)

Taken together, the analysis suggests that on single carriageway roads, speed, platoon length, HGV% and oncoming traffic have a clear impact on self-reported frustration. The large effect of speed is easily observed in Figure 3 and Figure 4; lower speeds lead to higher levels of frustration regardless of the levels of other factors. At higher speeds, levels of frustration are slightly higher when HGVs are present in the platoon compared with when they are not.

A small but statistically significant effect of platoon length can also be seen in Figure 3 and Figure 4; in general the platoon length of ten vehicles gives rise to higher levels of frustration than the platoon length of two vehicles. Similarly small effects are noticeable in self-reported frustration when considering HGV% and oncoming traffic individually. The presence of these two factors increases levels of frustration.

The effect of time pressure on frustration is more nuanced and, as the main effect of time pressure is not significant, it cannot be easily determined by the naked eye. It would appear that being under time pressure ('TP' bars in Figure 4) increases frustration differently depending on platoon length and the presence/absence of oncoming traffic; for clips with shorter platoons, time pressure seems to increase frustration more when oncoming traffic is present, while for clips with longer platoons the time pressure effect seems more pronounced when there is no oncoming traffic. This relationship can be seen in Figure 5.

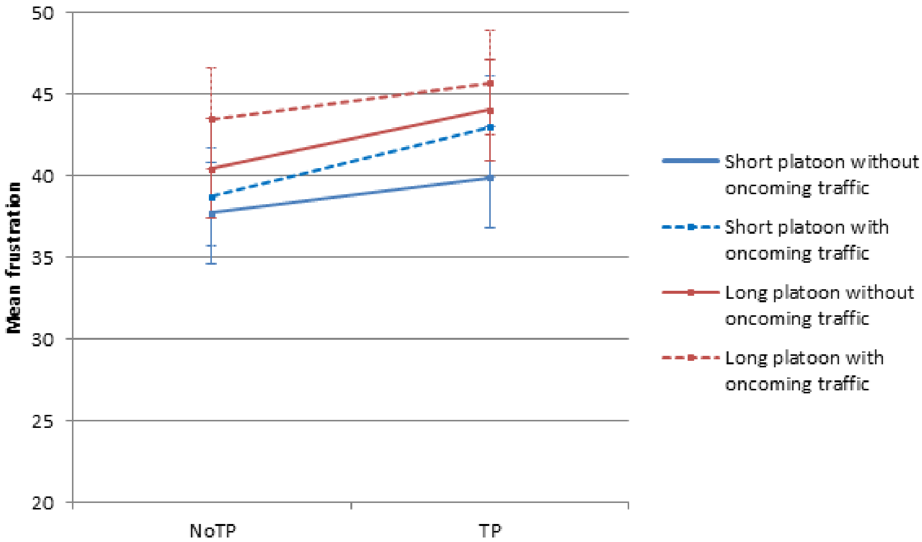

Figure 5: Three-way interaction between platoon length, oncoming traffic and time pressure[7]

3.1.2.2 Overtaking intentions on single carriageway roads

For overtaking intention data on single carriageway roads the five-way mixed ANOVA revealed significant main effects for all variables except time pressure. Speed, platoon length, HGV% and oncoming traffic main effects were significant ($p<0.001$).

[7] Throughout this report the y axes of some charts (displaying measures of mean frustration or intention to overtake) have been reduced to better visualise the relationship between variables. The full scale for frustration and intention to overtake ratings is 0 to 120.

Higher speeds led to a decrease in intention to overtake. This can be seen in Figure 6 and Figure 7. A decrease in intention to overtake was also apparent with longer platoons, as well as with the proportion of HGVs in the platoon and the presence of oncoming traffic. It is important to note that the four-way interaction between these four variables was also significant (p=0.017) which implies the relationships between these variables and intention to overtake are more complicated than they seem.

As with frustration, the four-way interaction means there is no simple relationship between any single variable and the intention to overtake; the impact of a variable on intention to overtake is dependent on the level or levels of the other variables. Nevertheless, the direction of the effect is consistent for each variable (i.e. it causes intention to overtake to either increase or decrease). Figure 6 shows the individual overall effect on intention to overtake of speed, platoon length, HGV% and oncoming traffic. While they show the effect of the individual variable on intention to overtake, they do not tell the whole story; that is, they do not show the effect that other variables have on the relationship between the individual variable and frustration. This variability can be seen by comparing bars in Figure 7.

As with frustration, time pressure had no statistically significant effect on intention to overtake in the single carriageway clips.

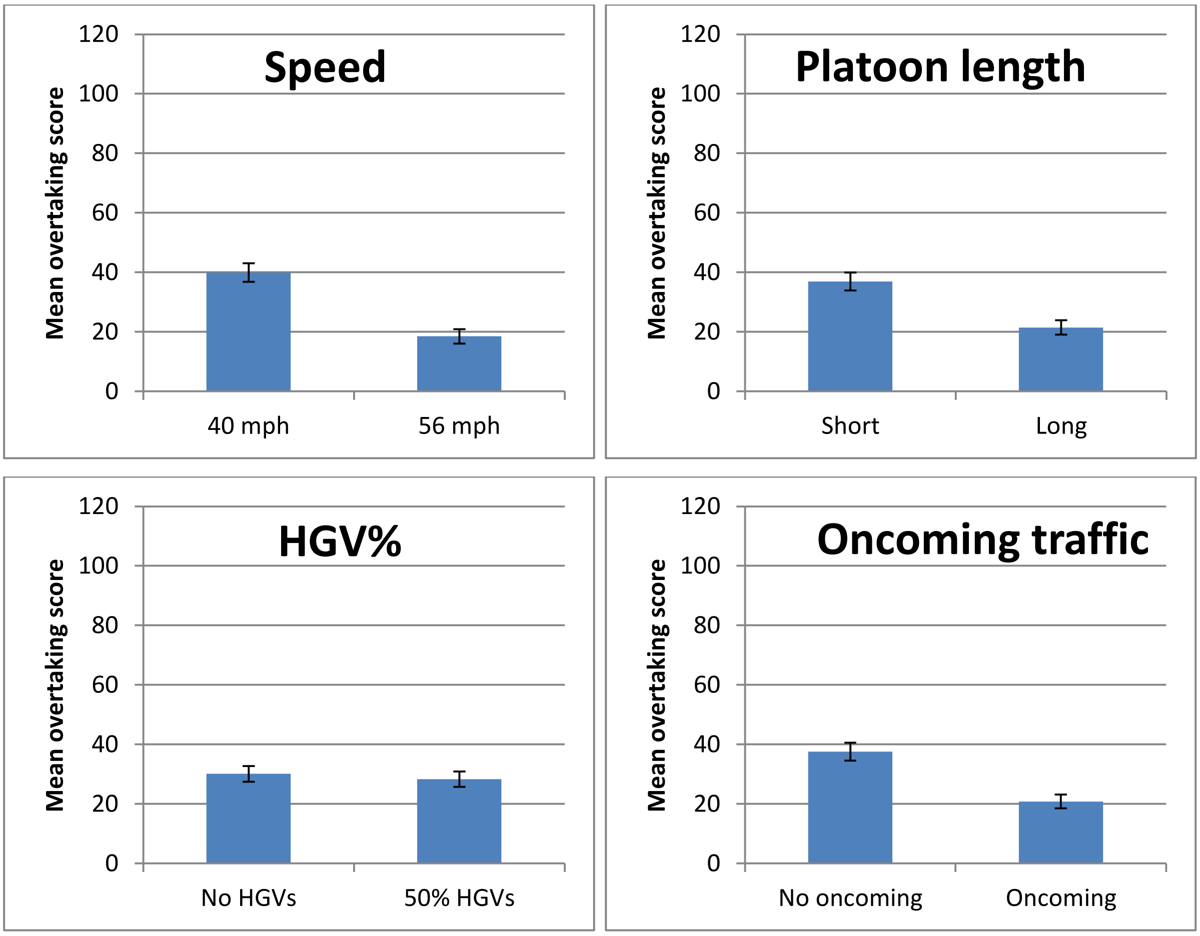

Figure 6: Mean intention to overtake scores by speed, platoon length, HGV% and oncoming traffic

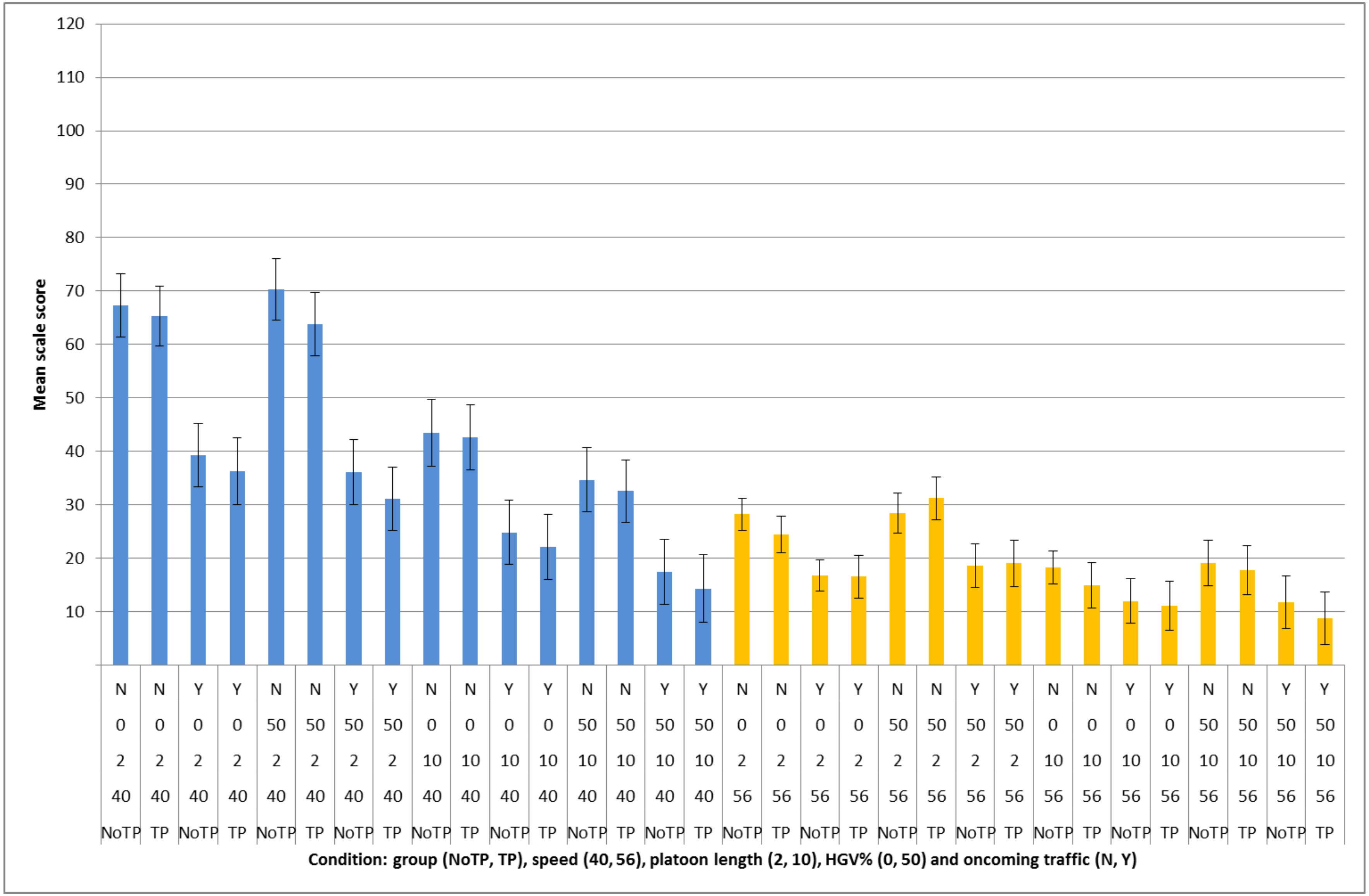

Figure 7: Mean overtaking intention by condition on single carriageway roads (blue bars = 40mph, yellow bars = 56mph)

3.1.3 Dual carriageway roads

The frustration data and overtaking intention data from dual carriageway roads are shown in Figure 9 and Figure 13 respectively.

3.1.3.1 Frustration on dual carriageway roads

For frustration data on dual carriageway roads a five-way mixed ANOVA revealed significant main effects of speed and platoon length ($p<0.001$ in both cases). In addition, the three-way interaction between speed, HGV% and time pressure was significant ($p=0.044$).

As with the single carriageway data there were clear effects of speed and platoon length on frustration, such that lower speed is associated with higher self-reported frustration and following a longer platoon also increases self-reported driver frustration. Both of these effects are visualised in Figure 8 and Figure 9.

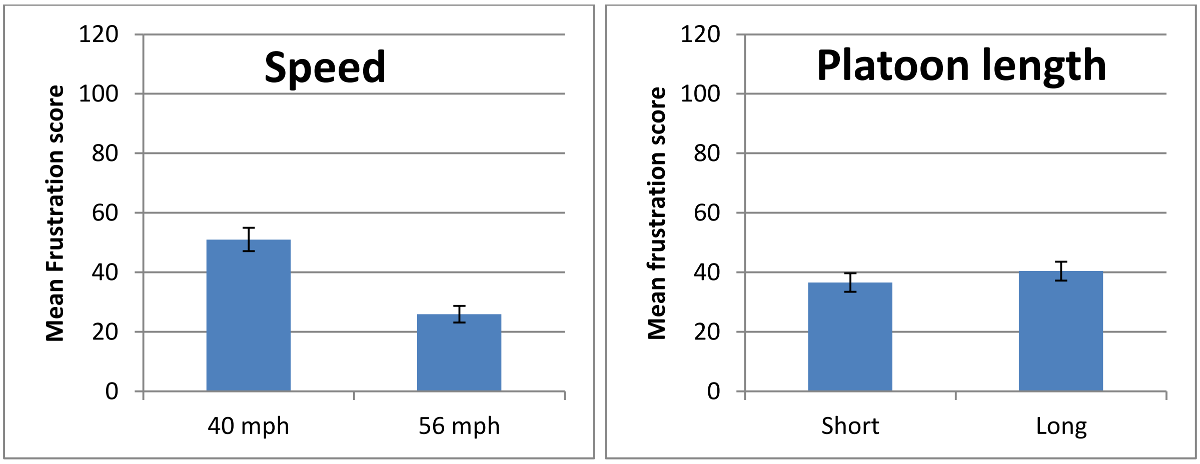

Figure 8: Mean frustration scores by speed and platoon length

However the picture is more complex than the singular effect of these variables on frustration. The three-way interaction between speed, HGV% and time pressure shows that the effect of being under time pressure increases frustration differently depending on speed and HGV%, however the size of the effects is small. In all cases, lower speed is associated with more frustration, but the difference between frustration in the lower and higher speed conditions is most pronounced when time pressure is not a factor and HGVs are absent. Figure 10 shows these relationships.

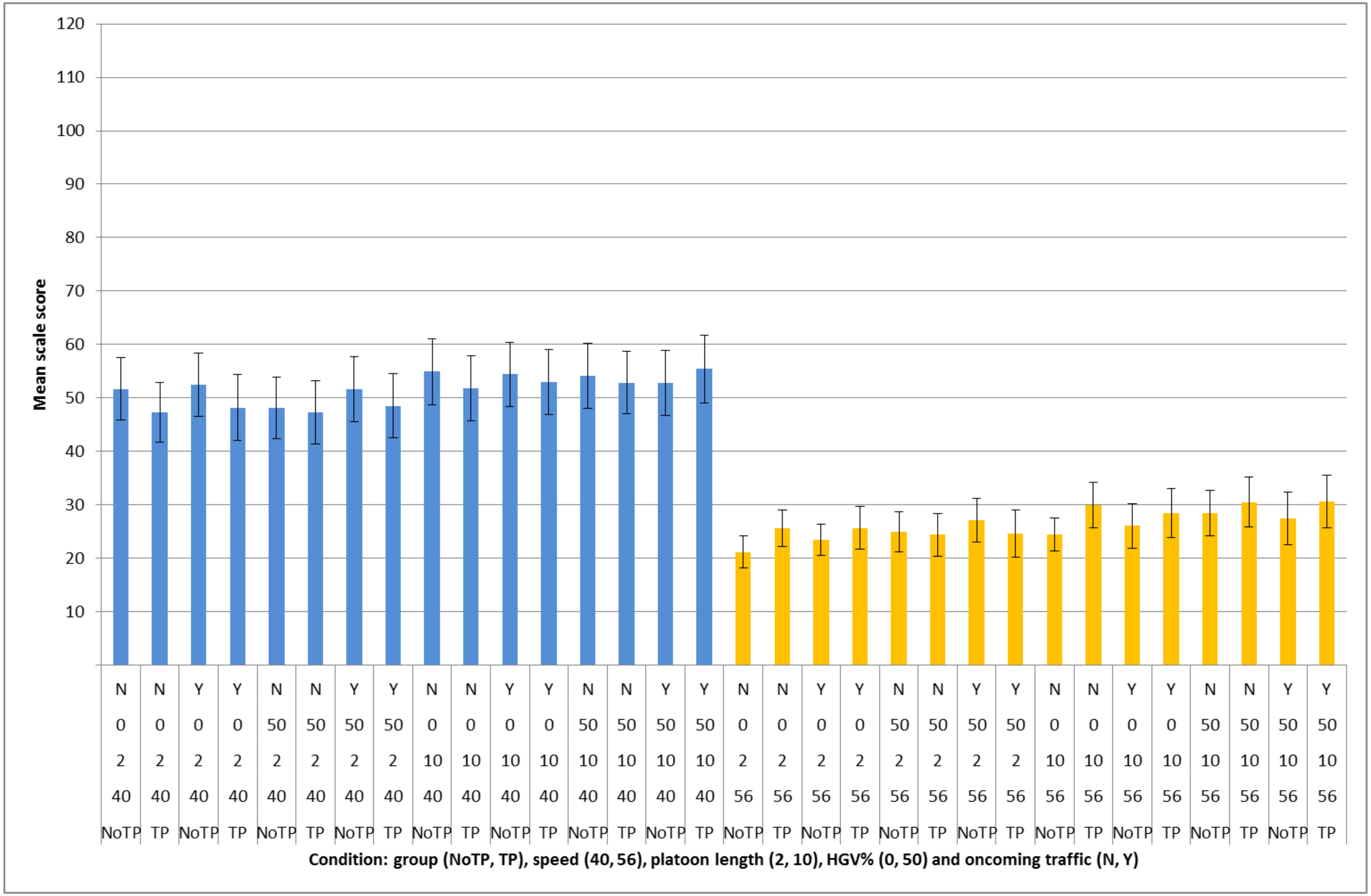

Figure 9: Mean frustration by condition on dual carriageway roads (blue bars = 40mph, yellow bars = 56mph)

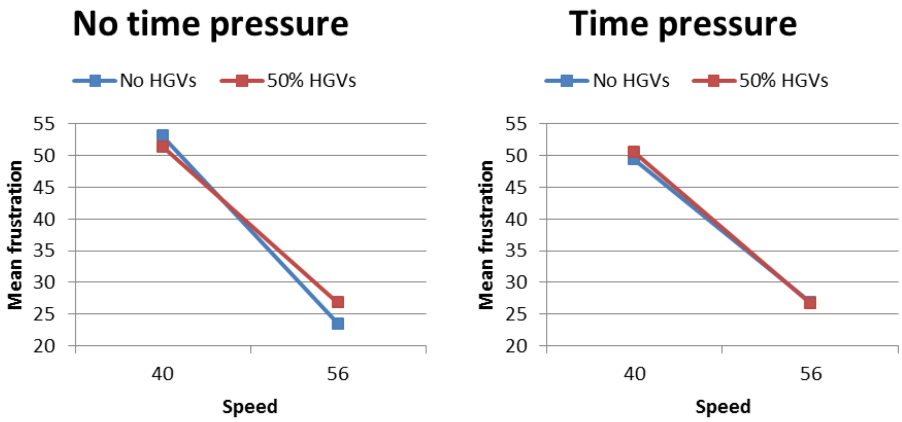

Figure 10: Three-way interaction between time pressure, speed and HGV%

3.1.3.2 Overtaking intentions on dual carriageway roads

For overtaking intention data on dual carriageway roads, the five-way mixed ANOVA revealed significant main effects of speed, platoon length and oncoming traffic ($p<0.01$ in all three cases). In addition, the interactions between speed and platoon length ($p=0.004$), speed and HGV% ($p<0.001$) and platoon length and HGV% ($p=0.001$) were significant.

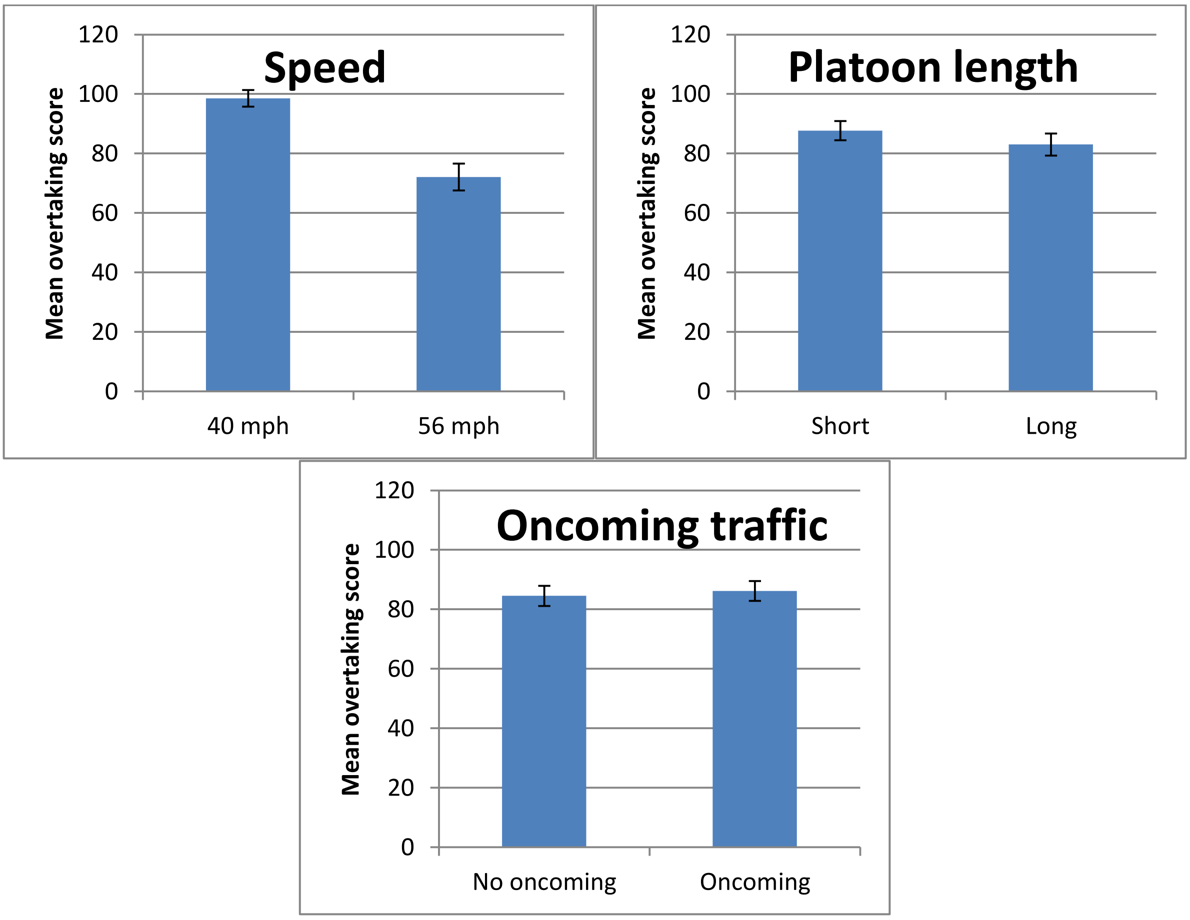

Figure 11: Mean intention to overtake scores by speed, platoon length and oncoming traffic

Lower speeds are associated with a greater intention to overtake, although the difference between speed does not seem as pronounced as in the single carriageway data, presumably because even with the higher speed clips overtaking can be done relatively safely on dual carriageways. Participants' intention to overtake is higher in general than in the single carriageway condition. In addition, smaller differences in intention to overtake between speeds are apparent when HGVs are present versus absent.

Shorter platoons also seem to be associated with higher likelihood of overtaking, and again this effect seems to be more prevalent at lower speeds. As was the case with speed, the difference in intention to overtake between platoon lengths is smaller when HGVs are present than when they are not.

All of these interactions can be seen in Figure 12.

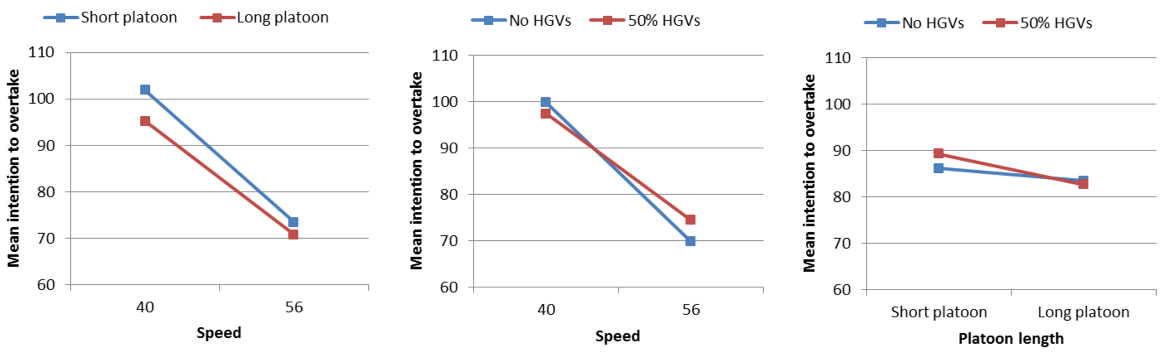

Figure 12: Two-way interaction between speed/platoon length, speed/HGV% and platoon length/HGV%

The presence of oncoming traffic seems to be associated with a higher intention to overtake, but the effect is not easily noticeable in the data. That there is an effect of oncoming traffic at all is peculiar given the nature of separation afforded by the dual carriageway design.

Time pressure had no statistically significant effect on overtaking intentions in the dual carriageway clips.

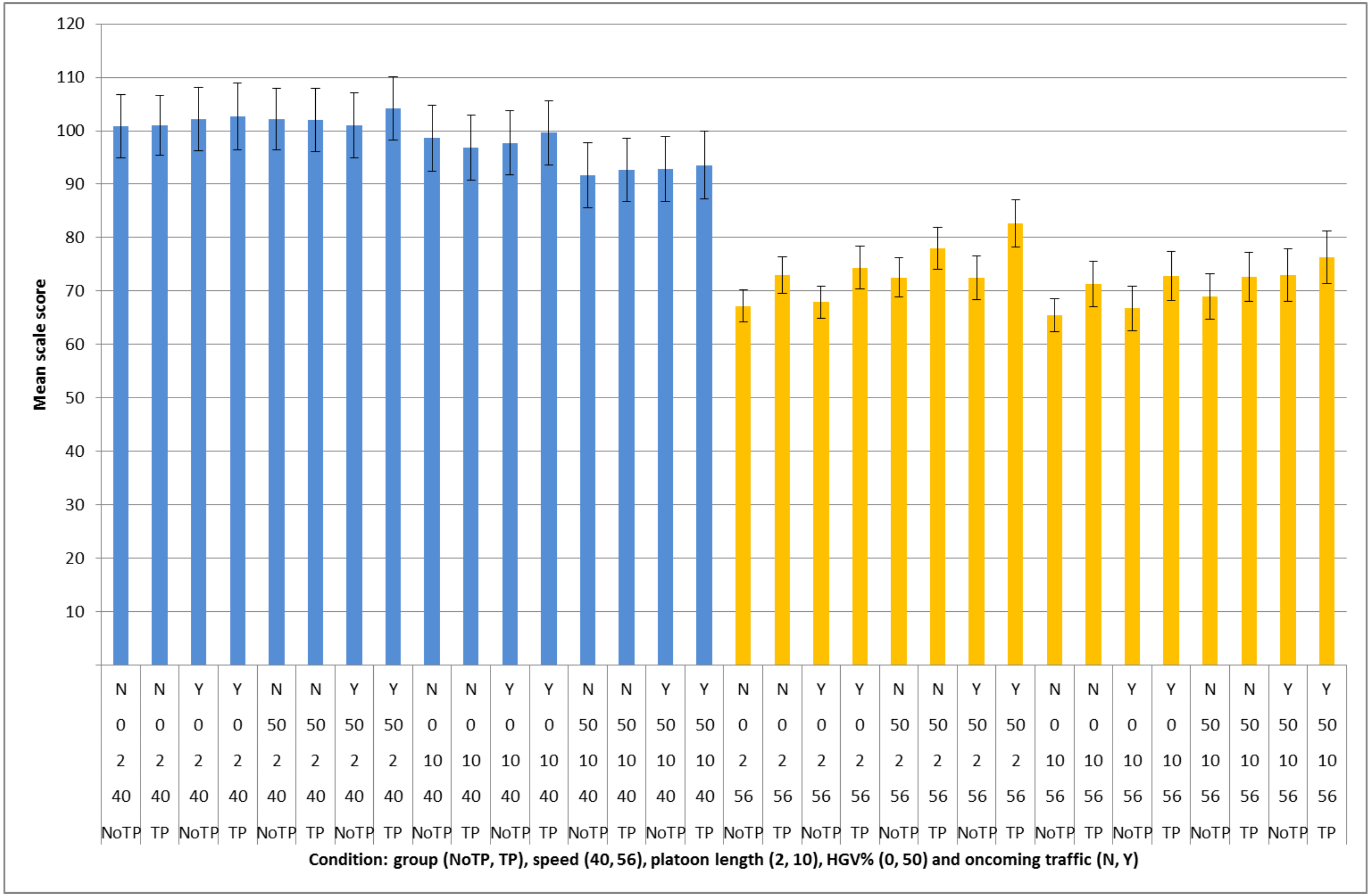

Figure 13: Mean overtaking intention by condition on dual carriageway roads (blue bars = 40mph, yellow bars = 56mph)

3.2 A9 – main analysis

3.2.1 The participant sample

Of the 231 participants who took part in the study, there were 61 males and 58 females in the no ASC group, and 59 males and 51 females in the ASC group[8]. A Chi-Square test confirmed that these proportions did not differ significantly. Independent samples t-tests (and a Mann-Whitney U test for A9 usage frequency) confirmed that the two groups also did not differ significantly on mean age, mean number of years holding a driving licence, mean engine size of vehicle, mean annual mileage, and mean frequency of driving on the A9. Finally, independent samples t-tests showed that the two groups did not differ on mean speeds given to the four baseline clips shown at the beginning of the study.

Taken together, the sample characteristics data suggest that the two groups did not differ *a priori* on any measures that might be expected to influence their propensity to overtake or their levels of frustration independently of the ASC conditions they were under. Twenty participants took part in the previous driver frustration study[9].

3.2.2 Single carriageway roads

The frustration data and overtaking intention data from single carriageway roads are shown in Figure 15 and Figure 19 respectively.

3.2.2.1 Frustration on single carriageway roads

For frustration data on single carriageway roads the five-way mixed ANOVA revealed significant main effects of speed ($p<0.001$), platoon length ($p<0.001$), HGV% ($p=0.019$) and oncoming traffic ($p=0.005$). The three-way interaction between HGV%, oncoming traffic and ASC presence was also significant ($p=0.026$), as was the five-way interaction between all variables ($p=0.013$).

These interactions mean there is no simple relationship between any single variable and frustration; the level of frustration reported is dependent on a combination of the variables. Nevertheless, for some variables the direction of the effect on frustration is consistent (i.e. it causes frustration to either increase or decrease). The magnitude of the effect is dependent on, and mediated by, the level or levels of other variables. Figure 14 shows the individual overall effects on frustration of speed, platoon length, HGV% and oncoming traffic. These show the effect of the individual variable on frustration, although they do not tell the whole story, that is, they do not show the effect that other variables have on the relationship between the individual variable and frustration. This is therefore explored in more detail below.

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[8] Two participants failed to provide information on whether they were male or female on the survey, hence these numbers sum to less than the full sample size.

[9] The previous study was conducted two years prior to this study and it was not considered that previous participation would bias current responses. Their data were therefore included in the analysis.

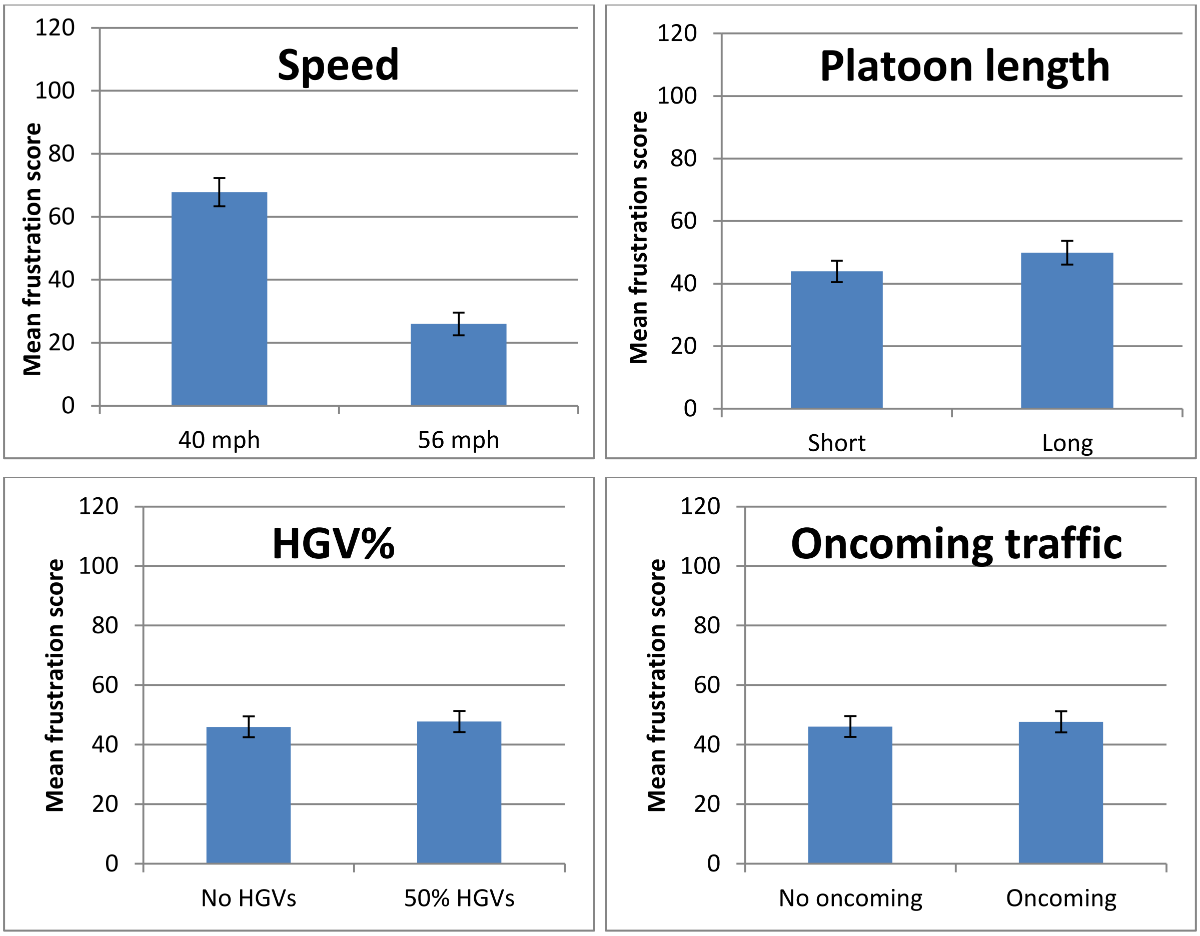

Figure 14: Mean frustration scores by speed, platoon length, HGV% and oncoming traffic

Taken together, the analysis suggests that on single carriageway roads, speed, platoon length, HGV% and oncoming traffic have a clear impact on self-reported frustration. Figure 14 and Figure 16 show that lower speeds lead to higher frustration levels. In addition, Figure 16 demonstrates that in general the long platoon length with ten vehicles gives rise to higher levels of frustration, the presence of HGVs leads to higher levels of frustration, as does the presence of oncoming traffic.

The three-way interaction shows that the effect of ASCs changes with respect to HGV% and the presence of oncoming traffic. Figure 16 illustrates that when oncoming traffic is present the effect of ASCs is to increase frustration when HGVs are not present compared with when they are. This suggests that ASCs may increase frustration when they are considered to limit the opportunity to make progress.

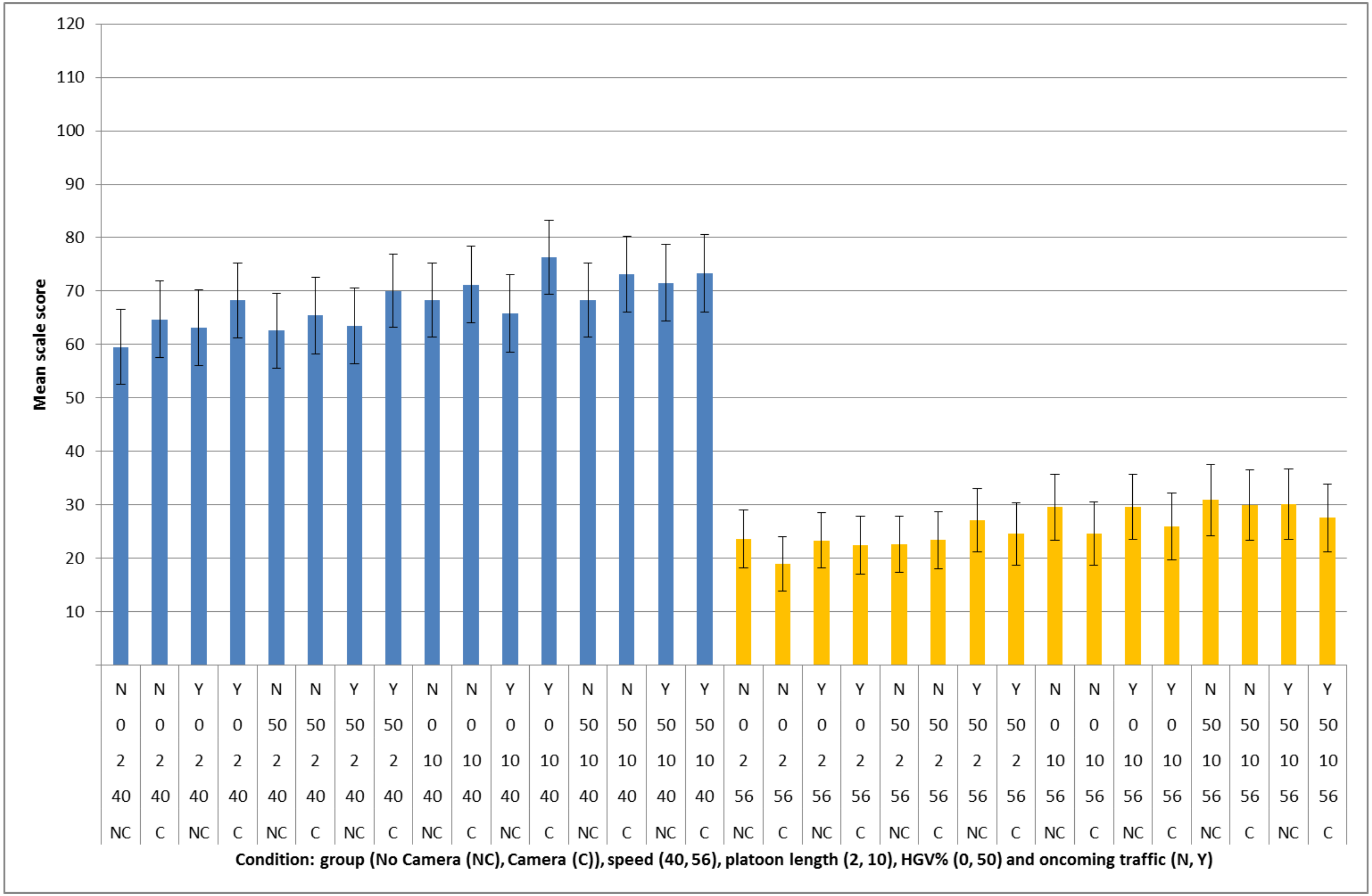

Figure 15: Mean frustration by condition on single carriageway roads (blue bars = 40mph, yellow bars = 56mph)

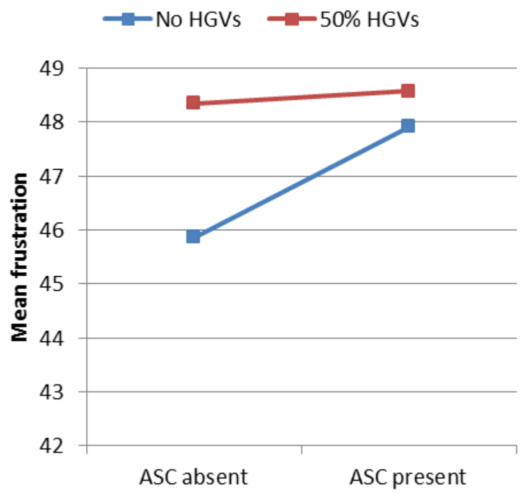

Figure 16: Interaction between ASCs and HGV% when oncoming traffic is present

When there is no oncoming traffic, the introduction of ASCs increases frustration when HGVs are present but decreases frustration when they are not, as seen in Figure 17.

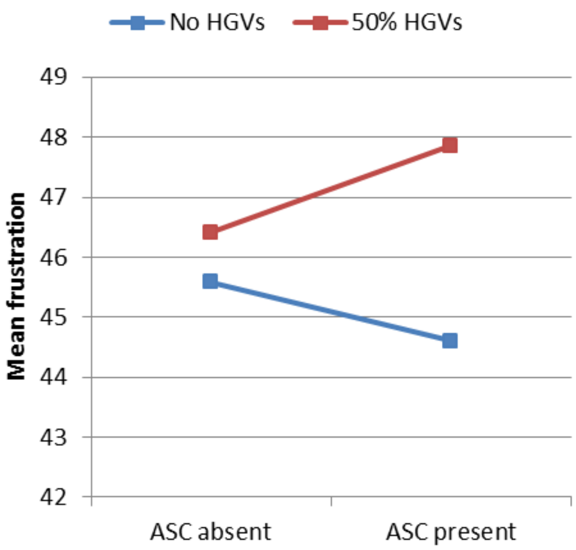

Figure 17: Interaction between ASCs and HGV% when oncoming traffic is absent

Although Figure 16 and Figure 17 show the effect of ASCs under specific conditions, the presence of a significant five-way interaction between all variables shows that the relationships between combinations of variables are complicated.

3.2.2.2 Overtaking intentions on single carriageway roads

For overtaking intention data on single carriageway roads the five-way mixed ANOVA revealed significant main effects of speed, platoon length and oncoming traffic ($p<0.001$ in all cases). In addition, a large number of interactions were significant. These interactions mean there is no simple relationship between any single variable and the intention to overtake; the intention to overtake is dependent on a combination of the variables. Nevertheless, for some variables the direction of the effect is consistent (i.e. it causes intention to overtake to either increase or decrease). The magnitude of the effect is dependent on and mediated by the level or levels of the other variables.

Figure 18 shows the individual overall effect on intention to overtake of speed, platoon length and oncoming traffic. While they show the effect of the individual variables on intention to overtake, they do not tell the whole story; that is, they do not show the effect that other variables have on the relationship between the individual variables and frustration. This variability can be seen by comparing the bars in Figure 19.

Higher speeds led to a decrease in intention to overtake. This can be seen in Figure 18 and Figure 19. A decrease in intention was apparent with longer platoons, as well as with the presence of oncoming traffic. On their own, the presence of ASCs had no statistically significant effect on intention to overtake in the single carriageway clips, however, they do interact with other variables to affect intention in certain circumstances.

As with frustration, time pressure had no statistically significant effect on intention to overtake in the single carriageway clips.

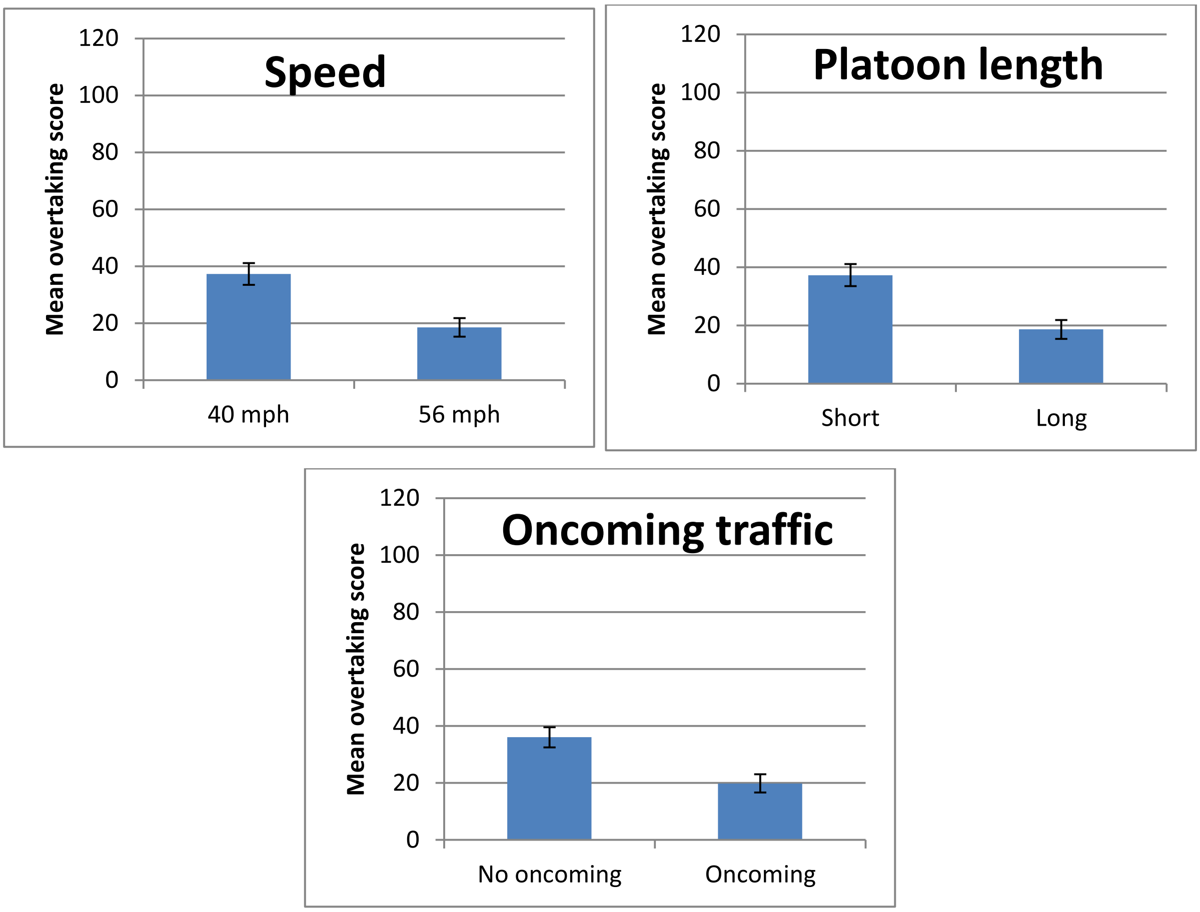

Figure 18: Mean intention to overtake scores by speed, platoon length and oncoming traffic

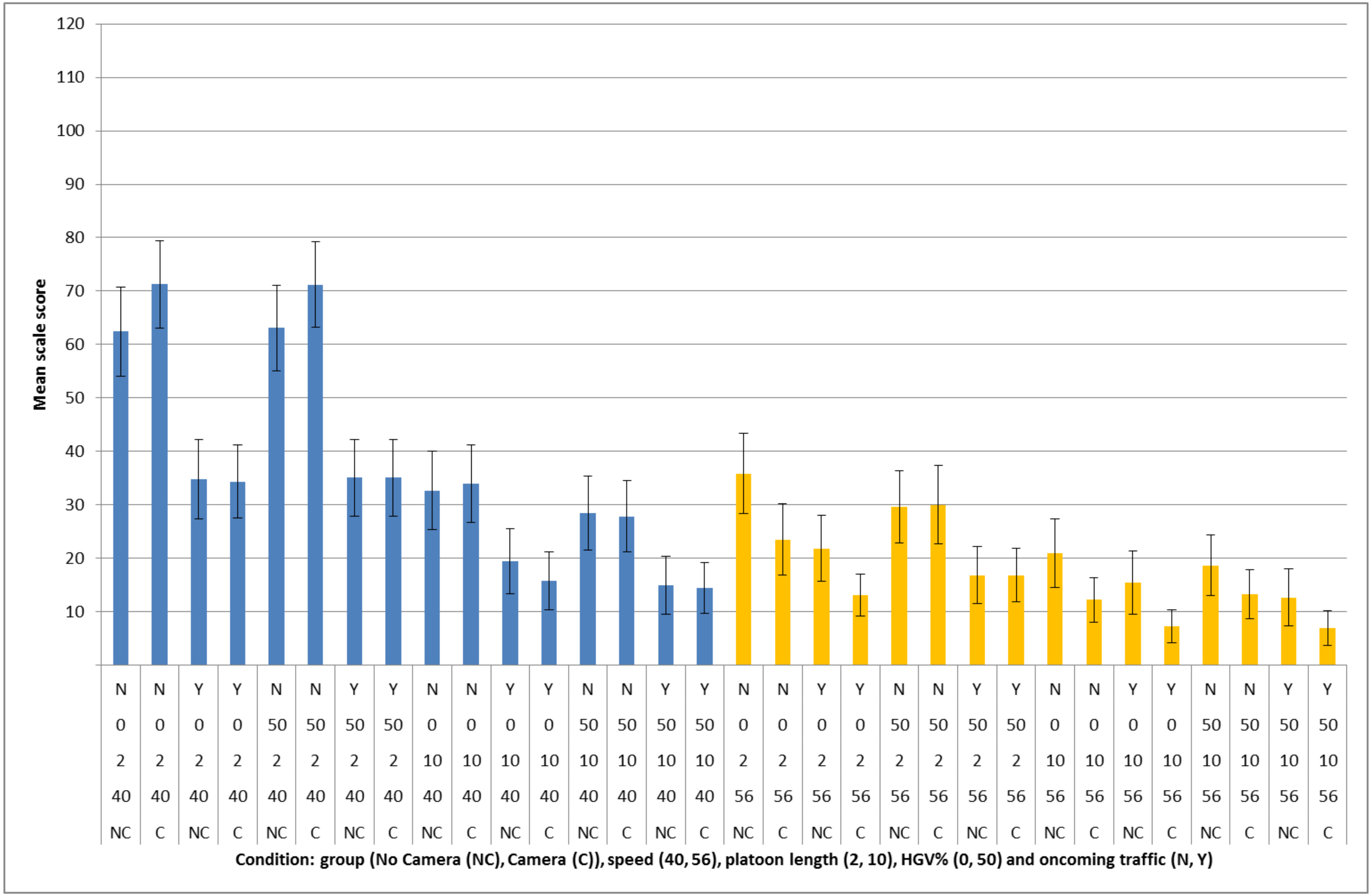

Figure 19: Mean overtaking intention by condition on single carriageway roads (blue bars = 40mph, yellow bars = 56mph)

3.2.3 Dual carriageway roads

The frustration data and overtaking intention data from dual carriageway roads are shown in Figure 21 and Figure 24 respectively.

3.2.3.1 Frustration on dual carriageway roads

For frustration data on dual carriageway roads the five-way mixed ANOVA revealed significant main effects of speed and platoon length ($p<0.001$ in both cases) and of oncoming traffic ($p=0.027$). In addition, the interaction between platoon length and HGV% was significant ($p=0.031$), as was the three-way interaction between platoon length, HGV% and oncoming traffic ($p=0.036$).

The individual effects of speed and platoon length are detailed in Figure 20. The effect of these variables is consistent whereby there is a clear effect of speed on frustration, such that lower speed is associated with higher self-reported frustration. Similarly, the longer platoon led to higher reported frustration. The presence of oncoming traffic generally led to lower frustration although this is inconsistent (depending on the interaction with other variables) and is therefore not presented independently.

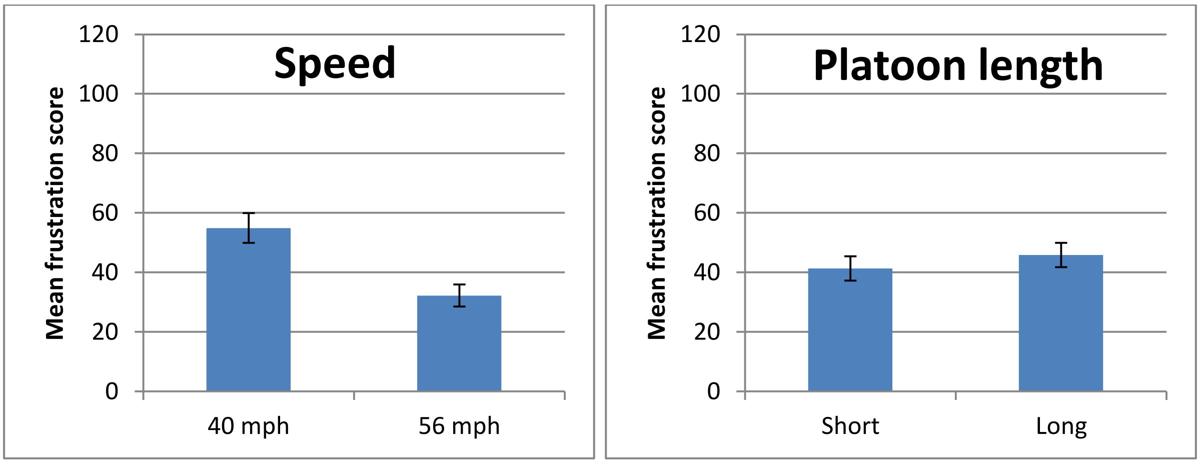

Figure 20: Mean frustration score by speed and platoon length

It is peculiar that oncoming traffic has any effect at all given the nature of separation afforded by the dual carriageway design.

The presence of ASCs had no statistically significant effect on frustration in the dual carriageway clips.

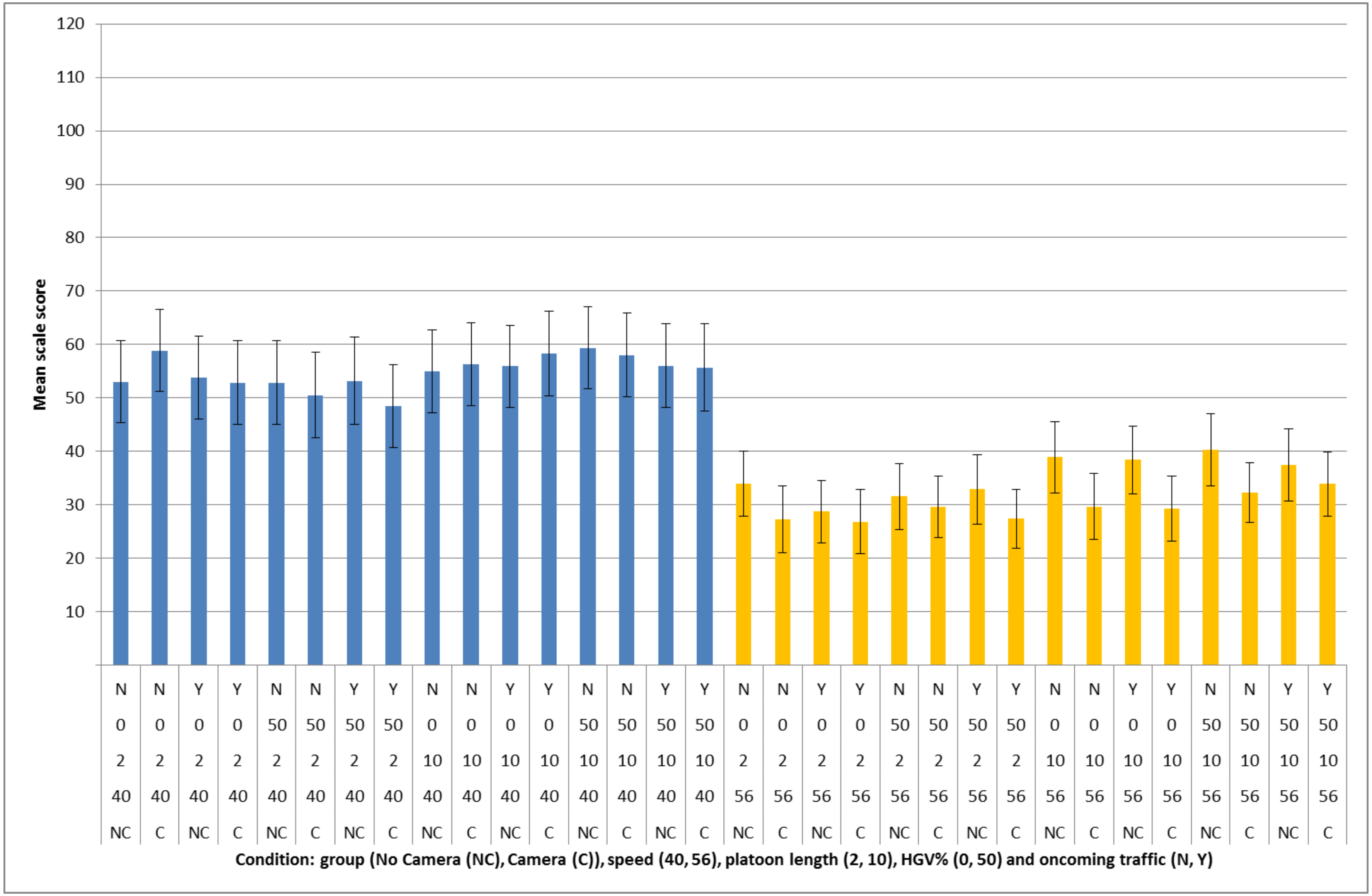

Figure 21: Mean frustration by condition on dual carriageway roads (blue bars = 40mph, yellow bars = 56mph)

3.2.3.2 Overtaking intentions on dual carriageway roads

For overtaking intention data on dual carriageway roads the five-way mixed ANOVA revealed significant main effects of speed and platoon length ($p<0.001$ in both cases). In addition, the interactions between speed and ASCs ($p=0.020$), HGV% and oncoming traffic ($p=0.044$) and platoon length, HGV% and oncoming traffic ($p=0.019$) were significant.

The effects of speed and platoon length can be seen in Figure 22 and Figure 24. Higher speed is generally associated with a reduction in the intention to overtake and a longer platoon is also generally associated with lower intention to overtake. The magnitude of the effect is dependent on other variables however, as indicated by the significant interactions.

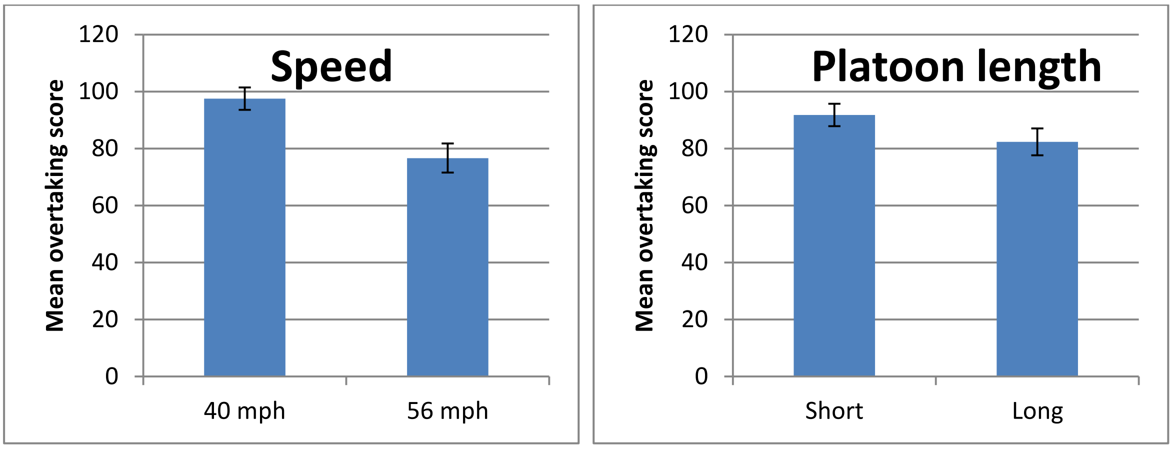

Figure 22: Mean intention to overtake scores by speed and platoon length

While increasing speed leads to lower levels of intention to overtake, this decrease is more pronounced when ASCs are present. This relationship is shown in Figure 23.

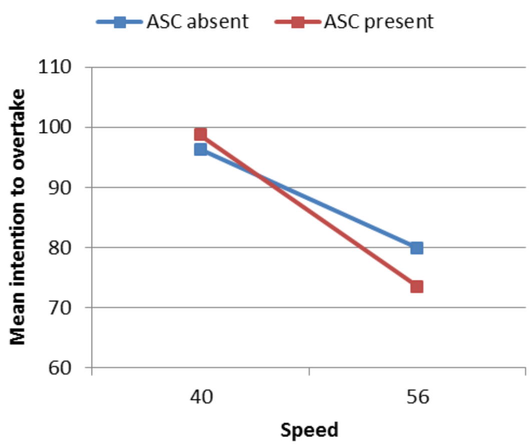

Figure 23: Two-way interaction between speed and ASCs

The three-way interaction shows that when there is no oncoming traffic, a decrease in platoon length leads to a larger increase in intention to overtake when HGVs are present than when they are not. It is not clear how to interpret this finding although it may simply suggest that drivers prefer to overtake HGVs when safe to do so rather than follow them.

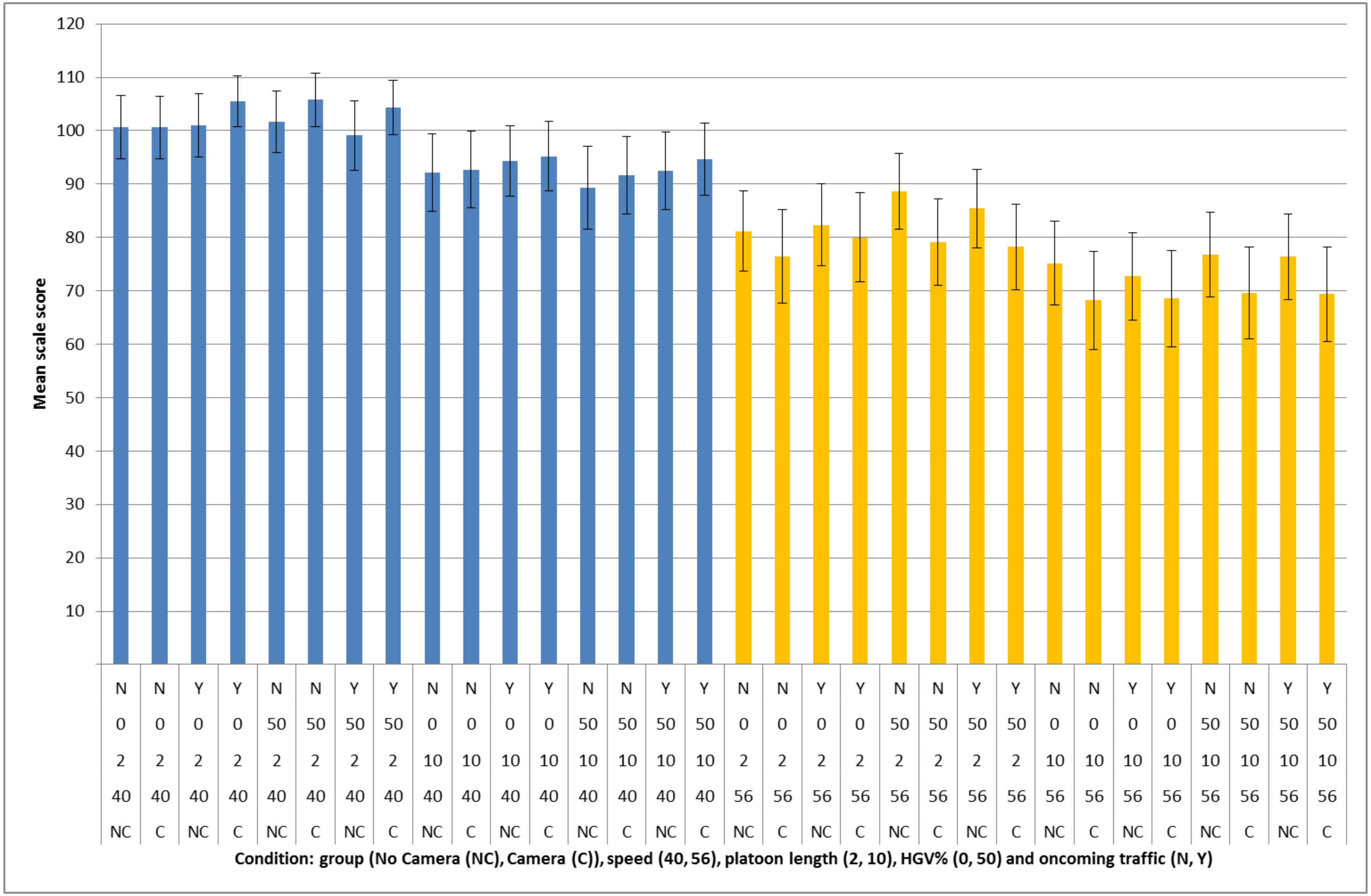

Figure 24: Mean overtaking intention by condition on dual carriageway roads (blue bars = 40mph, yellow bars = 56mph)

3.3 Difference in frustration between single and dual carriageway roads

In order to establish the effect of road type on frustration, the mean overall frustration score for single carriageway clips was compared with that for dual carriageway clips, for both the A96 and the A9 separately. On the A96, the mean frustration score for the single carriageway clips was 41.78, while the mean for the dual carriageway clips was 39.14. On the A9, the mean score for the single carriageway clips was 46.83, while the mean for the dual carriageway clips was 43.74. The analysis revealed that frustration differed significantly ($p<0.001$) between single and dual carriageway conditions for both the A96 and A9 studies. That is, drivers' ratings of frustration to clips with a single carriageway were statistically significantly higher than their ratings of frustration when the same clips were shown with a dual carriageway.

3.4 Relationship between frustration and overtaking

Each participant provided 32 data points for frustration with 32 corresponding data points for overtaking (for clips 5 to 36). The correlation coefficients between frustration and overtaking are 0.26 and 0.18 for the A96 and A9 studies respectively, which can be described as weak correlations (albeit statistically significant due to the large samples). This finding supports data reported previously (Kinnear et al., 2015) in showing that frustration and overtaking are not inextricably linked; if they were we would expect to see similar effects on frustration and overtaking of the other variables studied, and we would expect to see a stronger correlation between the two variables.

4 Discussion

This report details two similar but independent studies. One study tested participants recruited in areas local to the A96 (Elgin and Aberdeen) and one tested participants recruited in areas local to the A9 (Inverness and Perth). Both studies sought to gain an understanding of the impact of several situational variables (all associated with driving in platoons of vehicles) on levels of self-reported frustration and self-reported intention to overtake. This was achieved through the use of simulated video clips depicting a driver's-eye viewpoint of a driving situation following a platoon of vehicles that varied in size and the proportion of HGVs present, speed of progress, road type, and the presence or absence of oncoming traffic. The two studies differed with respect to the between groups variable tested. In the A96 study one group was instructed to respond as if they were under time pressure while another group was told they were under no particular time pressure. In the A9 study, one group viewed the clips with average speed cameras (ASCs) added to the driving scenarios, while the other group saw the same clips without ASCs.

The key findings for the A96 study are summarised in section 4.1 and the key findings from the A9 study are summarised in 4.2. Concluding comments are presented in section 4.3.

4.1 A96

4.1.1 Single carriageway

4.1.1.1 Frustration

- Statistically significant effects on self-reported frustration were found for speed, platoon length, HGV presence and oncoming traffic. Frustration is complex and influenced by a number of factors at any one time.
- The stand out variable was speed. Lower speed led to higher levels of frustration regardless of the levels of other factors.
- At the higher speed, levels of frustration were slightly greater when HGVs are present than when they are not.
- A small but noticeable effect of platoon length on frustration was also found. In general the platoon length of ten vehicles gave rise to higher levels of frustration than the platoon length of two vehicles.
- The effect of time pressure on frustration was more nuanced. By itself it did not appear to influence frustration. However, being under time pressure increased frustration depending on platoon length and the presence/absence of oncoming traffic; for clips with shorter platoons, time pressure seemed to increase frustration more when oncoming traffic was present, while for clips with longer platoons the time pressure effect seemed more pronounced when there was no oncoming traffic.
- These findings suggest that when the opportunity to make progress is close, but thwarted by a single variable (e.g. HGVs in the platoon or oncoming traffic), this leads to greater frustration.

4.1.1.2 Overtaking

- Statistically significant effects on self-reported intention to overtake were found for speed, platoon length, HGV% and oncoming traffic. Intention to overtake, like frustration, is complex and influenced by a number of factors at any one time.
- Intention to overtake was lower at the higher speed.
- Intention to overtake was also reduced by longer platoons, the presence of HGVs in the platoon and the presence of oncoming traffic. This suggests that drivers are responding to the reduced opportunity to overtake.
- There was no statistically significant effect of time pressure on the intention to overtake.

4.1.2 Dual carriageway

4.1.2.1 Frustration

- There were clear effects of speed and platoon length on frustration. Lower speed, and being behind a longer platoon were both associated with higher self-reported frustration.
- There was a small but statistically significant interaction between speed, HGV% and time pressure. The difference between frustration in the lower and higher speed conditions was most pronounced when time pressure was not a factor and HGVs were absent.

4.1.2.2 Intention to overtake

- Participants' overall intention to overtake was higher than in the single carriageway condition.
- Lower speeds were associated with a greater intention to overtake, although the difference between speed was not as pronounced as in the single carriageway data, presumably because even with the higher speed clips overtaking can be completed relatively safely on dual carriageways.
- Shorter platoons were also associated with higher likelihood of overtaking, and again this effect seemed to be more prevalent at lower speeds.
- As was the case with speed, the difference in intention to overtake between platoon lengths was smaller when HGVs are present than when they were not.
- Time pressure had no statistically significant effect on overtaking intentions in the dual carriageway clips.

4.2 A9

4.2.1 Single carriageway

4.2.1.1 Frustration

- Statistical analysis again confirmed that frustration is complex and influenced by a number of factors at any one time.

- The analysis suggested that on single carriageway roads, speed, platoon length, HGV presence and oncoming traffic had a clear impact on self-reported frustration.
- In general, the lower speed, the longer platoon length, the presence of HGVs and oncoming traffic led to higher levels of frustration. All of these factors can be considered to impede the opportunity to make progress.
- The effect of ASCs on frustration was complex. Rather than having a direct effect on frustration, ASCs interacted with and changed the effect of other variables (proportion of HGVs and oncoming traffic). In other words, ASCs had no predictable effect on levels of frustration by themselves.

4.2.1.2 Intention to overtake

- Statistically significant effects on self-reported intention to overtake were found for speed, platoon length and oncoming traffic.
- As with frustration, intention to overtake was lower at the higher speed.
- Intention to overtake was also reduced by longer platoons, and the presence of oncoming traffic. Again drivers appear to respond to the traffic conditions when considering the likelihood of attempting an overtake.
- There was no statistically significant effect of ASCs on the intention to overtake.

4.2.2 Dual carriageway

4.2.2.1 Frustration

- As with the single carriageway data there was a clear effect of speed on frustration, such that lower speed is associated with higher self-reported frustration.
- The longer platoon led to higher reported frustration.
- The presence of oncoming traffic led to lower frustration, which is difficult to interpret given the irrelevance of oncoming traffic in a dual carriageway scenario. It may be that oncoming traffic in the scene affected perceived vehicle speed giving the impression of travelling faster than in clips with no oncoming traffic.[10]
- When there was no oncoming traffic, the effect of HGVs in the platoon caused a large increase in frustration from short to long platoon length. This again may relate to the effect of the potential opportunity for progress being blocked.
- The presence of ASCs had no statistically significant effect on frustration in the dual carriageway clips.

[10] An interpretation of this result by a reviewer was that short sections of dual carriageway on the existing A9 route may have affected drivers' response. As road users know the dual carriageway sections are short, if drivers can see traffic on the opposite carriageway, they will anticipate that the preceding single carriageway section will be busy and therefore must overtake before the end of the dualled section, thus potentially inducing frustration and stress.

4.2.2.2 Intention to overtake

- Higher speed reduced the intention to overtake; this reduction was more pronounced when ASCs were present.
- Intention to overtake also decreased as platoon length increased.
- When there is no oncoming traffic, a decrease in platoon length lead to a larger increase in intention to overtake when HGVs are present than when they were not. This could suggest that drivers are less willing to follow HGVs when there is an opportunity to pass them.

4.2.3 Single versus dual carriageway

- In order to establish the effect of road type on frustration, the mean overall frustration score for single carriageway clips was compared with the one for dual carriageway clips for both the A96 and the A9 separately.
- Statistical analysis revealed that frustration differed significantly between single and dual carriageway conditions for both the A96 and A9 studies. Drivers' ratings of frustration to clips with a single carriageway were statistically significantly higher than their ratings of frustration when the same clips were shown with a dual carriageway. Although this effect of road type was statistically significant, it is important to note that the size of the effect was small (partial eta-squared = 0.006)[11]

4.2.4 Relationship between frustration and overtaking

- The correlation coefficients between frustration and overtaking can be described as weak correlations. This finding supports the notion that overtaking behaviour does not necessarily follow directly from increased driver frustration, as is often assumed. The result supports data reported previously (Kinnear et al., 2015).

4.2.5 Comparison with previous study

- The results of the studies reported here are similar to those reported in Kinnear et al. (2015). This suggests that using this methodology, the findings originally reported in Kinnear et al. are reliable.
- In all studies speed has been shown to have a consistent effect on ratings of frustration and the intention to overtake. Higher speeds were associated with lower frustration and lower intention to overtake.
- The length of the platoon also had a consistent effect in all studies. The longer platoon was associated with a greater frustration, but the shorter platoon was associated with a greater intention to overtake.
- Frustration and the intention to overtake were not closely correlated in any study.
- Single carriageway clips resulted in greater frustration than dual carriageway clips in all studies.

[11] Common guidelines by Cohen (1988) consider partial eta-squared values of 0.01 0.06 and 0.14 to represent small, medium and large effect sizes respectively.

4.3 Conclusions

The results of these studies demonstrate that driver frustration and the intention to overtake are not straightforward variables in terms of their causes. While there are some consistent findings (lower speeds, longer platoons and a higher proportion of HGVs in the platoon increase frustration), the impact of these factors is almost always dependent upon the context and role of other variables in the driving scene. The extent of a driver's frustration or intention to overtake is not simply equal to the addition of all causal variables present. In addition, frustration and intention to overtake are not closely related.

The results suggest that when the opportunity to make progress is close, but thwarted by a single variable (e.g. HGVs in the platoon or oncoming traffic), this leads to greater frustration. There is an underlying theme within the results that the perceived opportunity to make progress might be a factor closely related to driver frustration.

Time pressure had only an effect on driver frustration in some circumstances and no effect on drivers' intentions to overtake. However, the successful manipulation of this driver state in an experimental setting may again be limiting the true nature of the impact of time pressure on drivers.

Average Speed Cameras did not, on their own, affect drivers' ratings of frustration or intention to overtake.

References

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Kinnear, N., Helman, S., Wallbank, C., & Grayson, G. (2015). An experimental study of factors associated with driver frustration and overtaking intentions. Accident Analysis & Prevention, 79, 221-230.

Kinnear, N., Helman, S., Murphy, P., Casey, J. & MacDonald, J. (2014). Experimental and stated preference study of the factors that influence driver frustration on the A9. Proceedings of the Scottish Transport Applications and Research Conference 2014, 21st May, Glasgow, Scotland.

Parker, D., Stradling, S. G., & Manstead, A. S. (1996). Modifying Beliefs and Attitudes to Exceeding the Speed Limit: An Intervention Study Based on the Theory of Planned Behavior. Journal of Applied Social Psychology, 26(1), 1-19.

Appendix A Stimuli and orders used

The table below shows the clip numbers and their respective levels of each independent variable.

Clip no	Road type	Speed	Platoon	HGVs	Oncoming traffic
1	S	40	None	0	N
2	S	56	None	0	N
3	D	40	None	0	N
4	D	56	None	0	N
5	S	40	2	0	N
6	S	40	2	0	Y
7	S	40	2	50	N
8	S	40	2	50	Y
9	S	40	10	0	N
10	S	40	10	0	Y
11	S	40	10	50	N
12	S	40	10	50	Y
13	S	56	2	0	N
14	S	56	2	0	Y
15	S	56	2	50	N
16	S	56	2	50	Y
17	S	56	10	0	N
18	S	56	10	0	Y
19	S	56	10	50	N
20	S	56	10	50	Y
21	D	40	2	0	N
22	D	40	2	0	Y
23	D	40	2	50	N
24	D	40	2	50	Y
25	D	40	10	0	N
26	D	40	10	0	Y
27	D	40	10	50	N
28	D	40	10	50	Y
29	D	56	2	0	N
30	D	56	2	0	Y
31	D	56	2	50	N
32	D	56	2	50	Y
33	D	56	10	0	N
34	D	56	10	0	Y
35	D	56	10	50	N
36	D	56	10	50	Y

The table below shows the clip numbers (numbers in the 'Order 1', 'Order 2', Order 3' and 'Order 4' columns correspond to the clip numbers in the table on the previous page) that were shown to participants as 'Clips 1 to 36' in the four different orders.

Clip name (as displayed on screen)	Order 1	Order 2	Order 3	Order 4
Clip1	1	2	3	4
Clip2	3	4	1	2
Clip3	2	1	4	3
Clip4	4	3	2	1
Clip5	5	29	13	21
Clip6	36	12	28	20
Clip7	6	30	14	22
Clip8	35	11	27	19
Clip9	15	23	7	31
Clip10	26	18	34	10
Clip11	16	24	8	32
Clip12	25	17	33	9
Clip13	9	33	17	25
Clip14	32	8	24	16
Clip15	10	34	18	26
Clip16	31	7	23	15
Clip17	19	27	11	35
Clip18	22	14	30	6
Clip19	20	28	12	36
Clip20	21	13	29	5
Clip21	13	21	5	29
Clip22	28	20	36	12
Clip23	14	22	6	30
Clip24	27	19	35	11
Clip25	7	31	15	23
Clip26	34	10	26	18
Clip27	8	32	16	24
Clip28	33	9	25	17
Clip29	17	25	9	33
Clip30	24	16	32	8
Clip31	18	26	10	34
Clip32	23	15	31	7
Clip33	11	35	19	27
Clip34	30	6	22	14
Clip35	12	36	20	28
Clip36	29	5	21	13

Appendix B p-values

The tables below present the p-values associated with the ANOVA that were conducted for both the A96 and A9 studies. Values less than 0.05, are labelled with an asterisk (*).

Table 4: ANOVA p-values for the A96 study

ANOVA term	Single-carriageway roads		Dual-carriageway roads	
	Frustration	Overtaking	Frustration	Overtaking
Speed	0.000*	0.000*	0.000*	0.000*
Speed * Time pressure	0.858	0.379	0.180	0.181
Platoon	0.000*	0.000*	0.000*	0.000*
Platoon * Time pressure	0.819	0.926	0.113	0.440
HGV	0.001*	0.001*	0.318	0.112
HGV * Time pressure	0.258	0.728	0.836	0.896
Oncoming	0.000*	0.000*	0.054	0.002*
Oncoming * Time pressure	0.785	0.971	0.854	0.105
Speed * Platoon	0.551	0.000*	0.849	0.004*
Speed * Platoon * Time pressure	0.399	0.278	0.658	0.660
Speed * HGV	0.002*	0.000*	0.241	0.000*
Speed * HGV * Time pressure	0.830	0.167	0.044*	0.691
Platoon * HGV	0.925	0.000*	0.308	0.001*
Platoon * HGV * Time pressure	0.931	0.715	0.462	0.364
Speed * Platoon * HGV	0.189	0.048*	0.827	0.090

ANOVA term	Single-carriageway roads		Dual-carriageway roads	
	Frustration	Overtaking	Frustration	Overtaking
Speed * Platoon * HGV * Time pressure	0.526	0.286	0.462	0.641
Speed * Oncoming	0.930	0.000*	0.578	0.335
Speed * Oncoming * Time pressure	0.576	0.581	0.216	0.881
Platoon * Oncoming	0.719	0.000*	0.103	0.613
Platoon * Oncoming * Time pressure	0.033*	0.792	0.264	0.415
Speed * Platoon * Oncoming	0.296	0.000*	0.931	0.605
Speed * Platoon * Oncoming * Time pressure	0.287	0.871	0.766	0.602
HGV * Oncoming	0.864	0.063	0.581	0.480
HGV * Oncoming * Time pressure	0.357	0.574	0.581	0.814
Speed * HGV * Oncoming	0.773	0.743	0.512	0.246
Speed * HGV * Oncoming * Time pressure	0.948	0.123	0.286	0.719
Platoon * HGV * Oncoming	0.565	0.215	0.594	0.479
Platoon * HGV * Oncoming * Time pressure	0.612	0.787	0.254	0.063
Speed * Platoon * HGV * Oncoming	0.930	0.017*	0.718	0.891
Speed * Platoon * HGV * Oncoming * Time pressure	0.447	0.747	0.760	0.854
Time pressure	0.252	0.364	0.921	0.395

Table 5: ANOVA p-values for the A9 study

ANOVA term	Single-carriageway roads		Dual-carriageway roads	
	Frustration	Overtaking	Frustration	Overtaking
Speed	0.000*	0.000*	0.000*	0.000*
Speed * Time pressure	0.077	0.006*	0.110	0.020*
Platoon	0.000*	0.000*	0.000*	0.000*
Platoon * Time pressure	0.818	0.213	0.507	0.529
HGV	0.019*	0.050	0.852	0.189
HGV * Time pressure	0.844	0.005*	0.557	0.630
Oncoming	0.005*	0.000*	0.027*	0.303
Oncoming * Time pressure	0.410	0.232	0.857	0.238
Speed * Platoon	0.456	0.000*	0.380	0.835
Speed * Platoon * Time pressure	0.627	0.223	0.118	0.643
Speed * HGV	0.627	0.444	0.087	0.117
Speed * HGV * Time pressure	0.257	0.021*	0.130	0.111
Platoon * HGV	0.903	0.039*	0.031*	0.150
Platoon * HGV * Time pressure	0.584	0.181	0.285	0.583
Speed * Platoon * HGV	0.982	0.224	0.116	0.680
Speed * Platoon * HGV * Time pressure	0.518	0.116	0.849	0.576
Speed * Oncoming	0.144	0.000*	0.800	0.067

ANOVA term	Single-carriageway roads		Dual-carriageway roads	
	Frustration	Overtaking	Frustration	Overtaking
Speed * Oncoming * Time pressure	0.290	0.024*	0.162	0.753
Platoon * Oncoming	0.079	0.000*	0.136	0.420
Platoon * Oncoming * Time pressure	0.996	0.319	0.123	0.345
Speed * Platoon * Oncoming	0.507	0.000*	0.926	0.113
Speed * Platoon * Oncoming * Time pressure	0.995	0.051	0.482	0.512
HGV * Oncoming	0.614	0.945	0.995	0.044*
HGV * Oncoming * Time pressure	0.026*	0.984	0.859	0.455
Speed * HGV * Oncoming	0.835	0.329	0.334	0.924
Speed * HGV * Oncoming * Time pressure	0.529	0.171	0.438	0.914
Platoon * HGV * Oncoming	0.661	0.602	0.036*	0.019*
Platoon * HGV * Oncoming * Time pressure	0.201	0.301	0.264	0.954
Speed * Platoon * HGV * Oncoming	0.205	0.671	0.471	0.977
Speed * Platoon * HGV * Oncoming * Time pressure	0.013*	0.972	0.076	0.423
Time pressure	0.845	0.476	0.540	0.635

Appendix C Questionnaire (no time pressure)

Order –

Participant no –

A journey you have undertaken

Before you begin the study, we need you to think of a particular journey you have undertaken by car. This is to help you get into the right 'mind-set' for the study. It should be a journey (ideally recent) on which you were under no particular time pressure to arrive at your destination. Once you have this journey in mind, please complete the following details about the journey, as best you can:

Approximate date of journey	________________
Approximate length of journey	________________miles
Approximate time of day that journey began	______________________ am/pm (delete as appropriate)
Type of road on which the majority of the journey was done (tick one)	Motorway or dual carriageway Single carriageway main road Urban/residential roads

Briefly rate how relaxed or stressed you felt on the journey, by ticking one box on the scale below:

On the journey, I felt:

Extremely relaxed	Somewhat relaxed	Neither relaxed nor stressed	Somewhat stressed	Extremely stressed
☐	☐	☐	☐	☐

Now please wait for the experimenter to tell you to continue

Instructions – Part 1:

In this study, you will watch simulated video clips from the driver's perspective, driving on either a single- or dual-carriageway road (national speed limit in both cases). The speedo on the screen shows your speed in mph.

First of all there are four clips to get you started. For the first four clips, we would like you to imagine:

- That you have been driving on the road for around 30 minutes
- That you are driving your usual car (we will ask you what this is later)
- That you are not under any particular time pressure to be at your destination, which is about 30 miles away

Each clip lasts around 20 seconds. After each clip, you will be asked to answer some questions like the ones below. For each clip, and for each question, you are simply to mark a line on the scale, to indicate your response to the question. For example, if you thought for a given clip that you would be extremely frustrated, that you would find the driving situations somewhat difficult, and only a little bit risky, you might respond as below.

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ——— Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ——— Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ——— Extremely risky

For these first four clips, you will also be asked the speed that you would choose to drive in the situation depicted (in mph).

DO YOU HAVE ANY QUESTIONS?

CLIP 1

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ____________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ____________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ____________________ Extremely risky

At what speed would you normally drive at in the situation depicted? ___________mph

CLIP 2

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ____________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ____________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ____________________ Extremely risky

At what speed would you normally drive at in the situation depicted? ___________mph

CLIP 3

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

At what speed would you normally drive at in the situation depicted? ___________mph

CLIP 4

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

At what speed would you normally drive at in the situation depicted? ___________mph

Instructions – Part 2:

Now you will see clips similar to the other ones you have just seen, but there will be other vehicles present. As before you will watch simulated video clips from the driver's perspective, driving on a single- or dual-carriageway road (national speed limit in both cases) behind some other vehicles. The speedo on the screen shows your speed in mph.

For all the clips, we would like you to imagine:

- That you have been driving on the road for around 30 minutes, and have just come up to your current position behind the vehicles you are following
- That you are driving your usual car
- That you are not under any particular time pressure to be at your destination, which is about 30 miles away

Each clip lasts around 20 seconds. After each clip, you will be asked to answer some questions like the ones you have already seen. As before for each clip, and for each question, you are simply to mark a line on the scale, to indicate your response to the question.

There is an additional question on how likely you think it would be that you would overtake at any point during the clip. This question is answered just like the others, by placing a line on the scale.

The question about speed is no longer present.

DO YOU HAVE ANY QUESTIONS?

CLIP 5

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 6

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 7

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 8

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 9

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 10

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 11

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______ Extremely risky

CLIP 12

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______ Extremely risky

CLIP 13

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely	______________________________	Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated	______________________________	Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult	______________________________	Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky	______________________________	Extremely risky

CLIP 14

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely	______________________________	Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated	______________________________	Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult	______________________________	Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky	______________________________	Extremely risky

CLIP 15

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 16

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 17

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely	____	Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated	____	Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult	____	Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky	____	Extremely risky

CLIP 18

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely	____	Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated	____	Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult	____	Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky	____	Extremely risky

CLIP 19

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______ Extremely risky

CLIP 20

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______ Extremely risky

CLIP 21

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ________________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ________________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ________________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ________________________________ Extremely risky

CLIP 22

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ________________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ________________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ________________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ________________________________ Extremely risky

CLIP 23

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 24

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 25

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely	______________________________	Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated	______________________________	Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult	______________________________	Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky	______________________________	Extremely risky

CLIP 26

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely	______________________________	Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated	______________________________	Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult	______________________________	Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky	______________________________	Extremely risky

CLIP 27

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 28

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 29

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 30

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 31

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 32

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 33

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 34

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely ______________________________ Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated ______________________________ Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult ______________________________ Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky ______________________________ Extremely risky

CLIP 35

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely	________________________	Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated	________________________	Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult	________________________	Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky	________________________	Extremely risky

CLIP 36

How likely is it that you would have **attempted to overtake** at some point during the clip?

Not at all likely	________________________	Extremely likely

How **frustrated** would you feel if driving in the situation exactly as depicted in the clip?

Not at all frustrated	________________________	Extremely frustrated

How **difficult** would you find it if driving in the situation exactly as depicted in the clip?

Not at all difficult	________________________	Extremely difficult

How **risky** would you find it if driving in the situation exactly as depicted in the clip?

Not at all risky	________________________	Extremely risky

Driver survey

Please complete this short survey by answering the questions given. If you have any questions about the survey, please ask the experimenter.

Your age:	[ ] Years [ ] months
Are you (circle one):	Male / Female
For how long have you held your full driving licence?	[ ] years
What is the make of your usual car (e.g. Ford, Seat, BMW)?	[ ]
What model is it (e.g. Fiesta, Ibiza, 318)?	[ ]
What is the engine size of your usual vehicle (e.g. 1.4Litre, 1.9Litre, 2.4Litre)?	[ ] Litre
What is your typical annual car mileage? (If you find it difficult to estimate, one thing you can do is try and think about your mileage in an average week, multiple this by 100 and divide by 2)	[ ] miles per year
How often do you drive on the A96? (Circle one)	Every day 4-6 days per week 1-3 days per week Fortnightly Monthly Less than Monthly
Over the last three years, how may collisions have you been involved in while driving? Count all collisions, regardless of fault or severity.	[ ] collisions

Below are some statements about various things to do with driving. Please indicate how much you agree or disagree with each statement by placing a tick in the appropriate box on the scale.

	I strongly disagree	I disagree	I neither agree or disagree	I agree	I strongly agree
Some people can drive perfectly safely after drinking three or four pints of beer	☐1	☐2	☐3	☐4	☐5
People stopped by the police for close-following are unlucky because lots of people do it	☐1	☐2	☐3	☐4	☐5
I would welcome further use of the double white lines to let me know when it is unsafe to overtake	☐1	☐2	☐3	☐4	☐5
Speed limits are often set too low, with the result that many drivers ignore them	☐1	☐2	☐3	☐4	☐5
I think the police should start breathalysing a lot more drivers around pub closing times	☐1	☐2	☐3	☐4	☐5
It is quite acceptable to take a slight risk when overtaking	☐1	☐2	☐3	☐4	☐5
Close-following isn't really a serious problem at the moment	☐1	☐2	☐3	☐4	☐5
I know exactly how fast I can drive and still drive safely	☐1	☐2	☐3	☐4	☐5
Some drivers can be perfectly safe overtaking in situations which would be risky for others	☐1	☐2	☐3	☐4	☐5
Even one drink makes you drive less safely	☐1	☐2	☐3	☐4	☐5
I would favour stricter enforcement of the speed limit on 30 mph roads	☐1	☐2	☐3	☐4	☐5
Some people can drive safely even though they only leave a small gap behind the vehicle in front	☐1	☐2	☐3	☐4	☐5
The aim of the police should be to stop as many people as possible overtaking in risky circumstances	☐1	☐2	☐3	☐4	☐5
Even driving slightly faster than the speed limit makes you less safe as a driver	☐1	☐2	☐3	☐4	☐5
It's hard to have a good time if everyone else is drinking but you have to limit yourself because you're driving	☐1	☐2	☐3	☐4	☐5
I would be happier if close-following regulations were more strictly applied	☐1	☐2	☐3	☐4	☐5
Stricter enforcement of speed limits on 30 mph roads would be effective in reducing the occurrence of road accidents	☐1	☐2	☐3	☐4	☐5
Even driving slightly too close to the car in front makes you less safe as a driver	☐1	☐2	☐3	☐4	☐5
I think it is okay to overtake in risky circumstances as long as you drive within your own capabilities	☐1	☐2	☐3	☐4	☐5
The law should be changed so that drivers aren't allowed to drink any alcohol	☐1	☐2	☐3	☐4	☐5

Finally – please tick the box below if you took part in the study just like this one that we ran in Perth and Inverness in November 2013:

☐

That completes this part of the study

There is one remaining short survey to complete

The experimenter will now explain this