Participants' seating configuration and position preferences while travelling with their child occupants in fully automated vehicles

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Background

Fully automated vehicles (FAV) have the potential to completely revolutionise personal transport. In the future, FAV may not require any vehicle occupant to be a driver, and as a result, the driver will become a passenger, together with the other occupants. Consequently, FAV interiors may prioritise occupant comfort, interaction and entertainment, and offer the possibility for occupants to engage in activities – other than driving. In addition, given that there will be no need for a driver, new seating configurations and positions will be possible within FAV which are different to the conventional seating configurations and positions (i.e., with all seats forward-facing). In addition, it is likely that several factors will influence occupants' preferences for seating configurations and positions, including: trip purpose, trip length, the occupants with whom they are travelling, as well as social and/or cultural norms. Recently, Jorlov and colleagues (2017) explored future seating configurations, where Swedish participants were provided with a number of different travelling scenarios and asked to position four seats within the boundary of a FAV space. In shorter travelling scenarios, where participants could expect to be alone in the FAV, participants preferred a forward-facing seating configuration, but with possibility of a reclined seating position. In longer travelling scenarios, where participants could expect to be travelling with several occupants in the FAV, participants preferred a seating configuration that was similar to a 'living room' configuration (i.e., where occupants face each other). Participants also noted they would be willing to accommodate additional or alternative seatbelt configurations during FAV travel.

The current study aimed to conduct an online survey across multiple countries to understand: 1) Seating configuration and position preferences in a FAV across four hypothetical travelling scenarios, 2) Activities that they, and other occupants, would engage in during these travelling scenarios, and 3) Willingness to wear different seatbelt configurations while seated non-forward facing or reclined during FAV travel.

Methods

Participants completed an online survey where they were asked to imagine travelling in a FAV across four hypothetical travelling scenarios (1: by themselves; 2: with a partner/spouse; 3: with a child occupant(s); 4: with a partner/spouse and child occupant(s)). For each travelling scenario, participants were asked to select one of five seating configurations and one of four seating positions for themselves and for any additional occupants (based on the findings of Jorlov et al., 2017, see Figure 1).
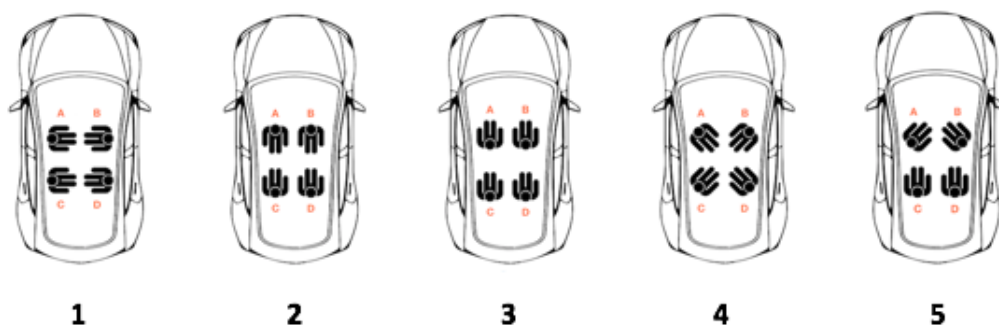

Figure 1: Hypothetical FAV seating configurations and positions. Positions are: 'A' (driver, front left); 'B' (front seat passenger, front right); 'C' (rear left) and 'D' (rear right).

Participants were asked to indicate any activities that they, and any additional occupants, would engage in during these scenarios. Finally, participants were asked about: 1) their current seat belt use; 2) their predicted seatbelt use in a FAV, and 3) whether they would be willing to wear a different seatbelt in a FAV while seated in a) a non forward-facing mode or b) while reclined (based on the findings of Östling et al., 2018, see Figure 2).

Figure 2: Hypothetical different seatbelt configuration: three-point restraint with additional cross-belt (reprinted with permission from Östling et al., 2018).

Participants were recruited through a range of online and social media advertising, including University and Organisation newsletters, Facebook pages, Twitter & LinkedIn feeds, etc. The online survey was administered from November 2018 – February 2019.

Results

One hundred and sixty four participants (Female = 59.9%; Mean age = 41.1 years, SD = 9.2 years, Range = 24.0 – 71.0 years) completed the online survey and indicated that they regularly travelled with a child occupant(s) in their motor vehicle. Most participants resided in Australia (49.7%), Sweden (24.8%), Lebanon (20.4%), or Spain (5.1%). Most of the child occupants that participants regularly travelled with were aged 8 years and older (61.6%) and their gender distribution was approximately equal (female = 51.3%, male = 48.7%).

Table 1: Participant characteristics

Participant characteristics		% (N)
Age (years)	18-30	4.5% (7)
	31-64	91.7% (144)
	65+	3.8% (6)
Sex	Male	40.1% (63)
	Female	59.9% (94)
Country of residence	Australia	49.7% (78)
	Spain	5.1% (8)
	Sweden	24.8% (39)
	Lebanon	20.4% (32)
Child(ren) age (years)	0-1	4.7% (12)
	2-4	14.0% (36)
	5-7	19.8% (51)
	8+	61.6% (159)
Child(ren) sex	Male	48.7% (126)
	Female	51.3% (132)

Across all four hypothetical travelling scenarios, participants were most likely to prefer a conventional seating configuration (i.e., all seats facing forward) (see Figure 3).
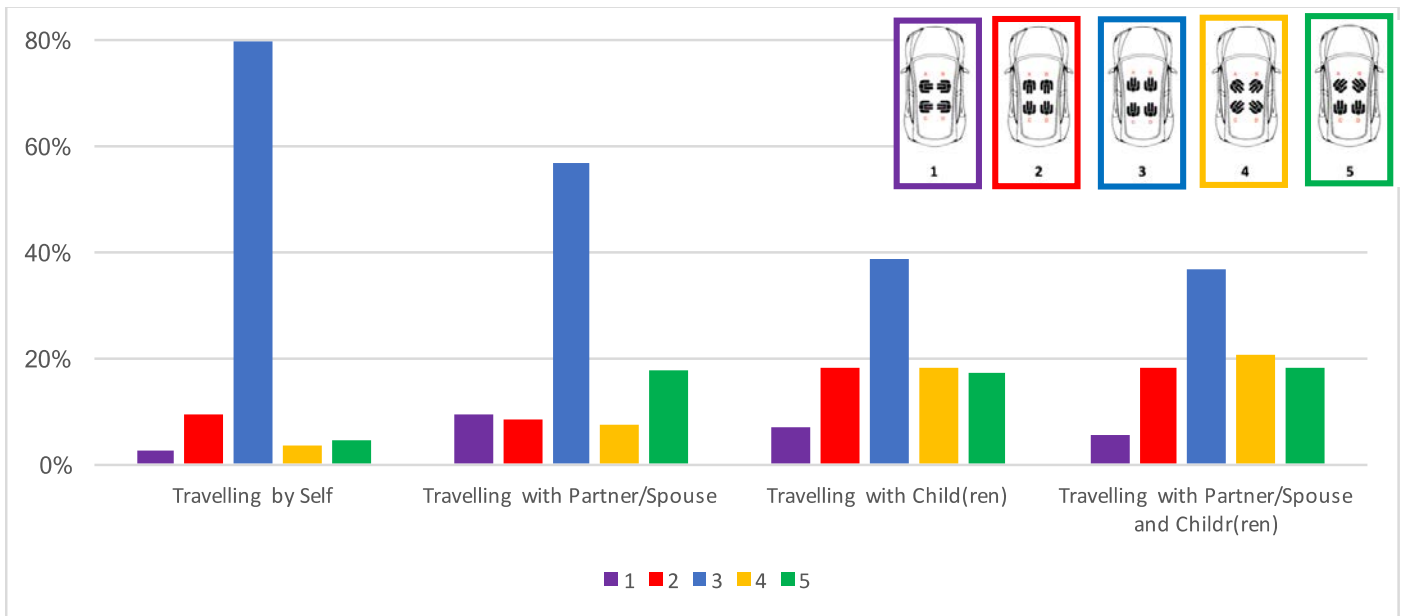
Figure 3: Participants' FAV seating configuration preferences across the four hypothetical travelling scenarios

However, participants' preferences for seating configuration and positions changed depending on the travelling scenario (i.e., whom they were travelling with).

Travelling by themselves:

Most participants indicated that they would prefer seating configuration #3 (#1: 2.5%; #2: 9.6% #3: 79.6%; #4: 3.8%; #5: 4.5%) and seating position A (A: 72.0%; B: 13.4%; C: 4.5%; D: 10.2%).

Travelling with their partner / spouse:

Most participants indicated that they would prefer seating configuration #3 (#1: 9.3%; #2: 8.7% #3: 56.7%; #4: 7.3%; #5: 18.0%), and seating position A for themselves (A: 55.1%; B: 32.0%; C: 6.1%; D: 6.8%), and seating position B for their partner/spouse (A: 34.0%; B: 50.7%; C: 4.9%; D: 10.4%).

Travelling with a child occupant(s):

Most participants indicated that they would prefer seating configuration #3 (#1: 7.2%; #2: 18.4% #3: 38.8%; #4: 18.4%; #5: 17.1%), and seating position A for themselves (A: 71.5%; B: 13.2%; C: 7.6%; D: 7.6%), and seating position B for Child 1 (A: 11.9%; B: 31.5%; C: 27.3%; D: 29.4%), and seating positions C or D for Child 2 (A: 1.8%; B: 10.9%; C: 43.6%; D: 43.6%).

Travelling with their partner / spouse and a child occupant(s):

Most participants indicated that they would prefer seating configuration #3 (#1: 5.7%; #2: 18.4% #3: 36.9%; #4: 20.6%; #5: 18.4%), and seating position A for themselves (A: 54.0%; B: 33.6%; C: 6.6%; D: 5.8%), seating position B for their partner/spouse (A: 33.6%; B: 52.6%; C: 8.8%; D: 5.1%), and seating position D for Child 1 (A: 6.6%; B: 7.4%; C: 39.0%; D: 47.1%), seating positions C or D for Child 2 (A: 2.0%; B: 7.1%; C: 40.4%; D: 50.5%).

When asked about activities that they would engage in during these travelling scenarios, a wide variety of activities was specified, however depended on the occupants with whom they were travelling with:

• Travelling by themselves = Read (27.4%), Listen to music/podcast/radio (13.4%), Relax/Rest/Sleep (10.2%);

• Travelling with partner / spouse = Talk (35.4%), Read (19.0%), Relax/Rest/Sleep (8.2%);

• Travelling with a child occupant(s) = Talk (29.6%), Read (7.5%), Play games (13.4%), and

• Travelling with partner / spouse and a child occupant(s) = Talk (38.7%), Read (16.8%), Play games (7.3%).

When asked about their current seat belt use, 98.1 percent of participants reported that they 'always' or 'almost always' wear their seatbelt when travelling in a motor vehicle (see Figure 4a, 4b).
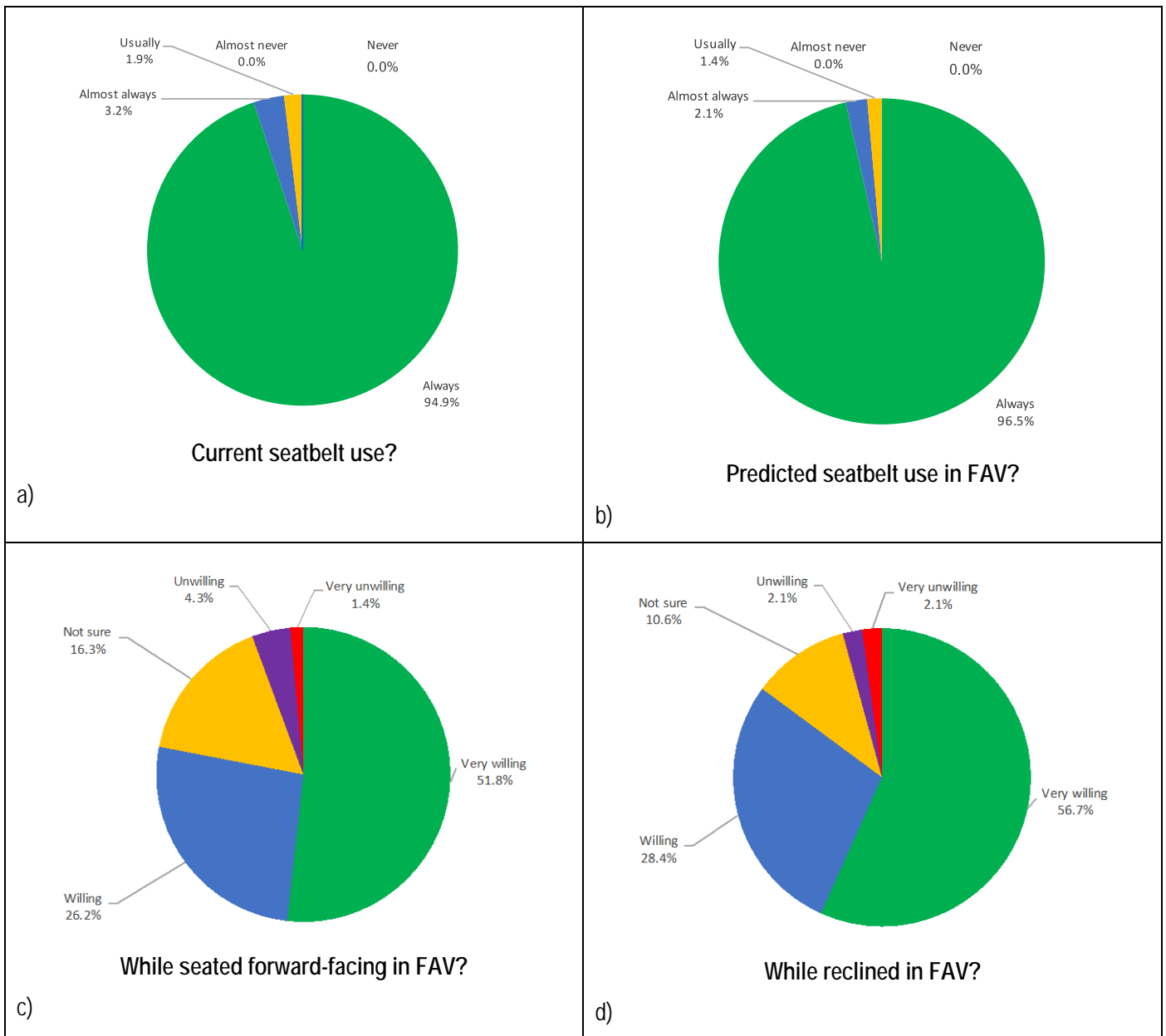
Figure 4 Participants' current (a, b) and predicted seatbelt use with a different seatbelt configuration (c,d).

Most participants predicted that they would 'always' or 'almost always' wear their seatbelt when travelling in a FAV (98.6%). In addition, most participants also reported that they would be 'very willing' or 'willing' to wear a different seatbelt configuration in a FAV while seated in a non forward-facing mode or while reclined (78.0%, 85.1%, respectively).

Discussion and Conclusion

The findings of the current study suggest that, across all travelling scenarios, participants were most likely to prefer the conventional, forward-facing seating configuration (i.e., #3). It was interesting to note that participants were most likely to prefer this seating configuration when travelling by themselves (79.6%) and least likely to prefer this seating configuration when travelling with their child occupant(s) (38.8%) or their partner and child occupant(s) (36.9%). These findings are consistent with those of Jorlov and colleagues (2017) who reported that participants' preferences depended the occupants with whom they are travelling.

Across all travelling scenarios, participants were most likely to prefer seating position A (i.e., conventional driver's seating position), regardless of whether they were travelling with any other occupants.

Participants predicted they would engage in wide variety of activities in while travelling in a FAV – however depended on who they were travelling with. The most common activity while travelling alone was reading (27.4%), followed by listening to music / podcast / radio (13.4%) and relaxing / resting /sleeping (10.2%). However, when travelling with other occupants, including child occupants, talking was the most common activity (35.4% - 40.3%).

Participants' predicted seatbelt wearing rates were very high, with ~ 99 percent indicating that they would 'always' or 'almost always' wear their seatbelt when travelling in a FAV. In addition, most participants reported that they were also 'very willing' or 'willing' to using different seatbelt configurations when travelling in a non-forward-facing mode (78.0%) or while reclined (85.1%). These findings are consistent with Jorlov and colleagues (2017) who reported that the majority of Swedish participants would be willing to

accommodate additional or alternative seatbelt configurations. Combined, these findings suggest that the introduction of new seatbelt configurations may be able to be accommodated by vehicle designers without inconveniencing vehicle occupants.

Several limitations should be noted. First, the findings of the current study are based on participants' *predicted* seating configuration and position preferences, and willingness to use different seatbelt configurations, without having experienced them in the real-world. It is possible that these preferences may change when participants experience these seating configurations and positions dynamically (i.e., motion sickness, Sivek & Schoettle, 2015). Secondly, the survey did not collect data on child occupants' restraint type (i.e., rearward-facing CRS, forward-facing CRS, booster seat, seatbelt). It is possible that the child occupant's restraint type may have influenced where participants seated them in the FAV. Future research should explore restraint type on seating configuration and position preferences. Thirdly, due to low numbers, it was not possible to explore potential differences in seating configuration and position preferences across countries. Future research should explore seating configuration and position preferences across countries – including the differences in restraint legislation for child occupants. Finally, the findings of the current study are based on a convenience sample and therefore may be result of 'volunteer bias' where individuals who participated may be more interested in FAV or road safety more generally. Future research should recruit larger sample (within each country) to ensure the findings are applicable to general driving population.

This study has provided valuable insight regarding seating configuration and position preferences while travelling with child occupants in a FAV, as well as predicted activities and restraint use. Future research will use this information to simulate likely injury outcomes of these preferences in the event of a motor vehicle crash, and provide a basis for the design of occupant protection systems for FAV in the future.

References

Jorlov, S., Bohman, K., & Larsson, A. (2017). Seating Positions and Activities in Highly Automated Cars – A Qualitative Study of Future Automated Driving Scenarios. *IRCOBI,* 13th – 15th September 2017, Antwerp, Belgium.

Östling, M., Saito, H., Vishwanatha, A., Ding, C., Pipkorn, B., & Sunnevång, C. (2018). Potential Benefit of a 3+2 Criss Cross Seat Belt System in Frontal and Oblique Crashes. *IRCOBI,* 12th -14th September 2018. Athens, Greece.

Sivak, M. & Schoettle, B. (2015). Motion sickness in self-driving vehicles. Report No. UMTRI-2015-12. https://deepblue.lib.umich.edu/

Declaration
This paper extends the results, for participants with child occupants, from a previous study which was presented at AAAM 2019: Koppel, S., Jiménez Octavio, J., Bohman, K., Logan, D., Raphael, W., Quintana Jimenez, L., & Lopez-Valdes, F. (2019). Seating configuration and position preferences in fully automated vehicles. *Traffic Injury Prevention*, 1-7.