

1           **WILLINGNESS OF PEOPLE WHO ARE BLIND TO ACCEPT AUTONOMOUS**  
2           **VEHICLES: AN EMPIRICAL INVESTIGATION**

3  
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10  
11 **ABSTRACT**

12 Attitudes of a sample of 211 UK people who are blind concerning autonomous vehicles  
13 (AVs), and the determinants of the willingness of people who are blind to travel in AVs, were  
14 examined. Participants answered an open-ended question regarding their attitudes towards  
15 level 5 AVs and the results were analysed using a semi-automated structural topic modelling  
16 procedure. (Level 5 AVs are fully autonomous anywhere, and do not require controlled areas  
17 in which to operate.) Four “topics” emerged from the exercise: (i) “hope” for future  
18 independence and freedom to travel offered by AVs to people who are blind, (ii) scepticism  
19 that AVs will ever be configured to meet the needs of people who are blind, (iii) concerns  
20 over safety, and (iv) the affordability of AVs. The four topics were employed as mediating  
21 variables in a structural equation model designed to explain the respondents’ willingness to  
22 travel in an AV. A number of covariates were presumed to influence the four mediating  
23 topics, including a participant’s desire for independence, comorbidity, locus of control, and  
24 level of generalised anxiety. Three of the mediating variables exerted significant influences  
25 on willingness to travel in an AV, i.e., hope for future independence, misgivings about safety,  
26 and affordability. Scepticism about AVs did not have a significant effect. Several  
27 implications for AV design and for the creation of public information messages promoting  
28 AVs are suggested. In particular, public information campaigns should emphasise the  
29 freedom to travel that AVs will provide for people who are blind; reassurances concerning  
30 safety; and the inevitability of AVs appearing on the roads of economically developed  
31 countries.

32  
33 **Key words.** Autonomous vehicles, blindness, structural topic model, structural equation  
34 model.

35  
36 **HIGHLIGHTS**

- 37       • Examines attitudes towards autonomous vehicles (AVs) and willingness to travel in  
38       AVs of people who are blind,  
39       • Uses an open-ended structural topic modelling (STM) methodology to identify  
40       attitudes

- 41 • Imports STM results into a structural equation model (SEM) containing variables that  
42 help explain the willingness of people who are blind to travel in an AV
- 43 • Assesses influences of desire for independence, comorbidity, generalised anxiety and  
44 locus of control
- 45 • Offers suggestions for public information campaigns

46

## 47 **1. Introduction**

48 This study examines attitudes towards level 5 autonomous vehicles (AVs) held by people  
49 who are blind. (Level 5 autonomous vehicles are fully autonomous anywhere, not just in  
50 controlled areas [see SAE, 2016].) Grey literature concerning the attitudes of people who are  
51 blind towards such vehicles, and their willingness to travel in them, typically assumes that the  
52 arrival of AVs will be enthusiastically welcomed (see for example Bohonas et al., 2007;  
53 Chapman, 2016; RNIB, 2016; Woyke, 2016; Dearden, 2018). Benefits assumed by this  
54 literature include improved abilities to gain paid employment, to attend entertainment and  
55 leisure activities, to travel door-to-door without assistance, and to avoid the loneliness that  
56 often results from social isolation experienced by people who are blind (O’Day, Killeen and  
57 Lezzoni, 2004), Bezyak, Sabella and Gattis, 2017; Claypool, Bin-Nun.and Gerlach, 2017).  
58 Because people with severe visual impairments cannot drive, they are compelled to rely on  
59 taxis, lifts from family and friends, and on public transport. Crudden, McDonnell and  
60 Hierholzer (2015) noted the frustrations felt by people who are blind that arise from having to  
61 depend on others, in conjunction with fears of possibly having to navigate unfamiliar  
62 environments without assistance.

63 As regards the use of public transport, research as well as casual observation confirms  
64 that public transport is complex and inconvenient for people with severe visual impairment  
65 (Montarzino et al., 2007; Soltani, Sham, Awang and Yaman, 2011; Bezyak et al., 2017).  
66 Buses travel on fixed routes, lifts may be inoperable, bus drivers might fail to announce stops,  
67 timetables can be unavailable and/or unreliable (a problematic issue for blind travellers who  
68 cannot view transit information [Crudden, McDonnell and Hierholzer, 2015]). Attitudinal  
69 issues among drivers or other passengers could also cause problems.

70

### 71 ***1.1 Importance of the issue***

72 One in five UK residents will experience some form of sight loss during their lifetime (RNIB,  
73 2018). At the time of writing two million UK citizens have some form of sight loss “that is  
74 severe enough to have a significant impact on their daily lives, such as not being able to  
75 drive” (p.1). The two million includes 360,000 individuals who are registered with the UK’s  
76 medical authorities as being blind or severely partially sighted. Many more (unregistered)  
77 people will have sight problems that prevent them from driving. UK residents who are blind  
78 are entitled to financial welfare benefits, which can include a contribution to the cost of  
79 travelling (see end note 2). According to RNIB (2018) estimates, there will be 2.7 million UK  
80 residents with a visual impairment by the year 2030 and, due to the rise of diabetes and  
81 obesity, this figure will rise to four million by 2050. In the USA, 2.4% of all 16 to 75-year  
82 olds (7,675,600 people) have a visual impairment and around 1.5 million US citizens are  
83 “totally blind” (see note 1) (NFB, 2017).

84

85 *1.1.1 Policy considerations*

86 People with severe visual impairments constitute a sizeable proportion of the population. It is  
87 essential, therefore, that the voice of this important community be heard in policy debates  
88 regarding the introduction of AVs. Vehicle designs should be configured to render AVs  
89 accessible to people who are blind (Dearen, 2018; Woyke, 2016) and who, according to  
90 Brinkley et al. (2019), need to be involved in the design process *ab initio*. RNIB (2016) also  
91 emphasised the necessity of manufacturers considering the requirements of visually impaired  
92 people at an early stage when developing AVs. Manufacturers should *not* create special  
93 models for blind people, RNIB (2016) argued, as special models (or adaption kits) would be  
94 expensive to produce and their selling prices could be prohibitive for most blind people.  
95 Rather, manufacturers should ensure that their AVs have adequate space for guide dogs and  
96 include voice control facilities (Hong, 2008) and/or tactile interfaces in Braille (Sucu and  
97 Folmer, 2014). Vehicle designs should provide software-controlled voice-overs that state (i)  
98 landmarks along a journey, (ii) which side of a vehicle to exit, and (iii) the presence of  
99 obstacles outside an AV (Adnan, Nordin, Bahrudin and Ali, 2018). Controls for adjusting  
100 air conditioning, changing radio channels, etc., that can be readily operated by people who  
101 are blind need to be built into AV designs (Woyke, 2016). Dearen (2018) observed that  
102 experimental work in US universities has created software apps to deal with many of these  
103 issues that can be downloaded to blind people's smartphones. Technologies also exist to help  
104 blind people overcome spatial and navigational problems via voice messages sent to their  
105 mobile phones, e.g., identification of specific places and landmarks, entrances to buildings,  
106 and nearness of parking facilities (see Bohonas et al., 2007; Brito et al., 2018).

107

108 *1.2. Transportation and people who are blind*

109 The present study considers autonomous vehicles that are fully autonomous anywhere, i.e.,  
110 level 5 AVs (see SAE [2016] for information on different levels of autonomy of driverless  
111 vehicles). This type of autonomous vehicle, according to Brinkley et al (2019), has  
112 "tremendous mobility potential for individuals who are visually impaired" (p. 1). The  
113 advantages of AVs for people who are blind are reported in much of the grey literature on the  
114 topic. RNIB (2016), for instance, noted how distance will no longer be an impediment to the  
115 ability of people who are blind to travel, thus transforming their lives. Use of AVs should  
116 enable people who are blind to participate more fully in society, to reduce social exclusion, to  
117 access education and training more easily (Crudden, McDonnall and Hierholzer, 2015), and  
118 generally to improve their quality of life (Chapman, 2016; Claypool et al., 2017).  
119 Nevertheless, a number of concerns have been voiced regarding the ability of people who are  
120 blind to interact with driverless vehicles. Depending on the age at which a person became  
121 blind, the individual may not have driven before and might be apprehensive about AVs,  
122 especially vis-à-vis their safety (RNIB, 2016). Fears might exist among people who are blind  
123 of, for example, a minor system failure (caused perhaps by malicious hacking [cf.  
124 Sanbonmatsu et al., 2018]) leading to a serious accident (Adnan et al., 2018); of being alone  
125 and helpless following a collision (Easton, 2014), of not knowing how to escape from a  
126 damaged vehicle (Chapman, 2016), of not being able to contact emergency services  
127 following an accident, and of not knowing how to return home from the scene of a collision  
128 (Claypool et al., 2017; Halsey, 2017).

129

130 **2. Contribution of the present study**

131 Although grey literature on the topic suggests that people who are blind will applaud the  
132 advent of AVs, little robust research has been undertaken into the views of blind people  
133 *themselves* about driverless vehicles. A study by Brinkley et al. (2019) did investigate the  
134 issue by inviting 20 blind people to take a “simulated” test drive in an AV within a  
135 laboratory, finding that the simulated test drive helped ameliorate the participants’ feelings of  
136 distrust of AVs. The simulation also improved the test subjects’ beliefs in the usability of  
137 AVs and increased their desire to purchase such a vehicle. Apart from this study, the topic is  
138 largely unexplored.

139 This paper presents the results of an empirical study of the attitudes towards AVs and  
140 willingness to travel in an autonomous vehicle (AV) within a sample of 211 people who  
141 satisfied standard criteria for being blind (see end note 1). It contributes to contemporary  
142 knowledge regarding the attitudes towards AVs of people who are blind, and their  
143 willingness to travel in AVs, via the presentation to a sample of people who are blind of a  
144 completely open-ended question concerning their views on driverless vehicles. The  
145 participants were not given a list of agree/disagree questions about AVs. Rather, a semi-  
146 automated structural topic modelling technique that did not require the construction of a  
147 coding scheme was employed to analyse responses. Themes and issues emerged naturally  
148 from the procedure, which extended to the completion of regressions to relate the outcomes  
149 to the open-ended question to a number of potential explanatory variables. Hence, the study  
150 adds to contemporary knowledge about the transportation needs of people who are blind,  
151 their willingness to accept new modes of transport, and the governmental policies that will be  
152 necessary to introduce people who are blind to driverless vehicles. It presents a novel  
153 methodology for determining attitudes towards new transportation technologies and examines  
154 in a fresh context the usefulness of a number of variables commonly found to predict  
155 attitudes regarding new transportation technologies. Insights provided by the results of the  
156 study offer valuable guidance for the direction of future research in the area.

157 The paper proceeds as follows. Firstly, the paper examines general matters to do with  
158 transportation issues and people who are blind. The methodology of the investigation is  
159 explained, the covariates used in the study are described, and the characteristics of the sample  
160 are specified. Results from the structural topic model and from a structural equation model  
161 are then given. Finally, the results are discussed and a conclusion, statement of limitations,  
162 and suggestions for future research are presented.

163

### 164 **3. Methodology**

165 The study proceeded in three stages. Firstly, the participants were asked an open-ended  
166 question worded “please tell me (or type a statement if the person was replying  
167 electronically) about all the things that come into your mind when you think about driverless  
168 vehicles”. This was followed by a short questionnaire that examined an individual’s  
169 characteristics. The use of a single open-ended question at the beginning of a questionnaire  
170 has a number of advantages. Responses present a direct view of their thinking, there is no  
171 need to devise lists of pre-established questions to explore an issue, and the person is not  
172 cued to think and reply in particular ways (Roberts et al., 2014). Study participants were  
173 drawn from two sources. The first source comprised beneficiaries of a charity (VoSAP-  
174 Specially Able People [www.voiceofsap.com]) that assists disabled people, including  
175 individuals who are blind, in India, the USA and the UK; is expanding internationally; and is  
176 a research collaborator of the United Nations Committee on the Rights of Persons with  
177 Disabilities (UNCRDP). Further participation was secured via a charitable Trust that helps

178 people with disabilities, including people who are blind, in the South East of England. The  
179 Trust owns residential accommodation, operates several charity shops and drop-in centres,  
180 and has an extensive outreach programme.

181 Two hundred and eleven participants were recruited (81 from VoSap), all of whom  
182 were blind (see end note 1). One hundred and six members of the sample had some kind of  
183 computer software for converting text appearing on a computer screen into speech or onto a  
184 Braille printer. These participants answered the open-ended question and the accompanying  
185 questionnaire items online. Sixty-six people were questioned by telephone, the remaining 39  
186 face-to-face at premises owned by the two charities. Both charities depend heavily on  
187 volunteers who furnish assistance to beneficiaries. Initial contact with potential study  
188 participants occurred via these volunteers (who were asked by the management of the  
189 relevant charity to request that an individual take part) or directly by telephone calls made by  
190 the researchers (who confirmed at the outset that the charity's management endorsed the  
191 study). All the beneficiaries of the two charities who were listed as blind were contacted and,  
192 given the organisational ratification of the study, acceptance rates were high: 82% of the  
193 people approached by the volunteers and 74% of those contacted by telephone.

194 If a person was interviewed by telephone or face-to-face the interviewer either wrote  
195 down the reply or recorded the answer on a smartphone. The participant was then asked a  
196 series of questions covering the variables listed in the Appendix to the paper. (When  
197 questioning the respondents, the ethical principles of the Declaration of Helsinki [WMA,  
198 2013] were followed; consent was obtained from subjects according to the procedure  
199 suggested by the WMA.) Answers to the open-ended question gathered face-to-face were  
200 transcribed and entered as narrative text strings into a Vocab character vector in R software  
201 (Roberts, Stewart and Tingley, 2018). Responses procured online were copied and pasted into  
202 the vector, each response comprising a row in the file.

203 Secondly, the responses to the open-ended question were analysed using structural  
204 topic modelling (STM) software (Roberts et al., 2014; Roberts et al., 2018). STM is a semi-  
205 automated machine-learning qualitative research method that identifies latent structures  
206 within responses to an open-ended question. It organises responses into "topics" according to  
207 the homogeneity of the participants' comments relating to each topic. A clustering algorithm  
208 examines the co-occurrence of words across responses and assigns words to various  
209 categories. A certain number of topics (but not their contents) is specified ab initio and the  
210 algorithm computes the probability that a person's response will belong to each topic (e.g.,  
211 15% to topic one; 30% to topic two, etc.; the percentages summing to 100). "Topic  
212 prevalence" figures, i.e., the degrees to which responses belong to various topics, can be  
213 aggregated across individuals. The most frequent and important words arising within each  
214 topic may be specified and the most representative answers reported. To establish the correct  
215 number of topics the model is computed for differing numbers of topics (e.g., two to six) and  
216 the best solution (in terms of internal homogeneity and the greatest level of discrimination) is  
217 selected (for details see Roberts et al. [2014]). Crucially, topics *emerge* from the data and are  
218 not pre-assumed. There is no requirement for the researcher to construct a coding scheme and  
219 hence it is not necessary to predetermine categories and/or dimensions for an analysis or to  
220 specify examples to guide the people completing the coding. Human coding can be  
221 influenced by a researcher's own theoretical position, background knowledge and reading.  
222 Also, human coders may tire and lose concentration. STM *discovers* topics from data rather  
223 than pre-assuming them. The topics that emerge may or may not correspond with a  
224 researcher's original expectations. Similarities and differences with extant theories are  
225 highlighted.

226 STM allows the incorporation of covariates into an analysis (a facility not available  
227 when using factor analysis or latent Dirichlet clustering). Thus, topic prevalence figures for  
228 each participant can be employed as the dependent variable in regressions with covariates  
229 (e.g., age, gender and other personal characteristics) as the independent variables. This can  
230 indicate the extents to which the selected independent variables influence a participant's  
231 specification of topics. Thirdly and finally, a structural equation model (SEM) was  
232 constructed containing variables that help explain the participants' willingness to travel in  
233 AVs.

234

### 235 *3.1. The covariates*

236 In the absence of literature specifically dealing with the topic of the current research, a review  
237 of literature regarding acceptance of new transportation opportunities in general (e.g., electric  
238 cars) and of other new technologies, was undertaken. This revealed a number of frequently  
239 recurring discussions of variables that are potentially relevant for explaining attitudes towards  
240 AVs among people with visual impairments (see for example Egbu and Long, 2012; Rezvani,  
241 Jansson and Bodin, 2015; Bansal, Kockelman and Singh, 2016; Anania et al., 2018;  
242 Acheampong and Cugrullo, 2019). The variables in question often involve personal locus of  
243 control and propensities to experience feelings of anxiety. Literature in the fields of disability  
244 and visual impairment also suggests that the desire for independence is an important  
245 motivating factor where transportation is concerned. Research undertaken by the authors in  
246 relation to transport and various forms of ambulatory and intellectual disability found that  
247 comorbidity and various demographic considerations can affect views regarding new forms  
248 of transport among people with disabilities (Authors, 2018; 2019). Each of these variables is  
249 discussed below.

250

#### 251 *3.1.1 Desire for independence*

252 "Dependence" entails "a desire to be taken care of by others or the ability to lean on others  
253 for support" (Nagurney, Reich and Newsom, 2004 p.215). Independence, conversely,  
254 involves the desire to take care of oneself and to stand alone when dealing with problems.  
255 Dependence on others may result in lack of initiative (Maneli, Sacu, Benesch and Wedrich,  
256 2007; Garaigordobil and Bernaras, 2009), and possibly in depression (Maneli et al., 2007;  
257 Thurston, 2010). This could be especially severe among individuals who lose their sight after  
258 early childhood and then face the task of "internal reorganisation" (Cholden, 1954, p. 207).  
259 Transportation availability has been found to be a major determinant of levels of  
260 independence among people who are blind, and independence is known to be a primary  
261 antecedent of their quality of life (Azenkot et al., 2011). In principle, the availability of AVs  
262 should reduce a blind person's dependence on others and enhance the individual's adaptation  
263 to blindness (Bow, 2001).

264 Individuals have differing feelings of innate need for independence (Nagurney et al.,  
265 2004; Montarzino et al., 2007; Gignac and Cott, 1998; Pomerantz, 2019). Thus, sentiments  
266 regarding AVs, i.e., an innovation that offers a blind person a higher degree of independence,  
267 might be more favourable among people who value their independence most dearly. Self-  
268 perceptions of the levels of independence held by people who are blind vary among  
269 individuals (cf. Wilkin, 1997) and may depend in part on environmental factors (e.g., extent

270 of family support, quality of the person’s [physically adapted] accommodation), and on  
271 people’s self-assessments of how much assistance they need (Gignac and Cott, 1998).

272

### 273 3.1.2 *Locus of control*

274 People who are blind and who possess a high “locus of control” (Rotter, 1966) have high  
275 expectations of their abilities to control events, environments or outcomes (Papadopoulos,  
276 Montgomery and Chronopoulou, 2013). “Internal” locus of control (LoC) refers to the extent  
277 of a person’s belief that events and outcomes are determined by effort and ability; “external”  
278 LoC involves the perception that outside forces substantially determine outcomes. Several  
279 considerations suggest links between LoC and attitudes regarding AVs held by people who  
280 are blind, although the results of studies into the matter have been mixed (see Papadopoulos,  
281 2014 for details of relevant literature). LoC is relevant for the present study for three main  
282 reasons. Firstly, it has been found to predict attitudes and behaviour vis-à-vis travel safety  
283 (Özkan and Lajunen, 2005; Huang and Ford, 2012). Secondly, LoC in general is known to  
284 affect the travel behaviour of people with disabilities (see, for example, Partridge and  
285 Johnstone, 1989; Gruber-Baldini, Jian, Anderson and Shulman, 2009). Thirdly, the construct  
286 is relevant in the present context considering its known connections with intention to use AVs  
287 (see Payre, Cestac and Delhomme [2014] for information regarding this matter).

288 A number of studies of connections between visual impairment and levels of LoC  
289 have concluded that high internal LoC helps visually impaired people to adjust  
290 psychologically and to adapt their behaviour to meet the challenges of loss of sight (see  
291 Papadopoulos, 2014). Papadopoulos (2014) reported significant correlations between being  
292 blind and having low internal LoC, concluding that LoC plays a “crucial role” in a person’s  
293 adjustment to “the daily challenge of living with blindness” (p.671). Stinnette (2009) also  
294 found that the higher an individual’s internal LoC the better the person adapted to vision loss.  
295 Using an AV could be an important part of successful adaptation.

296 Levels of internal LoC can affect the amount of stress that individuals experience in  
297 travel situations (Navaco, Stokols, Campbell and Stokols, 1979), and stress that acts as a  
298 barrier to participation in everyday life might be felt more acutely by people with disabilities  
299 (see Park, Faulkner and Schaller, 2003). Individuals with low internal locus of control may  
300 fear having to use a fresh and untried means of transport, whereas people with high internal  
301 LoC people (who believe that they can exert control over different outcomes of their lives)  
302 might welcome the introduction of AVs (cf. Chiteji, 2010). Research has shown, moreover,  
303 that individuals high on internal LOC are significantly more likely to be open to innovative  
304 ideas, and to be more willing to use new technologies (see McElroy, Hendrickson, Townsend  
305 and DeMarie, 2007). Such considerations imply that people who are blind and have high  
306 internal locus of control might possess attitudes towards AVs that are more favourable than  
307 those of people with low LoC.

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### 309 3.1.3 *Generalised anxiety*

310 Some people experience feelings of deep anxiety more often and more intensely than do  
311 others. Gossling (2017) noted how “anxiety permeates the automotive transportation system”  
312 given that “the automobile is an unsafe space *in itself*” (p.68), and since riding in a vehicle  
313 exposes a person to risk. Anxiety, according to the American Psychiatric Association is “the  
314 apprehensive anticipation of future danger or misfortune accompanied by a feeling of

315 dysphoria or somatic symptoms of tension” (APA, 2000 p.355). It is a distressing condition  
316 and is typically accompanied by frustration and stress. Anxiety is not the same as “fear”,  
317 however, because fear is a direct response to a specific threat whereas anxiety is a longer-  
318 term condition (APA, 2000). The term “generalised anxiety” describes the situation that  
319 arises when people constantly feel anxious about their lives and about a wide range of  
320 situations and issues (NHS, 2018). Generalised anxiety has been found to be especially  
321 common among disabled people who become increasingly dependent on others (Christie et  
322 al., 2017), e.g., for transportation (Holland and Walker, 2015).

323 *Transportation anxiety* can engender feelings of nervousness and discomfort (even  
324 dread) about travelling in a vehicle (Butcher, 2018). In extreme cases transportation anxiety  
325 can involve dystychiphobia (irrational fear of accidents), amaxophobia (irrational fear of  
326 riding in a vehicle), or both. Anxiety relating to transportation is more likely to arise among  
327 people who are generally anxious about life (Cooray and Bakala, 2005; NHS, 2015; MHF,  
328 2018) and perhaps about the safety of new technologies. An international survey of 5000  
329 drivers completed by Kyriakidis, Happee, and de Winter (2015) found AV safety to be a  
330 major concern of the respondents, particularly among individuals high in “neuroticism”. Such  
331 considerations imply that people who are blind and who experience high-generalised anxiety  
332 may possess less favourable attitudes towards the new technology of AVs.

333

#### 334 *3.1.4 Comorbidity*

335 Although there exists limited data on the extent of comorbidity among people with visual  
336 impairment (van Nispen et al., 2009), studies have suggested that various degrees of  
337 comorbidity affect the health, mobility and lifestyles of many people who are blind (see  
338 Crewe, Jones and Kim, 2006). Comingled disabilities affect people’s daily lives in disparate  
339 ways that may involve stress and anxiety (Bogart, 2014). Thus, the attitudes towards a new  
340 and convenient transportation opportunity (such as AVs) of people who are blind and who  
341 have compound disabilities may vary. Individuals with severe comingled disabilities might be  
342 extremely keen to use a novel transportation technology (AVs) that facilitates their capacity  
343 to travel independently (Forber-Pratt, Lyew, Mueller and Samples, 2017).

344

#### 345 *3.1.5 Controls*

346 A priori a number of demographic variables may be expected to influence attitudes towards  
347 AVs. Age is relevant to the investigation because age can impact on physical activities such  
348 as the use of transportation (Topinkova, 2008; DWP, 2018), and older people are more likely  
349 to be socially isolated (RNIB, 2003). Gender was included as it is known that females with  
350 disabilities, inter alia, can be more vulnerable than males to unemployment and social  
351 exclusion (Papworth Trust, 2018). Also, females might have different views to males on the  
352 usefulness of new transportation technologies (see Berliner, Hardman and Tal, 2018; Sener,  
353 Zmud and Williams, 2019). Income category was considered since travel can be expensive  
354 and may be an inhibiting factor on the transportation choices of low-income people with  
355 disabilities (DWP, 2018). A participant’s education level was queried because differing  
356 education levels could be associated with disparate employment experiences and hence  
357 differing transportation needs (ODI, 2015). Ethnicity was considered as individuals from  
358 ethnic minorities are overrepresented within the blind community. People of Afro-Caribbean  
359 heritage are more likely to experience higher levels of glaucoma than other groups;  
360 individuals of Asian heritage have a higher probability of developing cataracts, and members

361 of all UK ethnic minority groups are prone to experience lower levels of general health  
362 (notably diabetes) than white people, and poor general health impedes the ability to travel.  
363 Moreover, according to RNIB (2003), ethnic minority people who are blind tend not to travel  
364 “outside the locality where other ethnic minorities live unless they are accompanied by a  
365 family member or friend” (p.3). The study also queried the main modes of transport used by  
366 the participants and their frequencies of transport.

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### 368 *3.2 The sample*

369 Members of the sample had an average age of 39.4 years (range 18 to 71). Apart from  
370 participants who were blind from birth (16% of the sample), the sample members had been  
371 severely visually impaired for an average of 14.8 years (range four to 44 years). Forty-five  
372 per cent of the sample were male; 22% lived alone, the remainder with a partner and/or with  
373 family members. Forty per cent of the participants were in paid employment; mainly in  
374 professional, administrative or technical occupations (e.g., computer programmers, teachers,  
375 receptionists, telephone sales). Forty per cent of the sample had a post-school educational  
376 qualification. Pilot testing revealed a general reluctance of participants to disclose precise  
377 details of their personal and household incomes. Hence, people’s household incomes were  
378 queried by asking the participants whether they believed their household income to be higher,  
379 lower, or about the same as those of other people (not just blind people). Half the respondents  
380 reported a household income lower than others; 18% stated an income higher than average.  
381 These findings broadly match the profile of UK blind people in general (Hewitt and Keil,  
382 2014; RNIB, 2017).

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#### 385 4. The model

386 The model employed in the present study is shown in Figure 1.

387 **Figure 1. Structural Model**

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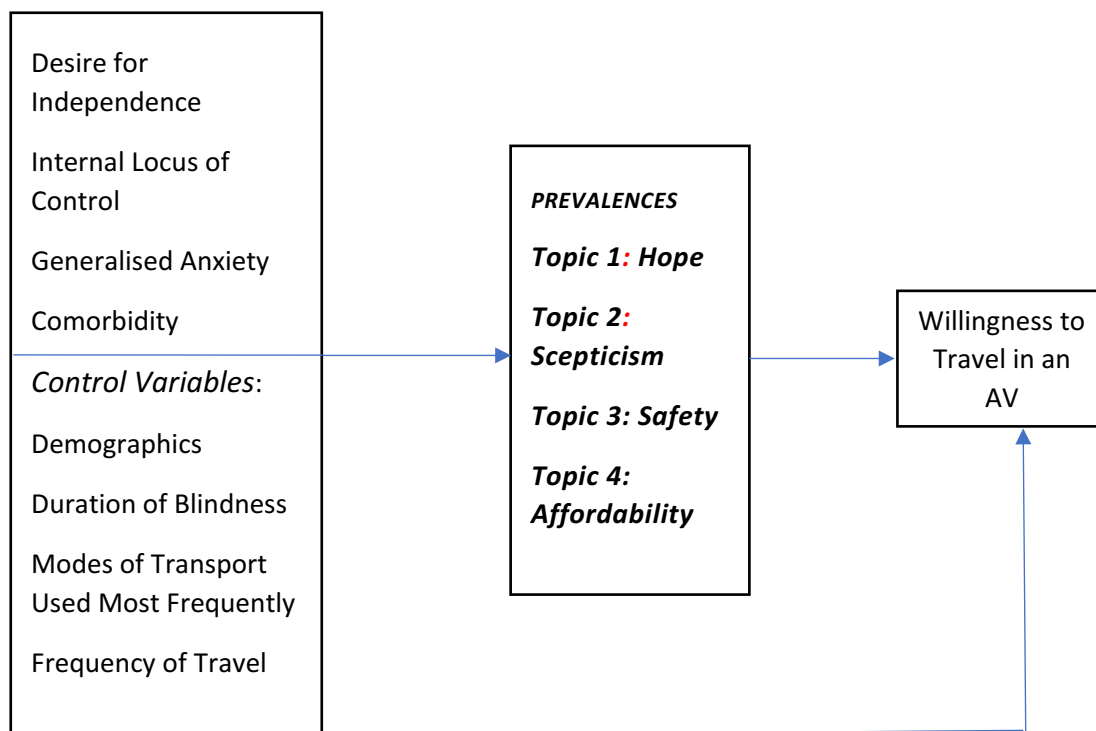
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#### 403 5. Results from the STM

404 Table 1 presents the results from the STM. Models for two to seven topics were estimated, a  
405 four-topic model producing superior results in terms of exclusivity (i.e., topics containing  
406 words with high probabilities of appearing in one topic but low probabilities of appearing  
407 elsewhere) and semantic coherence (i.e., responses within a topic containing very similar  
408 words). The average length of responses to the request worded “tell me about all the things  
409 that come into your mind when you think about driverless vehicles” was 47 words (median  
410 31 words, range ten to 139 words).

411

412 **Table 1. All-sample Topic Prevalence Averages**

<i>Topic number and label</i>	<i>Prevalence (%)</i>	<i>Most common words and phrases*</i>	<i>Representative comment</i>
1. “Hope” (for the future of transportation for people who are blind)	37%	Better future, can’t wait, will improve prospects, will be able to drive, exciting idea, really helpful, AVs are a dream come true	I always dreamt of driving. Thinking about driverless cars, it makes me feel excited and more independent. When I lived in the US, there were places

			where I had to travel with no public transport and cab service. The only option left out was to walk. I would love to have a car. It gives me an immense pleasure even to think about what I will be able to do in the future
2. “Scepticism”	24%	Will not work, misgivings, disbelief, do not trust AVs, unsuitable for people who are blind, suspect they will never happen, unproven technology, can’t be introduced	We ( <i>people who are blind</i> ) always lose out on things like this. I’ll believe it when it happens, and if it does they won’t be made suitable for us. I don’t trust these people ( <i>state agencies responsible for people who are blind</i> ), we get kicked around and end up with the rubbish ( <i>transportation methods</i> ). I’m sceptical about the entire thing
3. “Safety” concerns	21%	Dangerous, accidents ( <i>fear of</i> ), entry/exit obstacles, scary, other traffic ( <i>and accidents</i> ), too frightened to travel, unsafe	The idea scares me stiff. Collisions with other ( <i>conventional</i> ) vehicles will happen all the time – you travel at your peril in one of these things. The software is bound to fail and then what? How can a blind person cope with an accident or if the car just stops working? Suppose the car knocks somebody down, who’s to blame and who will be there to sort things out? The ( <i>AVs</i> ) are a lot too risky for a blind person like me
4. “Affordability” of AVs	18%	High price, travel allowance ( <i>state welfare payment</i> ) will not cover cost, pricey, too expensive, would need to cut down on other things, not worth the price, beyond the budget of people who are blind	They cost an arm and a leg, don’t they? I would have to sacrifice so many other parts of my life to be able to buy one. It’s an extravagance that few blind people could afford and anyway they might not be worthwhile considering how many taxi rides I can get with that amount of money. Even if I

			bought one it would have to be adapted and I'll bet that adaption kits will be very expensive and certainly not within the ( <i>financial</i> ) grasp of any ( <i>blind</i> ) person that I know
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413 \*The words and phrases shown are summary interpretations of the many words and phrases  
414 used to describe these feelings.

415

416 The major topic prevalence related to the “hope” for the greater freedom and independence  
417 that the use of an AV would bring. Responses in this category included statements that “I  
418 must start saving up to buy one”, “they will liberate our lives” and “how I would love to own  
419 one”. “I will be able to navigate with pinpoint accuracy, currently I get lost at least once a  
420 week,” opined one of the respondents. Conversely, the second topic prevalence displayed a  
421 considerable degree of scepticism towards AVs, extending to doubts about the feasibility of  
422 AVs and to whether they will accommodate the needs of people who are blind. Concerns  
423 included the possible unwillingness of manufacturers to modify AVs for people who are  
424 blind and of vehicle controls being inappropriate. Topic three involved concerns about the  
425 safety of AVs, e.g., of being alone and helpless in the event of an accident, and of not having  
426 access to first aid facilities. Topic four contained expressions of concern about the cost of  
427 leasing or buying a driverless vehicle and of the government not helping them to meet the  
428 cost of leasing or buying a vehicle (see end note 2).

429

### 430 **5.1 Analytical procedures**

431 Response figures for the four topic prevalence variables were employed in a structural  
432 equation model (SEM) containing variables intended to explain topic prevalence allocations  
433 and designed to relate the topic prevalence allocations to the sample members’ willingness to  
434 travel in an AV. The model was estimated using the method of partial least squares (PLS),  
435 because PLS does not impose any requirements regarding the distributions of independent  
436 variables and since the study involved “theory building” rather than “theory testing”. Figure 1  
437 assumes that the covariates affect willingness to travel via the mediating variables, and  
438 possibly exert direct effects independently of the mediators.

439

#### 440 **5.1.1 Measurement of variables**

441 Internal locus of control was measured using seven items based on the Pearlin Mastery Scale  
442 (Pearlin and Schooler, 1978), a scale that has been used extensively in healthcare and  
443 disability contexts (e.g., Eckland, Erlandsson and Hagell, 2012). The scale items assess the  
444 degree to which individuals perceive themselves to be in control of forces that significantly  
445 affect their lives. “Mastery” has been found to provide a protective buffer for an individual’s  
446 mental and physical health and well-being when facing persistent life stresses, e.g., severe  
447 visual impairment. Responses to the seven items were factor analysed, a one-factor solution  
448 emerging ( $\lambda=5.69$ ; Cronbach’s  $\alpha=.89$ ). Tendency to experience generalised anxiety  
449 was evaluated via Spitzer, Kroenke and Williams’ (2006) short-form seven-item “Hopkins  
450 Anxiety Proneness Scale”, a factor analysis of which produced a single-factor solution

451 explaining 82% of total variance ( $\alpha=.89$ ). Desire for independence was assessed through  
452 five items adapted from Nagurney et al. (2004). Four items adapted from Konig and Neumayr  
453 (2017) were employed to assess willingness to travel in an AV ( $\lambda=3.28$ ,  $\alpha=.86$ ).  
454 Four items based on Forber-Pratt et al. (2017) was used to measure perceived intensity of  
455 disability ( $\lambda=3.5$ ,  $\alpha=.90$ ). Apart from factual queries all items were scored using  
456 five-point agree/disagree scales. (Five rather than seven or 10-point scales were employed  
457 because the respondents were blind and had to listen to the instructions accompanying the  
458 questions or to read them in Braille.)

459 A questionnaire was constructed (see the Appendix) containing the open-ended  
460 question, the above items, and a number of socio-demographic queries. This was discussed  
461 with two senior managers in each of the charities collaborating with the investigation and  
462 with two senior academics in the disabilities studies domain. This resulted in minor  
463 adjustments to the wordings of certain items. The document was then pre-tested face-to-face  
464 on seven people in the first of the participating charities, and then via an online distribution to  
465 30 individuals. Nearly all the respondents reported that they relied on lifts from friends and  
466 family “all the time” or “very often”, and very few used taxis. The only “mode of travel”  
467 variable for which there was substantial variation was the degree to which a participant used  
468 public transport. Hence this variable was used to reflect “mode of travel” (see the Appendix).  
469 The ethnicity measure was based on a simple question as to whether the participant was white  
470 or non-white. People blind from birth will have been told this, but are unlikely to want to  
471 enter into further and more detailed discussions regarding their ethnicity. A binary variable  
472 was formed from the information on ethnicity that was provided. The pre-test of the  
473 questionnaire asked participants to place their household incomes into categories ranging, in  
474 £6K divisions, from £15K to £95K or above. However, the respondents were often unable or  
475 unwilling to give a figure. Also, some people lived in sheltered accommodation where the  
476 concept of “household income” has little meaning. Therefore, the sample members were  
477 requested to state whether they regarded their household income to be higher than that of  
478 most other people; lower; or about the same as that of most other people.

479

## 480 **6. Results from the structural equation model**

481 Table 2 gives the results of the regression analysis. It can be seen from Table 2 that  
482 willingness to travel in an AV was influenced positively and significantly by the “hope for  
483 the future” variable and negatively and significantly by concerns for safety and misgivings  
484 about affordability. Significant direct effects on willingness to travel occurred in relation to  
485 desire for independence, internal locus of control, generalised anxiety and the presence of  
486 comorbidity. (All the variance inflation factors for the variables shown in Figure 1 had a  
487 value less than five, indicating the absence of serious multicollinearity.) As regards the  
488 mediating variables, “hope” was affected positively and significantly by desire for  
489 independence, locus of control, the presence of comorbidity, extent of use of public transport,  
490 and frequency of travel. “Scepticism” was influenced negatively and significantly by locus of  
491 control and comorbidity and positively by generalised anxiety. “Safety” concerns were  
492 impacted positively and significantly by generalised anxiety and negatively by locus of  
493 control. None of the variables in the model had a significant effect on “affordability”.

494

495

## 496 **Table 2. Regression Results**

497

498

<i>Explanatory variables</i>	<b>Dependent variables</b>				
	Topic 1 Prevalence: Hope	Topic 2 Prevalence: Scepticism	Topic 3 Prevalence: Safety	Topic 4 Prevalence: Affordability	Willingness to Travel in an AV
Topic 1 Prevalence: Hope					.39 (3.99)** (.000004)
Topic 2 Prevalence: Scepticism					-.11 (1.01) (.157)
Topic 3 Prevalence: Safety					-.33 (3.88)** (.000071)
Topic 4 Prevalence: Affordability					-.28 (2.69)** (.004)
Desire for Independence	.31 (2.65)** (.004)	.07 (.019) (.492)	-.19 (1.44) (.076)	-.11 (1.47) (.456)	.31 (2.99)** (.001)
Internal Locus of Control	.36 (3.95)** (.000054)	-.27 (2.11)* (.018)	-.37 (3.16)** (.001)	-.12 (.099) (.461)	.28 (3.00)** (.001)
Generalised Anxiety	.14 (1.48) (.070)	.29 (3.09)** (.001)	.29 (3.07)** (.001)	.09 (.101) (.459)	-.26 (2.09)* (.012)
Comorbidity	.29 (2.55)** (.006)	-.26 (2.55)** (.006)	-.14 (.005) (.148)	.11 (1.00) (.159)	.24 (2.18)* (.013)
Age	-.17 (1.22) (.112)	.10 (1.22) (.112)	.18 (1.08) (.141)	-.03 (.006) (.476)	.10 (1.10) (.460)
Gender	.06 (0.33) (.371)	-.14 (1.16) (.124)	.90 (0.34) (.367)	.10 (.090) (.464)	.07 (.060) (.476)
Income	.11 (1.11) (.464)	-.05 (.080) (.468)	.05 (.080) (.468)	.06 (.090) (.464)	.17 (1.25) (.106)
Education	.15 (1.22) (.112)	-.10 (1.08) (.141)	-.03 (.061) (.476)	.14 (1.15) (.126)	.16 (1.04) (.150)
Ethnicity	.10 (1.11) (.134)	.15 (1.50) (.068)	.06 (.090) (.464)	.15 (1.44) (.076)	.09 (.090) (.464)
How Long a Person has Been Blind	.19 (1.47) (.071)	-.03 (.080) (.468)	.16 (1.51) (.066)	.14 (1.50) (.068)	.07 (.090) (.464)
Mode of Travel	.24 (2.19)* (.015)	.08 (1.04) (.150)	.08 (1.10) (.136)	-.03 (.040) (.484)	.02 (.040) (.484)
Frequency of Travel	.25 (2.39)** (.009)	.10 (1.10) (.136)	.09 (1.00) (.159)	.06 (.090) (.464)	.06 (.080) (.468)
R <sup>2</sup>	.40	.30	.27	.13	.45
Adj. R <sup>2</sup>	.36	.26	.23	.08	.40

499 *T-values and probability levels in parentheses. \*Indicates significance at the .05 level or*  
500 *below; \*\*at the .01 level or below.*

501

## 502 7. Discussion

503 Demographic variables failed to influence any of the dependent variables, a finding not in  
504 accord with the outcomes of some (but not all) prior research which found that lower age,  
505 male gender and higher level of education affected positively the perceptions of AVs held by  
506 people with (general) disabilities. However the results of studies have been mixed, and often  
507 inconclusive (for details of relevant literature see Hulse, Xie and Galea [2018]; Berliner et al.  
508 [2018]; Liljamo, Liimatainen and Pollanen [2018]; Sanbonmatsu et al. [2018]; Sener et al.,  
509 2019). A possible reason for the present outcomes is that, for most people (blind or sighted),  
510 AVs represent a completely new and untried technology, irrespective of whether a person is  
511 young or old, male or female, financially well-off or poor, or whether visual impairment was  
512 incurred at birth or in later life. It is clear from Table 2 that three independent variables  
513 exerted powerful effects on the mediating topics: comorbidity, locus of control, and  
514 generalised anxiety. Additionally, the “hope for the future” mediator depended substantially  
515 and significantly on a participant’s desire for independence. This last result suggests the  
516 desirability of incorporating information about the liberating potential of AVs in public  
517 campaigns intended to secure acceptance of AVs among people who are blind.

518 Comorbidity, which is associated with the presence of one or more extra disabilities,  
519 will typically mean that an individual requires greater amounts of help with transportation,  
520 and will be more dependent on other people and on state and private support services. People  
521 with comorbidities often need large amounts of help with daily tasks and, in consequence it  
522 seems, were more enthusiastic than others about the liberating aspects of AVs. These  
523 individuals were also less sceptical and less concerned about the safety aspects of AVs. The  
524 use of public transport might be highly problematic for people with comorbidities.  
525 Individuals who are blind and who have other disabilities might experience higher levels of  
526 social isolation and possibly may need to travel to health care providers more frequently (see  
527 Fried et al., 2004 for a discussion of these issues). AVs may offer a great deal to people who  
528 are blind *and* who have another disability, in terms of greater freedom to travel and general  
529 improvements in their quality of life. It follows that public information campaigns directed at  
530 people who are blind should include messages aimed specifically at people with  
531 comorbidities. The freedom enhancing dimensions of AVs should figure prominently in  
532 campaigns.

533 High internal locus of control influenced all the topics except for affordability, thus  
534 confirming the critical role of locus of control in the attitudes and behaviour of people who  
535 are blind (cf. Özkan and Lajunen, 2005; Huang and Ford, 2012; Papadopoulos, 2014).  
536 Possession of a high internal locus of control indicates a belief in being able to control one’s  
537 life (i.e., having high self-efficacy vis-à-vis critical activities) and hence to be competent to  
538 operate a new technology (such as AVs) to one’s own advantage and to control a driverless  
539 vehicle successfully. Locus of control is likely to affect how a person who is blind will react  
540 to information regarding the safety and feasibility of AVs (Srinivason and Tikoo, 1992;  
541 Venkat and Ogden, 2002) and the capacity of AVs to contribute to independent living. High  
542 locus of control will normally be associated with favourable responses to such information  
543 (and possibly with a desire actively to search for information [Venkat and Ogden, 2002]).  
544 Research has found that individuals with high locus of control tend to be more receptive to  
545 positive marketing messages and hence to be easier to influence, provided that they are  
546 interested in the product or activity (McCarty and Schrum, 2001). Past studies have found  
547 that “self- efficacy expectations” can be manipulated and strengthened within health-related  
548 contexts (Smith, 1989, p. 230; see also Chung, Preveza, Papandrea and Prevezas, 2006;  
549 Jacobs-Lawson, Waddell and Webb, 2011). Accordingly, self-efficacy expectations might be

550 bolstered among people who are blind and who are low in internal locus of control by  
551 communicating to them the ease with which a blind person will be able to understand and  
552 control AVs, the minimal effort required and the reliability and dependability of AVs.

553 High levels of generalised anxiety had a significantly positive effect on scepticism  
554 and safety, and a negative impact on willingness to travel in an AV. Clearly, therefore, public  
555 information messages targeted at people who are blind should include messages designed to  
556 assuage anxieties and to emphasise the safety features of AVs (cf. Konig and Neumayr,  
557 2017). Konig and Neumeyr (2017) suggested that AVs should be introduced gradually and  
558 with much publicity in order to increase trust and to assuage people’s worries about the safety  
559 of driverless vehicles. Thus, information campaigns might usefully include scenarios that  
560 systematically educate people with high generalised anxiety about the ease of use of AVs and  
561 the low risk of accidents that AVs entail. Safety measures could be described (cf. Titov et al.,  
562 2013) and various travel scenarios examined in order to build confidence among people who  
563 experience generalised anxiety (Gale and Davidson, 2007).

564 Scepticism did not significantly predict willingness to travel in an AV, indicating that  
565 a person who is blind may be sceptical of the introduction of AVs yet still be favourably  
566 inclined towards them. It may be that, in the present context, scepticism matches a general  
567 cynicism regarding any new initiative aimed at people who are blind and which involves their  
568 welfare. Research completed in the USA has suggested that people who are blind “face  
569 special challenges in obtaining care that is safe, effective, timely and patient centred” (O’Day  
570 et al., 2004). Similar sentiments have been expressed in the UK vis-à-vis governmental  
571 support for people with visual impairments (see RNIB, 2019). Participants who used public  
572 transport extensively (the measure of the “mode of transport” variable) welcomed the  
573 “freedom-enhancing” dimension of AVs, as did people who travelled very frequently.

574

## 575 **8. Conclusion**

576 Attitudes of the participants towards AVs were characterised by four constructs: hope that  
577 AVs will enable people who are blind to travel more freely, extensively, conveniently and  
578 independently; scepticism regarding the likelihood that AVs will *actually* be configured in  
579 manners that help people who are blind; and concerns about safety and the affordability of  
580 AVs. Participants with high levels of desire for independence welcomed the prospect of  
581 travelling in AVs, which were seen to offer exciting opportunities to travel to places not  
582 previously accessible to people who are blind. These results were obtained from the un-  
583 prompted responses of the study participants to an open-ended question. The methodology of  
584 the study did not presume any particular patterns of output. Thirty-seven per cent of the  
585 present sample directly expressed positive views about AVs, with 45% being sceptical or  
586 holding reservations about safety. This figure of 37% is comparable to that obtained in a  
587 survey completed by Howard and Dai (2014), who reported that 37% of the respondents were  
588 “comfortable” with the idea of AVs. An international survey of 8862 people undertaken by  
589 Bazilinsky, Kyriakidis and de Winter, (2015) concluded that 29% of the participants could  
590 be described as possessing a positive attitude to AVs, with 18% revealing negative attitudes.  
591 Haboucha, Ishaq and Shifan’s (2017) study of 721 US and Israeli drivers found that at least  
592 44% of the sample had severe hesitations about using an AV. Other surveys have produced  
593 similar results (see Authors, 20XX). Thus, the outcomes to the present study reinforce the  
594 observation of Konig and Neumayr (2017) that for all groups, including people who are  
595 blind, “the widespread acceptance and hence adoption of this new technology is far from  
596 certain” (p. 42).

597 The results of the present study have a number of implications both for the  
598 manufacturers of AVs and for state policy makers and agencies. Public information  
599 campaigns and manufacturers' advertisements will (in the near future) be needed to secure  
600 public acceptance of AVs (see Sanbonmatsu et al., 2018), including acceptance by disabled  
601 communities (Harper, Hendrickson, Mangones and Samaras 2016). This will require some  
602 degree of segmentation of target audiences and of messages. Acheampong and Cugurullo  
603 (2019) observed how public acceptance will depend on approval by "a complex network of  
604 heterogeneous potential users who possess different attitudes, perceptions, motivations,  
605 preferences, socio-demographic attributes and mobility needs" (p. 350). Government  
606 agencies will be tasked with supplying useful and persuasive information about AVs to user  
607 communities of people with disabilities alongside the promotional communications of  
608 manufacturers. Hence, state agencies need to know the sorts of message that will be most  
609 effective for persuading people who are blind to accept AVs. The results of the current  
610 research provide valuable insights into the use of AVs by people who are blind and offer a  
611 template of factors that government agencies should emphasise when formulating public  
612 information campaigns aimed at people who are blind and when communicating with them  
613 directly in order to secure their acceptance of driverless vehicles. Specifically, the outcomes  
614 suggest that communications aimed at people who are blind need to emphasise the freedom  
615 and independence that AVs will provide, their safety features, and the fact that AVs are  
616 irrefutably the future of road transportation. As regards concerns about affordability, it is  
617 relevant to observe that consequent to mass production AVs should be cheap compared to  
618 conventional vehicles, due to their simple construction (Alves, 2017). Disability charities  
619 have a pivotal role to play in spreading constructive information about AVs to their  
620 constituencies.

621 Furthermore, government policies will be required vis-à-vis AV road and traffic  
622 layouts and traffic regulations appropriate for people with disabilities, including people who  
623 are blind (Herrmann, Brenner and Stradler, 2018). Consideration should be given to special  
624 requirements for people who are blind in relation to entrance and exit facilities of AVs;  
625 internal vehicle control features, user-friendly methods for recharging AV batteries, self-  
626 parking systems and vehicle retrieval systems, etc. It is important, therefore, that the  
627 representative organisations of people who are blind be involved *from the outset* in public  
628 debates about the future of transportation, and specifically about the creation of policies and  
629 regulations (Harper et al., 2016; Lu et al., 2017). State agencies' knowledge of the views  
630 concerning AVs of people who are blind will, according to Herrmann et al. (2018), help state  
631 agencies to develop and implement appropriate and effective policies on disability-friendly  
632 road and traffic layouts and systems. Claypool et al. (2017) argued that "it is imperative that a  
633 broader disability community coalesce around a constrained set of policy recommendations"  
634 concerning AVs if social inclusion is to be improved in the transportation sphere (p.7).

635 Governments could encourage early take up of AVs by offering incentives to people  
636 who are blind and who are considering leasing or buying a driverless vehicle. In the UK,  
637 physically disabled citizens with severe mobility problems qualify for financial mobility  
638 allowances with values up to and including the cost of adapting or leasing a new vehicle. At  
639 present, UK residents who are blind receive a tax allowance, but since they cannot drive, do  
640 not enjoy a separate mobility allowance. Consequent to the introduction of AVs, blind and  
641 ambulatory disabled people in principle should in principle have equal access to mobility  
642 allowances, although extending allowances to the UK's 360,000 people who are registered  
643 blind would be a heavy burden on the government's welfare budget. As an alternative to  
644 leasing or buying, AVs might become an on-demand shared service for people who are blind  
645 (Fragnant and Kockelman, 2015); with free-floating car sharing or trip sharing door-to-door

646 AV systems wherein a person can summon “Uber-style” a (possibly shared) AV (Anania et.  
647 al, 2018 p.220). Charities concerned with visual impairment have an important role to play in  
648 lobbying government to make transportation allowances available to people who are blind.

649

### 650 *8.1 Limitations and areas for future research*

651 The study used a convenience sample of a size constrained by the time and financial  
652 resources available for the investigation. However, the researchers did not target participants  
653 with any particular characteristics and there is no reason to expect selection bias or  
654 overrepresentation of people with particular traits (cf. Etikan, Musa and Alkassim, 2016).  
655 There are no a-priori grounds for believing that the participants would have wanted to  
656 misrepresent their views about AVs and, in the present study, it would not have been  
657 appropriate to present the participants with a frame of reference to help them answer the  
658 open-ended question. Outcomes to the study provide information on variables considered  
659 important as determinants of attitudes towards AVs among people who are blind. This  
660 information will be useful for future studies.

661 An issue with all methodologies based on open-ended interviews is that different respondents  
662 may interpret a question in disparate ways, and reply at different lengths and with disparate  
663 levels of enthusiasm. Fundamental attitudes might not be revealed. On the other hand, open-  
664 ended responses avoid the biased responses that can arise from the cues implicit in structured  
665 questioning. In the present study, the authors examined all the responses to identify obvious  
666 absurdities, none actually arising. Replications of the investigation in other countries and  
667 cultures would be valuable, perhaps using the evidence base provided by the present  
668 investigation. Generalised anxiety is a wide-ranging construct with several dimensions.  
669 Examinations of the influences of various aspects of generalised anxiety on the attitudes  
670 towards AVs of people who are blind would be worthwhile. Also, the effects of personality  
671 traits other than those covered by the present study could usefully be investigated. In  
672 addition, the construct of “affordability” deserves further study within the AV and disability  
673 context. Affordability might be self-assessed relative to a person’s income, to total wealth, to  
674 expected future income or wealth, or to the extent that a purchase means having to make  
675 sacrifices elsewhere. It is, according to Garner, Stinson and Shipp (1996), a subjective  
676 measure with many facets and psychological manifestations.

677 Despite these limitations, the study adds substantially and significantly to knowledge  
678 concerning the possible responses to the introduction of level 5 AVs of people who are blind.  
679 So far, developments in the AV domain have focused on the mechanical functions of  
680 vehicles, but soon the human aspects of AVs will require attention, including consideration of  
681 people with disabilities such as people who are blind. Outcomes to the investigation show a  
682 distinct segmentation of attitudes among the present sample of people who are blind, and  
683 these results offer a platform for the construction of messages to be directed towards this  
684 particular consumer group. Specifically, the outcomes indicate the touch points most likely to  
685 encourage people who are blind to want to travel in level 5 AVs. Messages based on concepts  
686 of freedom, independence, and greater ability to control one’s own life should have higher  
687 probabilities of influencing people who are blind to accept AVs. Similarly, promotions that  
688 emphasise the safety aspects of AVs will seemingly be effective in assuaging the anxieties of  
689 potential AV passengers who are blind. Moreover, the results suggest that campaigns  
690 segmented simply with respect to demographics are unlikely to succeed.

691

692 **End notes**

- 693 1. The USA regards anyone with visual acuity of 20/200 as “legally” blind. UK  
694 authorities define people to be “legally blind” if they cannot see very well even with  
695 the best corrective lenses (RNIB, 2018). There is no internationally accepted  
696 definition of “severe visual impairment”. The WHO (2015) describes “visual  
697 impairment” as a “decreased ability to see that causes problems *not* fixable by usual  
698 means, e.g., glasses.
- 699 2. UK citizens who are blind receive an automatic tax allowance and are eligible for a  
700 range of welfare benefits. At present, *physically* disabled UK citizens who have  
701 significant mobility problems qualify for financial mobility allowances with values up  
702 to and including the cost of adapting or leasing a new vehicle. Since AVs enable blind  
703 people to operate a vehicle even though they cannot drive, the same financial  
704 assistance should in principle become available to people who are blind.

705

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## 973 **APPENDIX: THE QUESTIONNAIRE**

974

### 975 **General**

976 How often do you use transportation – daily; 3 or 4 times a week; once a week; once every 2  
977 weeks/3 weeks/four weeks/less than once a month?

978

- 979 What is your location (city or town centre; city or town suburb; rural area)?  
980
- 981 How long have you been blind? (1 to 3 years; 4 to 6 years; 7 to 9; 10 to 12; more than 12;  
982 “All my life”)?  
983
- 984 Gender: male/female  
985
- 986 Age (17-22; 23-28; 29-34; etc. up to “75 and above”)  
987
- 988 Income category: Household income regarded as (i) higher than that of most other people, (b)  
989 about the same as most other people, (c) lower than that of most other people.  
990
- 991 Do you have a post-school qualification (post-graduate; degree/post-school  
992 diploma/professional qualification; matriculation qualification; none of the above)?  
993
- 994 How do you usually travel (six-point scale: All the time, very often, occasionally, very  
995 occasionally, hardly ever, never): I get lifts from family/friends; I get taxis; I use public  
996 transport; I walk?
- 997 **Comorbidity**
- 998 Apart from being blind do you have a physical disability that (five-point scales: 5 = strongly  
999 agree; 1 = not applicable, I do not have a physical disability):
- 1000 (a) Requires a lot of help to move around inside my house  
1001 (b) Requires a lot of help with self-care (dressing, bathing, etc.)  
1002 (c) Requires a lot of help with shopping, housework, laundry, etc.  
1003 (d) Greatly impedes my ability to travel?  
1004
- 1005 **Hopkins Anxiety-proneness Checklist (Measure of Generalised Anxiety)**
- 1006 (a) I often suddenly feel scared for no reason  
1007 (b) I often feel fearful  
1008 (c) I often feel nervous and shaky inside  
1009 (d) I often feel tense or keyed up  
1010 (e) I often have spells of panic  
1011 (f) I spend a lot of time worrying about things  
1012 (g) I often feel afraid that something awful might happen  
1013
- 1014 **Pearlin Mastery Scale (Measure of Internal Locus of Control)**
- 1015 (a) There is really no way I can solve some of the problems I have  
1016 (b) I often feel that I am being pushed around in life  
1017 (c) I have little control over the things that happen to me  
1018 (d) I can do just about anything I really set my mind to  
1019 (e) I often feel really helpless in dealing with the problems of life  
1020 (f) What happens to me in the future mostly depends on me.  
1021 (g) There is little I can do to change many of the important things in my life  
1022
- 1023 **Desire for Independence**

- 1024 1. It is very important for me to retain my independence  
1025 2. It is very important for me to work through my problems by myself  
1026 3. I enjoy being taken care of by others (RS)  
1027 4. I would rather have others take care of things for me because it's easier  
1028 5. I don't like having to tackle my problems on my own  
1029

1030 **Willingness to Travel in an AV**

- 1031 (a) I would be willing to travel in an AV  
1032 (b) I would not want to travel in an AV for everyday use, only for special occasions  
1033 (c) I would be delighted to travel in an AV  
1034 (d) The prospect of travelling in an AV does not appeal to me at all  
1035  
1036  
1037