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Co-driving: Passenger actions and distractions

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ABSTRACT

Approximately one third of car trips involve one or more passengers and yet we know little about how the presence of a passenger helps or hinders safety and efficiency. To date, research in this area has focused on the possible distractive effects of passengers. Although we know that drivers conversing on a mobile phone is distracting and unsafe, epidemiological studies suggest that driving with a passenger has a lower crash risk than driving alone. This paper describes two studies into how drivers and passengers interact during a journey; a survey regarding the most common actions of passengers and how drivers view their helpfulness, and an on-road study of driver and passenger interactions. The results indicated several areas that drivers felt passenger assistance was quite helpful, but in some cases was exhibited very rarely. The on-road study revealed some interesting gender differences in who offers driving support, and who requests it. By understanding how passengers can contribute to safer journeys we can provide that information to drivers at risk, such as those very early or late in their driving careers.

1. Introduction

A significant proportion of the automobile journeys we make involve passengers. In New Zealand approximately one third of all trips by cars, vans and utility vehicles carry one or more passengers (MoT, 2015). To date, most research into the effect of passengers on driving has focused on the widely-held belief that passengers are a distraction for drivers. This belief comes in part from stereotypes and humorous caricatures of overly talkative passengers and “back-seat drivers” in film and television. In fact, epidemiological studies have shown that driving with a passenger is associated with a reduced crash risk compared to driving alone (OR = 0.7) (Rueda-Domingo et al., 2004). In a detailed analysis of crash records it was found that the presence of passengers increased the likelihood of safe driving behaviours (e.g., seatbelt use and lower alcohol levels), and decreased the likelihood of both traffic citations and driver injuries and fatalities (Lee and Abdel-Aty, 2008). Similarly, observational data have shown that the likelihood of committing traffic violations is reduced by the presence of one or more passenger (Rosenbloom and Perlman, 2016).

When the available evidence is considered, however, it is clear that the presence of passengers does not have the same effects for all drivers. Orsi et al. (2013) reported a pronounced age difference in the injury outcome of car crashes such that drivers aged 25 years and older were more likely to be injured in a crash if they were alone (OR = 4.14) whereas drivers younger than 25 were more likely to be injured when travelling with one or more passenger (OR = 3.02). When young drivers carry same-aged peers, their crash risk increases with each additional peer passenger (Preusser et al., 1998; Regan and Mitsopoulos, 2001). Similarly, Lee and Abdel-Aty (2008) examined crash records in Orlando Florida and found that younger drivers accompanied by only young passengers were more likely to cause crashes and more likely to be involved in single-vehicle crashes at high speeds. In New Zealand young drivers (under 25 years) the likelihood of a serious injury crash was 15.55 times more likely when they carried two or more same age passengers whereas no increase in risk was observed for older drivers carrying two or more passengers (Lam et al., 2003). These finding and others have led to a prohibition on young drivers with restricted licences carrying unlicensed passengers in New Zealand and other jurisdictions with graduated driver licence systems.

Orsi et al. (2013) suggested that these disparate findings associated with age may be the result of passengers helping adult drivers (25 and older) avoid dangers and remain focussed, whereas younger drivers’ passengers (particularly male passengers) serve as “spectators” occasioning a greater likelihood of risk taking in both driving style and failure to wear seatbelts. This suggestion was substantiated to some extent by Simons-Morton et al. (2005) who observed that young male drivers with passengers drove faster and followed more closely than other drivers or other young males without passengers. In contrast, when young drivers are in the presence of adult passengers their risky driving is reduced (Simons-Morton et al., 2011). This corresponds well

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with the epidemiological evidence showing that even the safety of young drivers is improved when they are carrying an adult passenger, compared to driving alone (Rueda-Domingo et al., 2004). The source of this effect has been attributed to the interaction between the younger drivers and their older passengers, with the older passengers offering tips on good driving, as the mere presence of silent older passengers does not have the same beneficial effect (Chung et al., 2014).

With the exception of young drivers carrying young passengers, and in spite of the negative stereotype of the backseat driver, the safety data suggest that there is something beneficial about having a passenger in the car. Because much of the research has focussed on distraction produced by passengers, there has been very little consideration given to understanding the protective effects of passengers. In two simulator studies comparing drivers' conversations with passengers to their conversations over mobile phones it was reported that drivers and passengers often discuss the road and traffic situation ahead and passengers often offer brief alerting comments to the driver (Charlton, 2009; Gaspar et al., 2014). Gaspar et al. (2014) go on to suggest that a passenger can function as a 'collision warning system', particularly for hazards in the periphery of the scene, outside the driver's typical gaze.

Passengers often take on many driving-related or supporting activities without being prompted, (Haddington et al., 2012). Anecdotal evidence suggests that it is common for drivers and passengers to share some aspects of the driving task, such as at intersections when passengers voluntarily scan a portion of the visible field and give drivers a signal when it is safe to enter. Similarly, passengers often help look for landmarks or signs when navigating an unfamiliar or busy road environment. Drivers and their passengers keep up a fairly steady flow of communication, sometimes emphasising or foregrounding the journey or immediate driving situations and at other times focussing on non-driving subjects (Mondada, 2012). Naturalistic studies have shown that switches in attentional focus from driving to socialising, and back to driving are managed jointly through the use of words but also pauses, gesture and gaze (Mondada, 2012). In a study of Australian drivers and their passengers, Regan and Mitsopoulos (2001) reported that the sorts of assistance rendered by passengers was of two sorts, the first comprised of actions such as adjusting the radio or heater, answering the mobile phone, reading signs and maps or getting items out of the driver's reach, the second was conversational, for social purposes or to help keep the driver awake.

There is also some evidence, however, that driver-passenger interactions are not always positive. In a study of female drivers' strategies for coping with feelings of vulnerability, it was found that their relationship to the passenger made an important difference in the value of any help offered (Gwyther and Holland, 2014). For example, a male partner's uninvited collaboration could result in the drivers feeling stressed or reacting negatively to perceived criticism. In one survey, over 65 percent of respondents indicated that they had arguments with their partners at least once a month while driving, most often about directions or map-reading (Quain, 2010; Williams, 2010). While some arguments were the continuation of disagreements that began before leaving home, other causes included discussion of the actions of other road users, road conditions (i.e., traffic jams), and choice of music. Twenty-five percent of the 2200 respondents thought that the disagreements were distracting enough to lead to a crash. Other researchers have similarly reported that contentious conversations between drivers and passengers can significantly impair driving performance, even more so than conducting the same conversation over a mobile phone while driving (Lansdown and Stephens, 2013).

In a study of Australian drivers and their passengers, Regan and Mitsopoulos (2001) asked drivers and passengers about the kinds of comments passengers make about the driver's behaviour. Here, the drivers indicated three separate factors; responsible passenger comments (e.g., inform the driver they are speeding, following too closely, the presence of hazards, providing directions), anti-social comments (e.g., encouraging honking or flashing headlights at other road users, or expediting comments (encouraging the driver to speed up, or overtake another driver). Passenger answers were composed of two factors, the responsible comments (telling drivers to slow down, not to follow too closely, about the presence of hazards), and the expediting comments (speeding up, overtaking).

Further descriptive work needs to be done to identify the co-driving interactions of drivers and their passengers, in terms of both conversation and supporting actions. Identifying the kinds of comments and actions that drivers find beneficial has the potential to improve the mobility and safety of drivers, particularly when they find themselves in cognitively demanding situations. With that context, the present study had two general aims: first, to identify drivers' and passengers' attitudes and opinions about how passengers interact with drivers, and second to examine and describe the extent and form of passengers' comments and assistance. To do this we began with a large on-line survey asking respondents to rate the contributions and comments made by passengers to drivers across a range of driving situations and rate the influence their most frequent passengers has on their driving (as compared to when they drive alone).We followed this with an observational study of drivers and their most frequent passengers interacting while driving on familiar roads. We hoped to document examples of passengers' assistance to drivers and get a sense of how frequently it occurred, as well as whether drivers felt it was a help or a hindrance to their driving.

2. Study 1 - Survey of driver-passenger interactions

The purpose of this first study was to describe New Zealand drivers' current experiences of passenger assistance. Specifically, we wanted to identify the types of passenger input and assistance that drivers find helpful or valuable as well as the action or advice they find unhelpful or distracting.

2.1. Method

2.1.1. Participants

Participants were recruited in two ways: an advertisement inviting potential respondents to complete the survey was distributed via email to the research team's network; and additional respondents were recruited via an on-line market research company (Research Now/Dynata). To participate, respondents were required to be over 25 years of age, and to have driven with a passenger aged over 16 years of age in the last month. All of the recruitment and test procedures were approved by the School of Psychology Research and Ethics Committee (#18_34).

A total of 880 participants started the survey, 31 (3.5 %) did not consent, and 257 (29.2 %) were excluded from the analyses because they failed to report their or their passenger's age and/or gender. The final sample was comprised of 592 participants, 50.7 % male, with a mean age or 51.25 years (*SD* = 15.7, range 25–87 years). Further demographic characteristics of the sample are presented in Table 1. As can be seen in the table, we had slightly fewer respondents aged over 65

Table 1
Demographic characteristics of the survey respondents.

	Male n = 300	Female n = 292	Total N = 592
Mean Age	53.25 (SD = 16.1)	49.20 (SD = 15.0)	51.25 (SD = 15.7)
25 – 44 years (n, %)	109 (36.3 %)	107 (36.6 %)	216 (36.5 %)
45 – 64 years	98 (32.7 %)	131 (44.9 %)	229 (38.7 %)
65 + years	93 (31.0 %)	54 (18.5 %)	147 (24.8 %)
Ethnicity (n, %)			
NZ European	220 (73.6 %)	232 (79.5 %)	452 (76.5 %)
Maori	11 (3.7 %)	9 (3.1 %)	20 (3.4 %)
Pacific	5 (1.7 %)	2 (0.7 %)	7 (1.2 %)
Other	59 (19.7 %)	45 (15.8 %)	105 (17.8 %)

Table 2
Driving- related characteristics of the survey respondents.

	Male n = 300	Female n = 292	Total N = 592
Current licence (yes n, %)	299 (99.7 %)	292 (100 %)	591 (99.8 %)
NZ full licence	284	262	546 (92.5 %)
NZ restricted	9	16	25 (4.2 %)
NZ learners	3	7	10 (1.7 %)
NZ motorcycle	1	0	1 (0.5 %)
Overseas licence	1	5	6 (1.0 %)
Length of licensure (years)	M = 30.44 (SD = 18.9)	M = 25.04 (SD = 17.1)	M = 27.91 (SD = 18.2)
Primary commuting mode			
Private car or truck	276 (92.0 %)	274 (93.8 %)	550 (92.9 %)
Public transport	11 (3.7 %	6 (2.1 %)	17 (2.9 %)
Motorcycle	1 (0.3 %)	1 (0.3 %)	2 (0.3 %)
Walk/cycle	10 (3.3 %)	10 (3.4 %)	20 (3.4 %)
Passenger age (years)	M = 46.51 (SD = 18.9)	M = 45.76 (SD = 19.4)	M = 46.30 (SD = 19.1)
Passenger gender (male n, %)	71 (23.7 %)	166 (56.8 %)	237 (40.0 %)
Passenger licenced (yes n, %)	258 (86 %)	246 (84.5 %)	504 (85.3 %)

years compared to those aged 25 − 44 or those aged 45 − 64 years. The majority of the respondents were of NZ European ethnicity, and lived in major New Zealand cities (e.g., Auckland 23.7 %, Canterbury, 9.1 %, Wellington 8.0 %), but respondents from all areas of NZ were represented.

The driving-related characteristics of the sample are presented in Table 2. As can be seen, almost all of the respondents held a current drivers' licence, the majority (92.5 %) having a full NZ Drivers' licence. The male participants had been licenced drivers for about 5 years longer on average compared to the female drivers (approximately equivalent to the difference in mean ages). The majority of participants used a private vehicle as their main form of transport (92.9 %), with only a small proportion of respondents using public transport, or walking/cycling. Over three quarters of male respondents (76.3 %) reported that their most frequent passenger was female; in contrast 56.8 % of the female respondents reported that their most frequent passenger was male.

2.1.2. Materials

The first part of the on-line survey asked respondents to rate how likely was it that their most frequent passenger would do each of 44 different actions (including making specific comments), rating them from 0 to 10 with 0 being not likely, 1 = not very likely and 10 being very likely. When respondents gave a rating between 1 and 10, they were asked how helpful it was when they did this, rating them from 0 = not helpful and 10 = very helpful. [If respondents answered 0 (ie., not likely), they were asked how helpful it would be if the passenger did do this, there were not enough responses in this category to include in subsequent analyses.] These 44 actions were drawn from previous research reports investigating driver-passenger interactions (e.g., Mårdh, 2016; Regan and Mitsopoulos, 2001; Vrkljan and Polgar, 2007) supplemented by suggestions from our research steering group. These questions were presented in a randomised order.

The second part of the survey asked respondents to rate how likely it would be that their most frequent passenger would influence them to do each of 44 different driving actions, rated as 0 = much less likely, 10 = much more likely, and 5 = no different to driving alone. These 44 driving actions were based on the 44-item Multidimensional Driving Style Inventory (MDSI) (Taubman-Ben-Ari et al., 2004). Use of the scale has led to four broad driving styles: 1 Reckless and Careless, 2 Anxious, 3 Angry and hostile, and 4 Patient and careful (Taubman - Ben-Ari and Skvirsky, 2016). We adapted the MDSI items to capture how the presence of a passenger may change drivers' driving style.

The third part of the survey asked 11 questions about the respondents' demographics; gender, age, driving history, place of residence, and the characteristics of their most frequent passenger. These three question areas were combined into an on-line survey and pretested with volunteers from our university that gave detailed feedback on the wording and structure of the survey.

2.2. Results

There are several ways to examine the survey results but of principal interest to us were the actions that passengers engage in, and which ones that drivers found most and least helpful. In order to compare similar types of passenger actions we divided the 44 actions that drivers rated into three categories; doing (10 items), telling (18 items), and remarking (16 items). We based these categories on the results of Regan and Mitsopoulos' (2001) factor analysis of Australian driver and passenger interactions as well as our own preliminary work. There is undoubtedly some degree of overlap between these three categories (particularly telling and remarking) and the items in them are not intended to be manifestly separate. They do, however, provide a useful way to begin looking at interactions in a way that facilitates comparison. It is also worth noting that the questions used to collect these ratings were presented to the respondents in mixed order, doing, telling, and remarking questions were separated into categories later for analysis.

The respondents' ratings (n = 592) of how often their most frequent passengers engaged in the "***doing***" activities) are shown in Table 3. As can be seen in the table, the female and male respondents' mean ratings of their passengers' actions were very similar. The action rated most likely to occur was "carry on a social conversation", which was rated as

Table 3
Respondents' mean ratings of "Rate the likelihood of you passenger doing…" on a scale where 0 = not at all likely, 1 = not very likely, to 10 = very likely. And "Rate the helpfulness of your passenger doing…" where 0 = not helpful and 10 = very helpful.

Passenger doing…	Females		Males	
	Likelihood	Helpful	Likelihood	Helpful
Carry on a social conversation/keep you company *	7.80	7.42	7.03	7.15
Remain quiet during a difficult manoeuvre	6.60	7.92	6.45	7.66
Unwrap a food item/open a beverage for you	6.41	7.94	6.42	7.86
Get things that are out of reach	6.59	7.85	6.17	7.20
Adjust the heater, air conditioning, or radio	6.15	6.11	5.82	5.85
Read a map or navigation device to find where to turn	5.34	7.34	5.44	7.43
Look after children of other passengers	5.01	7.69	5.48	7.40
Read aloud street signs or addresses	5.08	6.54	5.38	6.58
Talk to you to keep you awake	4.75	7.67	4.86	7.15
Answer your mobile phone	4.63	7.84	4.41	7.54

* indicates a significant gender difference in the likelihood ratings.

somewhat more likely by the female respondents. In some respects, the action rated second most likely by both men and women was the opposite of the first, stopping talking and remaining quiet during a difficult manoeuvre. The next group of actions involved assisting the driver by unwrapping food, opening a beverage, getting things that are out of reach, or adjusting the air conditioning or radio; in essence serving as another pair of hands for the driver. This was followed by several actions in which the passenger served as another set of eyes; reading a map, reading road signs, and looking after children or other passengers. Finally, the last two actions were helping the driver stay awake, or answering the driver's phone, both of which were identified as fairly unlikely.

Table 3 also shows that the likelihood of passengers doing these actions was not the same as how helpful the respondents said they would be to drivers. As described previously, the respondents answered this question only if their answer to the likelihood of their most frequent passenger performing it was at least 1 (i.e., "not very likely" or higher). As shown in the Table the action rated most helpful was unwrapping or opening food or drink, followed by remaining quiet during a difficult manoeuvre. Answering the driver's phone, or assisting with a child or other passenger were rated next most helpful, even though this was the least likely action to occur. Conversely, the action rated as least helpful, adjusting the heater or radio, was rated as occurring fairly often.

A statistical comparison of female and male respondents' likelihood ratings with a one-way repeated-measures Manova indicated that there was a significant gender by question interaction [Wilks' Lambda = .957, $F(9,582) = 2.91$, $p = .002$, $\eta_p^2 = .043$] but no main effect of gender [$F(1,590) = .323$, $p = .570$, $\eta_p^2 = .001$]. The item with a significant gender by item interaction is indicated in Table 3. Older respondents tended to provide lower ratings for nine or the 10 actions (Pearson's r (591) > .109, ps < .008), with the exception of "remain quiet during a difficult manoeuvre." (Note that when respondent age was included as a covariate in a repeated-measures Mancova it was significant, $F(1,589) = 41.68$, $p < .001$, $\eta_p^2 = .066$, but did not change the relationships between the other variables.) For the helpfulness ratings a similar one-way Manova did not show any gender by question interaction [Wilks' Lambda = .983, $F(9,254) = .475$, $p = .891$, $\eta_p^2 = .017$] nor a main effect of gender [$F(1,262) = .007$, $p = .932$, $\eta_p^2 < .001$].

The next type of passenger activity was ***telling*** the driver about things that passengers wanted drivers to do, and Table 4 shows all 18 likelihood and helpfulness ratings for each respondent gender. There was good agreement between the genders for the likelihood and helpfulness ratings for the top five items, pointing out a parking spot, whether the intersection is clear, the destination, road hazards, and directions to turn at an intersection (albeit female respondents rated the likelihood of pointing out a parking spot as more likely). Similarly, there was good agreement on the bottom five items, both in terms of their likelihood and helpfulness; being told to drive through an amber or red traffic light, to honk your horn, to overtake, to speed up or to relax. Fortunately these five items could be considered to be socially undesirable. There were several noteworthy, and somewhat surprising relationships in these data; for example being told to slow down was rated as much more likely, and much more helpful, than being told to speed up. Telling drivers not to answer their mobile phone while driving, or not to follow another car so closely were rated as helpful, but unlikely to occur.

A one-way repeated-measures Manova assessing the gender differences in the likelihood ratings revealed a significant gender by question interaction [Wilks' Lambda = .842, $F(17,574) = 6.32$, $p < .001$, $\eta_p^2 = .158$] but there was no main effect of gender [$F(1,590) = 2.03$, $p = .155$, $\eta_p^2 = .003$]. The items with significant gender interactions are indicated in Table 4. Older respondents tended to provide lower ratings for 15 of the 18 questions (Pearson's r (591) > .106, ps < .010) (the exceptions were being told to slow down, about an available parking spot, and whether the intersection is clear). When respondent age was included as a covariate in a Mancova it was significant, $F(1,589) = 37.72$, $p < .001$, $\eta_p^2 = .060$, but did not change the relationships between the other variables. For the one-way Manova of the helpfulness ratings the gender by question interaction was not significant [Wilks' Lambda = .776, $F(17,89) = 1.51$, $p = .108$, $\eta_p^2 = .224$] and there was no main effect of gender [$F(1,105) = .395$, $p = .531$, $\eta_p^2 < .004$].

Passengers' remarks to drivers are shown in Table 5. As shown in the table, the most common remarks made by passengers were about the behaviour of another road user and the weather, but they were not rated as being very helpful. The most helpful remarks were about police cars, animals or items in the road, and cyclists or pedestrians. Interestingly, being asked whether you are sober enough to drive was rated as being helpful, but was the least likely remark to be made. Analysis of gender differences in these ratings with a one-way repeated-measures Manova indicated a significant gender by question interaction [Wilks' Lambda = .909, $F(15,574) = 3.84$, $p < .001$, $\eta_p^2 = .091$] but there was no main effect of gender [$F(1,588) = 2.07$, $p = .151$, $\eta_p^2 = .004$].

Table 4
Respondents' ratings of the relative likelihood, and helpfulness of passengers ***telling*** drivers….

Passenger telling…	Females		Males	
	Likelihood	Helpful	Likelihood	Helpful
Point out an available parking spot *	7.68	8.42	7.21	7.88
Tell you whether or when the intersection is clear (in one direction)	6.65	7.27	6.47	7.63
Point out the destination when they see it	6.52	6.95	6.23	6.59
Point out a potential road hazard such as a sharp curve or dip	5.31	6.69	4.94	6.65
Tell you to turn right or left at an intersection	5.07	6.53	5.29	6.36
Tell you about the likely amount of traffic ahead	4.10	5.64	4.29	5.99
Point out what time it is *	3.57	4.56	4.20	5.18
Tell you to slow down *	3.53	5.32	4.99	5.80
Tell you to be careful as you approach an intersection *	3.36	4.95	4.10	5.71
Tell you to dip your lights/turn your high beams on	3.36	6.14	3.08	5.87
Tell you not to answer your mobile phone	3.17	6.17	3.63	6.54
Offer advice on the best way to park the car	3.14	3.74	3.10	4.17
Tell you not to follow so closely *	2.74	5.01	3.88	5.50
Tell you to relax *	2.52	4.14	3.27	5.05
Tell you to speed up	2.42	4.09	2.62	4.74
Tell you to overtake	2.37	3.72	2.01	4.17
Tell you to honk your horn at other road users	1.75	3.35	1.90	3.32
Tell you to drive through a red or amber light	1.11	3.33	1.29	4.03

* indicates a significant gender difference in the likelihood ratings.

Table 5
Respondents' ratings of the relative likelihood, and helpfulness of passengers ***remarking*** to drivers….

Passenger remarking	Females		Males	
	Likelihood	Helpful	Likelihood	Helpful
Make a remark about another road users' behaviour	6.76	4.75	6.46	5.24
Remark on the weather conditions/ visibility	6.17	5.61	6.08	5.88
Remark on the presence of a police car (or speed camera)	6.01	6.96	5.88	6.93
Point out the presence of cats, dogs, or items in the road	5.93	7.37	5.48	6.90
Remark on/point out road works or road workers	5.34	6.48	5.14	6.18
Remark on the route that you are taking	5.20	4.68	5.15	5.20
Remark on the direction to turn at an intersection ahead	5.13	6.46	5.30	6.33
Remark on the distance or location of the destination	5.05	5.61	4.93	5.70
Point out a cyclist or pedestrian	4.88	7.02	5.22	6.76
Remark when you are driving faster than the speed limit *	4.81	5.91	5.65	6.38
Remark on the starting time of an event at your destination	4.41	4.43	4.64	5.03
Remark on the speed limit *	4.12	5.30	5.11	5.76
Remark on an amber or red traffic light *	4.10	5.38	4.86	5.93
Make a remark about your style of driving	3.66	2.74	4.01	3.37
Remark on the distance to a car ahead *	3.34	5.07	3.93	5.18
Ask whether you are sober enough to drive *	2.33	6.59	3.29	6.30

* indicates a significant gender difference in the likelihood ratings.

The items with significant gender interactions are indicated in Table 5. For the helpfulness ratings there was no gender by question interaction [Wilks' Lambda = .8923, F(15,177) = .923, p = .471, η_p^2 = .077] and there was no main effect of gender [F(1,191) = .242, p = .623, η_p^2 = .001].

Another way to consider these data is in terms of the gender mix of the driver and their passenger. In the questionnaire we asked the respondents to tell us the gender and age of their most frequent passenger, and then asked them to think of that person as they answered the subsequent questions. With that information it was possible to categorise the participants into pair type groups: Female drivers with female passengers (FF), female drivers with male passengers (FM), Male drivers with male passengers (MM), and male drivers with female passengers (MF). We re-ran the Manovas described above substituting pair type for respondent gender. The results of these analyses paralleled the gender analyses reported above, non-significant pair type differences and significant pair type by question interactions for likelihood measures, and no significant pair type differences for helpfulness measures. For the sake of brevity, and because the effect sizes were quite small we have not presented them.

The last area we asked the respondents to rate was the effect that a passenger had on their driving. Based on the 44 item MDSI we were able to calculate four scores for each participant based on how they said the presence of a passenger made them more or less: reckless and careless, anxious, angry and hostile, or patient and careful. Fig. 1 shows the respondents' means for these four scores. Overall, the respondents indicated that the presence of a passenger made them less reckless, less angry, and more patient, all beneficial attributes. Although these beneficial effects tended to be greater for women and in the two older age groups, there were no gender or age differences that met the Bonferroni-adjusted criterion for statistical significance.

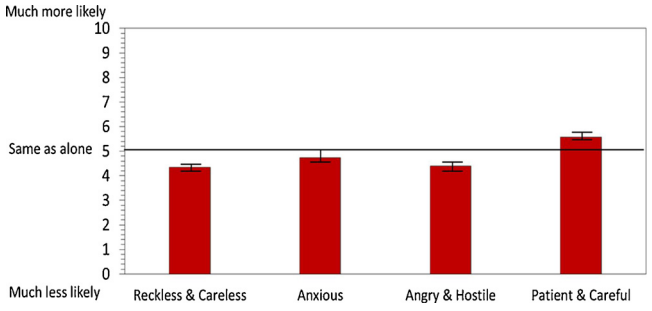

Fig. 1. The passengers' effect on driving via the MDSI items. The whiskers show the 95 % confidence intervals.

3. Study 2 - Driving conversations during everyday trips

The purpose of the second study was to describe driver-passenger interactions that occurred during a short journey. We hoped to see examples of the driver passenger interactions we asked about in the survey and determine whether there were any obvious differences between what respondents said occurred, and how drivers and their passengers actually interacted on familiar roads. Previous research into driver-passenger interactions have, for the most part, used survey or interview methods, or have been conducted to examine distraction, without benefit of a set interaction categories. For the present study we developed a set of mutually exclusive and exhaustive scoring categories and recruited drivers and passengers that travel together frequently.

3.1. Method

3.1.1. Participants

For this study we recruited passenger-driver pairs using an advertisement distributed via email. We asked that participant drivers be aged between 25–65 years, and have a family member or friend over the age of 16 whom they drive with often. All of the recruitment and test procedures were approved by the School of Psychology Research and Ethics Committee (#18_37).

We recruited 25 passenger-driver pairs (drivers aged 25–65 years). Three pairs had to be discarded; 2 conversed in a language other than English during the drive, 1 due to equipment failure. In the remaining sample (a total of 22 pairs; 22 drivers and 22 passengers) the mean age of the drivers was 41.64 years (*SD* 12.62) and the mean age of the passengers was 37.46 (*SD* 14.45). All but two (91 %) of the drivers said their passenger was the person they drove with most often; 11 of the pairs were spouses or partners, seven pairs were family members, and four pairs were friends. There were a total of 14 female drivers and eight male drivers in the sample, with 11 Female driver-Female passenger pairs (FF), 3 Female driver-Male passenger pairs (FM), 5 Male driver-Female passenger pairs (MF), and 3 Male driver-Male passenger pairs (MM).

3.1.2. Materials and apparatus

The participants drove a 15.1 km route through urban and suburban streets in an area adjacent to the research laboratory. The speed limits on these streets included 50 km/h, 60 km/h, and 80 km/h. The route was selected for its safety and because of the diversity of road types it

Fig. 2. A view from the camera used to record driver-passenger interactions.

contained including roundabouts, signalised and priority intersections, two school zones, two shopping areas, and a limited access road. The drive took approximately 25 − 30 min to complete.

Each experimental session was conducted using the participants' own car, and the drive was recorded by a camera mounted between the driver and passenger headrests. The camera recorded the audio and video throughout the drive, showing a view of the road ahead, the dashboard, and a portion of the participants, as shown in Fig. 2. At the end of the drive, the participant pairs returned to the laboratory to complete a short post-drive questionnaire to assess their experience of the drive; rating how the presence of the passenger affected their driving, telling us what kinds of driver passenger interactions had occurred during the drive, and to rate the helpfulness of those interactions (on a 3-point scale where 1 = helpful, 2 = neutral, 3 = unhelpful), and providing some demographics (e.g., typical shared journey, age, driving experience, relationship, etc.).

3.1.3. Procedure

When the participants arrived at the laboratory for their session they were asked which one was usually the driver when they travelled together. They were then told that was who we wanted to drive during the session and we checked their licence to make sure that it was a current NZ unrestricted driving licence. The participants were then told that the drive would be recorded and shown the camera. Participants were then given a printed map of the route and it was discussed with them and were assured that their conversations and driving performance would be kept confidential. The participants were given a chance to ask questions and then asked to complete an informed consent sheet. Once consent had been given the camera was turned on and the participants were reminded to follow the road rules, keep to the route shown on the map, and relax, drive normally, and converse about anything they wished to during the drive.

When the participants returned to the laboratory at the end of the drive, the camera was removed and they were invited in to each complete a post-drive questionnaire presented on desktop computers. Participants were then given another chance to ask questions, and thanked by giving each person (driver and passenger) a $20 voucher.

3.1.4. Analysis

The main focus of the analysis was to measure driving support requested by the driver, and unprompted support given by the passenger. To capture this support from the recordings of the drive we developed a mutually exclusive and exhaustive list of categories shown in Table 6. We began by transcribing all of the recordings into paper and pencil form. We developed the scoring categories in iterative fashion, based initially on previously published research, our survey results (from Study 1), and early research in our laboratory. We scored topics and actions rather than individual utterances; a topic might consist of a single action or utterance, or might be longer including a reply and several follow-ups (according to Gee, 2005). The scoring categories included five topics or actions that were passenger-initiated, five that were driver-initiated, and three that were conversational in the sense that they ebbed and flowed between both driver and passenger and did not refer to any immediate action or event. Independent scoring of the same transcripts showed good agreement between the researchers, Kappa = .876. The main analyses using the scoring categories were descriptive rather than inferential in the sense that our goal was to describe driver-passenger interactions that occurred during a short journey and we had not developed any a priori predictions or hypotheses.

3.2. Results

In order to describe the driver-passenger interactions we summed the number of instances in each scoring category for each driver-passenger pair. Some of the pairs talked more than others, and total topic instances for the pairs ranged from 38 to 126 (M = 70.73 [SD = 23.12]). To address this difference, we calculated a percentage of total topics for each category for each driver-passenger pair (note that these were based on instances rather than elapsed time). The means of these percentages are shown in Fig. 3. As shown in the figure, the preponderance of topics were conversations about the journey (M = 26.82 %, SD = 7.27), followed by social conversations (M = 23.17 %, SD = 11.19). As described earlier, conversations about the journey do help the driver maintain good situation awareness, although in Study 1's survey results remarks about other road users or the route were rated only moderately helpful (M = 4.46–5.24). Next most frequently observed were passengers offering driving support (M = 18.29 %, SD = 9.11) and drivers requesting support (M = 15.83 %, SD = 6.50). All the other topics ranged from 2.95 % (C2) to 0.77 % (D2).

Unfortunately the sample sizes were too small to permit analysis with inferential statistics, but it was apparent that assistance and comments were not offered by all passengers equally. The two most frequent support-oriented categories (P1 & D1) are shown in the top row of Fig. 4. As can be seen in the figure female passengers were most likely to offer support, particularly to male drivers, and male drivers were more likely to request support if their passenger was also male. The other two areas with evident gender differences are shown in the bottom row of Fig. 4. Female passengers were the most likely to offer advice to male drivers and the least likely to make critical comments to male passengers whereas male passengers offered direct advice to male drivers very rarely.

In addition to differences in who offered assistance, not all of the driver-passenger interactions that we observed were equally valued, and we used the ratings from the end-of-drive questionnaire to assess these differences. When asked to identify the types of interactions the passengers had with the drivers, all but one of the drivers (n = 21), and all of the passengers (n = 22) said they assisted the driver by assisting with navigation and offering directions. Similarly, 15 of the drivers said that their passenger commented on the traffic situation, and said when it was safe to cross an intersection, even though only 11 of the passengers said they had done this. These were followed by passengers making comments about driving performance (8 drivers and 8 passengers said this) and providing non-driving support by handing them something or opening food or drink (3 drivers and 4 passengers). All but one of the drivers (n = 21) and all but two of the passengers (n = 20) also said that the passenger conversed with them about non-driving topics. When asked to rate the helpfulness whether these interactions were helpful, unhelpful, or neutral, the drivers said that the non-driving support and navigation were the most helpful passenger actions. The drivers' ratings of these interactions are shown in Fig. 5. Drivers also provided examples of these interactions such as:

Table 6
Scoring categories used for driver-passenger interactions.

Code	Topic	Description
Passenger initiated		
P1	Driving support	Read map, turn left/right, read sign, check clearance, point out destination, police, other driver, cyclist, pedestrian, parking spot, red light
P2	Non-driving support	Adjust radio, AC, care for children, open food/beverage, reach item, answer phone
P3	Advice (direct)	Slow down, speed up, indicate, overtake, following distance, speed limit, dip headlights, honk horn, be careful, don't answer phone, how to park, criticise style
P4	Advice (indirect)	Time to destination, current time, ask if sober or tired, what constitutes bad driving, ask what lane or what speed is appropriate, tell driver to relax
P5	Self-comment	Comment on own performance, map reading, navigation help, being a distraction
Driver initiated		
D1	Driver requests driving support	Asks directions, speed limit, clearance
D2	Direct request non-driving support	Ask passenger to retrieve item, change music, answer phone, assist passenger
D3	Criticise passenger	Reject advice, reject conversation, failure of support
D4	Indirect request	Ask about noise, presence or location of items
D5	Self-comment	Comment on own driving, speed, lane choice, indicating, etc.
Joint topic		
C1	Conversation: journey	Weather, bad drivers, traffic, road condition, other road users, or people/animals/ objects at roadside, discussion of route alternatives
C2	Conversation: purposive	Keep driver awake, stop talking during manoeuvre
C3	Conversation: social	Non-driving discussion of people, places, events

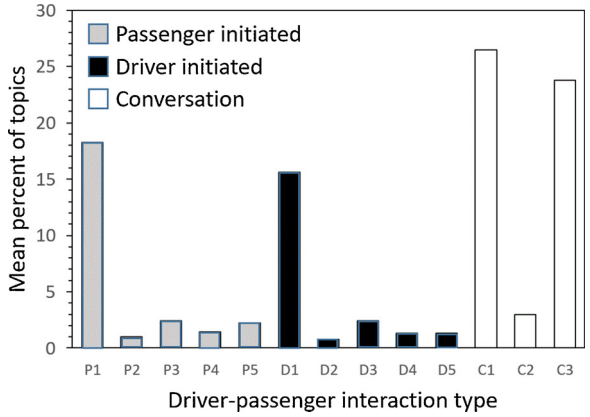

Fig. 3. Instances of driver-passenger interactions calculated as a percentage of total interactions and averaged across passenger-driver pairs.

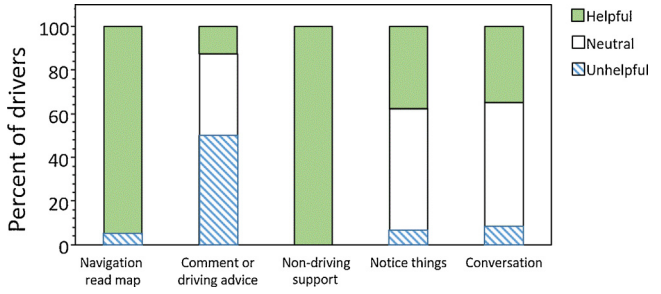

Fig. 5. Drivers' ratings of the helpfulness of passenger interactions during the drive.

It is safer for her to find my phone than me trying to when driving, lets me concentrate on the road - Male, 50 yrs, female passenger, spouse
I didn't have to think about where to go - Male, 37 yrs, female passenger, spouse

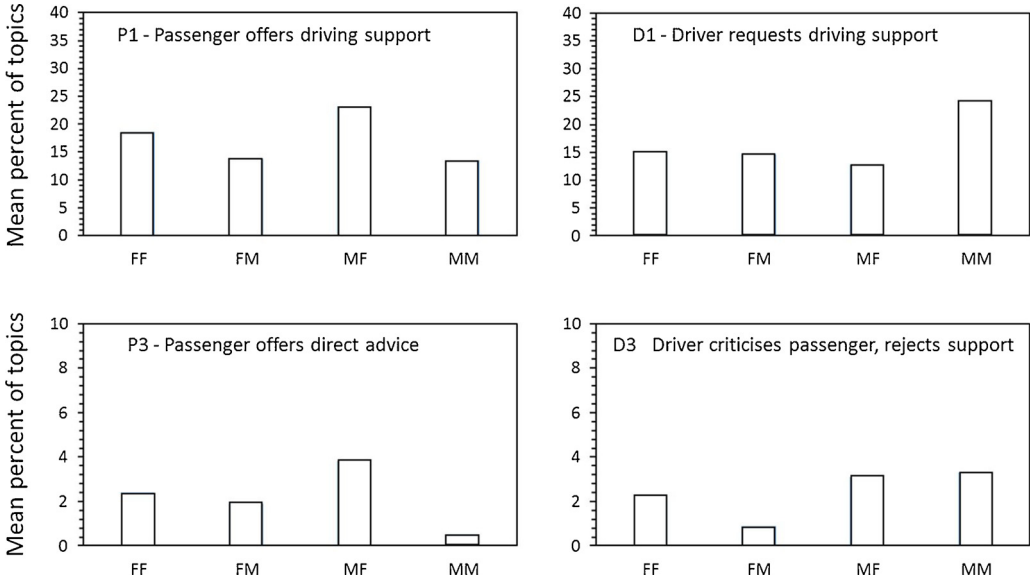

Fig. 4. Pair type differences in driver-passenger interactions.

Making comments on driver performance (offering driving advice) was rated as the least helpful passenger action, it was ranked lowest by 66.7 % of drivers. Comments on these interactions included:

It distracted me more - Male, 31 yrs, female passenger, spouse
It was annoying - Female, 41 yrs, female passenger, family
It was unnecessary - Male, 37 yrs, female passenger, spouse

The drivers also noted a few other things that they found unhelpful and wished their passengers had not done:

He turned up the heater and made the car too hot, I had to turn it down - Female, 50 yrs, male passenger, spouse
Not being able to read the map accurately and questioning while driving - Male, 31 yrs, female passenger, spouse
Was quite nervous at times at what was happening on the road, which was distracting - Female, 41 yrs, female passenger, family

Drivers also noted some things they wished their passengers had done during the drive, including:

Given directions in time to follow the correct route - Female, 26 yrs, female passenger, spouse
Focus and give directions according to the map - Male, 31 yrs, female passenger, spouse
Not argue with her mother! - Female, 64 yrs, female passenger, family
By not making smart comments about my driving - Male, 37 yrs, female passenger, spouse

Finally, we also asked drivers to rate how the presence of the passengers affected their driving, particularly as regards their caution, the number of driving errors, and their level of stress. As with the helpfulness ratings, the drivers used a simple three point scale for each of these three areas, where 1 = more caution, fewer errors, less stressed, 2 = no different to driving alone, and 3 = less caution, more errors, more stressed. Fig. 6 shows the drivers' ratings, and what is readily apparent is that 70.83–83.33 % of drivers felt the passenger did not affect their driving. None of the drivers said their driving was less cautious, but they did say that they made more errors (12.50 %) and felt more stress (16.67 %) with the passenger present.

4. Discussion

The current study was a mixed methods examination of passenger-driver interactions. The on-line survey revealed that drivers have good agreement regarding the kinds of things their passengers do, and which of these are helpful (and which are not). For example, passengers doing things for drivers, such as getting things that are out of reach, unwrapping or opening food or beverage, and reading a map were all viewed as very helpful by drivers (but not adjusting the heating or radio). This is in contrast to the sorts of things passengers tell drivers to do, some of which were valued highly (e.g., pointing out a parking spot or scanning an intersection for traffic) while others were viewed as quite unhelpful (advice on how to park or when to overtake). Passengers remarking on the presence of a police car, a cyclist, or an animal in the road was rated as being very helpful by the drivers. Passengers' remarks about driving style was rated as the least helpful item, although passengers telling drivers to slow down or remarking when the driver is over the speed limit are viewed positively. Although there were some significant differences between women and men respondents in the magnitude of the likelihood ratings, these gender differences were typically very small as indicated by the effect sizes.

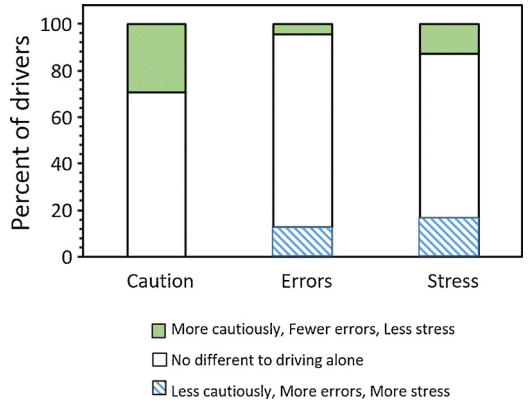

Fig. 6. Drivers' ratings of the effect of the passengers on their driving.

We were able to see examples of many of these interactions in the on-road portion of the study, and importantly did see some noteworthy gender differences particularly related to the higher likelihood of women passengers offering driving support and driving advice to male drivers. Males were very unlikely to offer driving advice to male drivers, but often requested driving support from their male passengers. These participants rated non-driving support, and help with navigation as being the most helpful passenger actions, whereas the comments and driving advice they received was viewed as unhelpful by half of the drivers. Relatively few of the drivers (< 30 %), however, said that the presence of their passenger made them drive differently than they would have had they been alone.

These results are encouraging from the perspective of promoting safe mobility. Identifying how and when passengers are beneficial to drivers could be of large value for increased road safety and improved mobility. The concept of a co-driver, as it is used in competitive rally driving, transforms the role of the passenger into an active participant, responsible for navigation and advising the driver on possible obstacles, hazards, and progress towards their shared goal. Similarly, the practice of co-driving could, if promoted, improve drivers' situation awareness and performance, and good passengers could become recognised in a positive way and valued for their contributions, rather than disdained as a distraction or annoyance.

One area where passenger coaching has been tried is with young drivers and their passengers (Lenné et al., 2011). In this trial drivers holding a probationary licence and their similar-aged passengers received training to promote safe behaviours while driving. The effects of the training, assessed in a driving simulator, were a significant reduction in unsafe comments by the trained passengers. Interestingly, there are some parallels in the risks and benefits of passenger presence for young drivers and older drivers (65–79). Bedard and Meyers (2004) found that the presence of passengers increased the likelihood of some unsafe driving by older drivers (e.g., ignoring signs and failure to give right of way) but was offset somewhat by reductions in the likelihood of other unsafe activities (driving in the wrong direction for the lane). In a study of four older couples (the drivers were > 70 years) that regularly drive together it was observed that the passengers provided driving and directional support, without necessarily being asked, spontaneously advising of the appropriate speed limit (or the fact they are driving too fast) as well as providing ongoing directional advice (e.g., we are going right here) (Mårdh, 2016). Our samples were limited to drivers older than 25 years because we were interested in understanding how the large majority of drivers interact with their passengers, rather than the interesting, but exceptional minority of young drivers. To be sure, this group is of interest, and we have plans to study them in the future, along with an on-road sample of older drivers (75+).

There were of course limitations to our studies of passenger-driver interactions. Respondent's attitudes were captured by the on-line questionnaire data, but not a verifiable record of their actual interactions with passengers, and we did not capture the passengers' view of these drivers. In the on-road study we were not able to recruit a sufficiently large sample of driver-passenger pairs to permit a robust statistical analysis, and the observational categories might have emerged somewhat differently with a larger sample. Possibly even more importantly, future research should examine trips that passenger-driver pairs take together frequently. In an attempt to ensure a degree of

comparability in our limited sample, all of our participants drove the same route, and although the roads were familiar, the route needed to be followed with a map provided by the researchers. This no doubt inflated the amount of navigation interactions between the passengers and drivers, and although important in everyday circumstances (as seen in the questionnaire ratings) its frequency in our study was higher than would be typical.

We believe there are a range of possible benefits that could be achieved by letting drivers and passengers know how the passenger can assist a driver, and how drivers might accept and encourage that assistance. Among some populations in particular, e.g., tourist drivers, the young, and the elderly, explicit training on how to take a "team approach" during a trip could result in significant safety benefits for these at-risk groups. For elderly drivers, changes in visual acuity, field of view, and reaction time often lead to a reduction in driving, limiting driving to only essential trips and effectively decreasing quality of life through restricted mobility. By providing senior drivers with advice and recommendations about the benefits of co-driving could extend and enhance their mobility and offer significant improvements to their standard of health, happiness, and safety. Further research might productively explore the development of co-driving training programmes for these at-risk groups.

Authors statement

This research was jointly conceptualised and conducted. The first draft of this manuscript was prepared by the first author (Charlton) and revised jointly by both authors (Charlton & Starkey).

Data availability

The data analysed during the this are not publicly available due lacking participant consent for open data-sharing, but are available from the corresponding author on reasonable request.

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Ethical approval

All participant recruitment and test procedures were approved by the School of Psychology Human Research Ethics Committee at the University of Waikato and were in accordance with the 1964 Declaration of Helsinki. Informed consent Informed consent was obtained from all of the participants in the study.

Declaration of Competing Interest

The authors declare that they have no competing interests.

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