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WILLINGNESS OF PEOPLE WITH SEVERE VISUAL IMPAIRMENTS TO ACCEPT NEW TRANSPORTATION ASSISTIVE TECHNOLOGIES

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ABSTRACT

BACKGROUND: Technology-driven assistive devices provide numerous benefits to people with severe visual impairments, yet device take-up rates are often low. OBJECTIVE: The study sought to determine the strengths of connections between transportation self-efficacy, technophobia, personal inertia, innovation resistance, and willingness to adopt high-tech transportation assistive devices among visually impaired individuals. It also examined certain potential barriers to device acceptance; namely the perceived safety and complexity of assistive devices and the effects on a person's self-image of using a device. METHODS: A model was developed and tested via a questionnaire survey of 319 people with visual disabilities, each of whom was presented with five examples of hypothetical high-tech mobility and transportation assistive devices. RESULTS: Technophobia exerted a powerful negative impact on innovation resistance and was itself significantly determined in part by transportation self-efficacy. Personal inertia and the effects of device use on self-image failed to impact significantly on the participants' levels of innovation resistance. CONCLUSION: The results have implications for the promotional activities of manufacturers of mobility and

transportation assistive devices and for visual disability support organisations that wish to secure acceptance of new assistive devices.

Key words: visual impairment, assistive technologies, transportation self-efficacy, innovation resistance, technophobia, personal inertia.

1. Introduction

The research reported below sought to determine major reasons for the non-adoption of new transportation assistive devices among people with “severe” visual disability, i.e., with impairments that result in complete, or very severe, loss of vision (WHO, 2015, see end note 1). One in five UK residents will experience some form of sight loss during their lifetime, and two million have some form of sight loss that is severe enough to impact significantly on their daily lives (NHS, 2021). According to RNIB (2018), 2.7 million UK residents will have substantial visual impairments by the year 2030 and, due to the rise of diabetes and obesity, this is forecast to rise to four million by 2050. The USA has approximately 12 million people aged 40 years and over with vision impairments, including 1.2 million citizens who are blind (CDC, 2020). Worldwide an estimated 2.2 billion individuals have a near or distance vision disability (WHO, 2021). “Assistive devices”, in the current context, involve “technologies, equipment, apparatus, services, systems, processes and environmental modifications that enable people with visual impairments to overcome various physical, social, infrastructural and accessibility barriers to independence” (Paredes, Fernandes, Martins and Barroso, 2013 p.81). They increase a visually impaired individual’s ability to “live an active, productive and independent life as an equal member of the society” (Bhowmick and Hazarika, 2017 p.149), especially vis-à-vis accessing information and improving mobility (Manduchi and Coughlan, 2012; Claypool, Bin-Nun and Gerlach, 2017).

Despite recent increases in the availability of high-tech assistive devices (typically associated with mobility and transportation [see Giampapa, 2017]) to people with severe visual impairments (Fact. MR, 2022; TMR, 2022), take-up rates of devices have often been low. For instance, a study completed by Federici and Borsci (2011) estimated the incidence of device non-adoption to be around 25%. An investigation by Roentgen, Gelderblom, Soede, and de Witte (2009) put this figure at 47%, while Gitlin's (1995) sample of older visually impaired individuals found that 50% chose not to use new and free-of-charge assistive devices. Other estimates of rates of non-adoption vary from 53% (Blasch and De l'Aune, 1997) through to 75% (see Riemer-reiss and Wacker, 2000). Federici, Meloni and Borsci's (2016) review of literature concerning non-adoption of assistive devices by people with disabilities in general concluded that abandonment rates averaged 30% one-year following device delivery. This figure of 30%, Federici et al. (2016) continued, is often used by researchers as the threshold to define a "high" rate of abandonment. Such findings are unfortunate, considering the capacity of assistive devices to improve the quality of life of people with visual impairments.

2. Transportation assistive devices for people with severe visual impairments

High-tech devices in the transportation field have related mostly to mobility, public transport, object identification, navigation, access to transport information (particularly information on printed materials), and interactions with service providers at transport terminals (Terven, Salas and Raducanu, 2013). Global positioning systems that give voice commands to blind users on a smart phone app have been available for many years (Gianoglio, 2017), although the received signals can be inaccurate and many systems will only work outdoors. Thus, "beacon" technologies based on small transmitters placed in and around buildings, railway stations and bus stops have been developed which send real time travel information to mobile devices. Messages are transmitted about the locations of bus stops and/or train platforms, routes, schedules, terminal exits and entrances, and where and how to find an assistance provider (Gianoglio, 2017; Sobnath and Rehman, 2019). Bluetooth based beacon systems have been successfully tested in Warsaw and on the London Underground (Euklidiadas, 2021). Wearable smart systems have been created that comprise a microcontroller board, sensors, a cellular network, and a solar panel capable of tracking a person's path that (through wrist vibrations) generates alerts about routes and obstacles (Ramadhan, 2018). Mandal and Chandran (2020) designed a wearable "blind shoe" that provides directional information to visually impaired people via ultrasonic sensors that detects nearby obstacles and alert the wearer. Wearable glasses have been manufactured which translate images of physical objects into sounds and then partially enable an individual to construct real-time interpretations of local environments (Merrifield, 2017; Al-Heeti, 2020).

A lightweight navigational robot has been invented to take a visually impaired person by the hand and steer the individual through an airport, providing information on flight delays and gate changes (Harrison, 2018). The robot moves independently using a camera that detects and measures distances to objects. A message will instruct the user to lift the robot whenever stairs are encountered. Similarly, a four-legged "robotic dog" on a hand-held leash has been developed to mimic the actions of a live guide dog (Majeed, 2021). The robotic dog carries a laser mapping system which determines the best route for its handler, cameras, and sensors for avoiding obstacles.

3. Reasons for rejection

Factors encouraging non-adoption could involve cost (Kim, Kim and Kim, 2006; Calder, 2009) (in the UK two-thirds of all blind people live in low-income households [see Dailly, 2012]), excessive complexity (Arthanat et al., 2007), unsuitability for indoor use (e.g., picking up unwanted ambient echoes), and concerns about a device's safety during use

(Ahmed et al., 2017). Also, a device could make a person negatively self-conscious (Arthanat et al. 2007; Sachdeva and Suomi, 2013). Young visually impaired people in particular might regard the visible use of assistive technologies as "symbols of restriction, difference and dependency" (Söderström and Ytterhus, 2010 p.307). Calder (2009) observed how some devices are so cumbersome and conspicuous that they advertise (and possibly stigmatise) a user's disability. Certain personal trait considerations could explain non-adoption, including self-efficacy, technology phobia, or general resistance to innovation (Huang, Jin and Coghlan, 2021).

Abandonment of new high-tech assistive devices following a short period of use may be caused by lack of training (e.g., on the interpretation of the sounds made by devices [Davies, Burns and Pinder, 2006]), by a device's prioritisation of obstacles immediately in front of the user as opposed to objects adjacent or overhead, and by the extensive cognitive effort needed to analyse continuous flows of information. A device might be viewed as helpful initially, but unnecessary once the user becomes familiar with local environments (Roentgen et al., 2009; Sachdeva and Suomi, 2013).

3.1 Innovation resistance

Some individuals resist innovation more than others, actively or passively, and innovation resistance is a primary cause of non-adoption of new technologies (Heidenreich and Kraemer, 2015; Huang, Jin and Coghlan, 2021). Ram and Sheth (1989) characterised innovation resistance as "the resistance offered [by an individual] to an innovation, either because it poses potential changes from a satisfactory status quo or because it conflicts with a belief structure" (p. 6). The trait is common (see Talke and Heidenreich, 2014) and constitutes a significant reason for the non-adoption of innovations (Sivadas and Dwyer, 2000). Heidenreich and Handrich (2015) noted how innovation resistance can be both active and passive, the latter comprising a generic predisposition to resist innovations even before they are evaluated. Active innovation resistance, conversely, occurs after evaluation and/or the implementation of an innovation and, according to Talke and Heidenreich (2014), is an attitudinal and/or behavioural outcome of passive resistance. Heidenreich and Handrich (2015) similarly described passive innovation resistance as "a predisposition that determines the whole course of the adoption process", whereas active innovation resistance and active rejections are likely to be caused by passive resistance (p. 881).

Research has found that three variables impact significantly on innovation resistance: low self-efficacy (transportation self-efficacy in the present context) (e.g., Ellen, Bearden and Sharma, 1991; Kim and Lee, 2021; Yan, 2022), technophobia (see Bauer, 1995; Sinkovics, Stöttinger, Schlegelmilch and Sundaresan, 2002), and personal inertia (e.g., Dibrov, 2015; Mani and Chouk, 2018; Seth et al., 2020). These variables are discussed below.

3.1.1 Low transportation self-efficacy

"Transportation self-efficacy" derives from general self-efficacy, i.e., "a person's belief in her/his capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997 p.7) and involves confidence in the ability to plan and use transportation effectively (Cmar, McDonnall and Crudden, 2018). As such, transportation self-efficacy affects the amount of stress experienced when dealing with transport and transportation issues (see Crudden, Antonelli and O'Mally, 2016; Cserdi and Kenesei, 2020). Critically, it has been found to influence attitudes and behaviour regarding transport and transportation among people with many disabling conditions (see for example Carlson et al., 2012; Skarin, Olsson, Friman and Wästlund, 2019). Research has established that people with disabilities who are high in transportation self-efficacy are likely to respond positively to the task of finding and using new, improved, but unfamiliar transportation methods (Cmar et al., 2018). Block et al (2010) observed conversely how people with disabilities sometimes refrain from using certain modes of transport because they believe they do not possess the skills necessary to navigate them.

General technological self-efficacy is associated with an individual's perceptions of being able to perform technology related tasks (Karavidas, Lim and Katsikas, 2005). According to Tihic, Hadzic and McKelvie (2021), self-efficacy determines (i) the likelihood that an individual will choose particular technological options, and (ii) whether the person regards technology issues as challenges rather than obstacles or threats. A connection between self-efficacy and innovation resistance is to be expected on the grounds that a person's perceived ability to use a device successfully will affect the individual's evaluation of the device, particularly in terms of ease of use (Ellen et al., 1991). Self-efficacy might also affect a person's capacity to adapt to new technologies and hence willingness to accept them (Park and Chen, 2007).

3.1.2 Technophobia

Connections between technophobia and technology avoidance are well established in academic literature (see Brosnan, 2002; Osiceanu, 2015; Khasawneh, 2018a). Brosnan (2002) suggested that technophobia has three aspects: (i) internal resistance arising within people when they think or speak about a new technology, (ii) fear or anxiety connected with the use of a technology, and (iii) hostile or aggressive attitudes towards a new technology. Technophobia differs from low self-efficacy in that the latter only captures a person's belief in not being able to use a technology, as opposed to resistance to the technology (Blut and Wang, 2020). Nevertheless, research has found that low self-efficacy influences an individual's level of technophobia (Osiceanu, 2015) resulting perhaps from technophobes' fears of personal failure when using technology and unpleasant feelings of anxiety when exposed to new technology of any kind (Bozionelos, 2001; Khasawneh. 2018b). Technophobes have been observed to assume that new technologies carry higher levels of risk of failure during use compared to existing technologies (Hirunyawipada and Praswan, 2006). Perceptions of risk and uncertainty vis-à-vis reliability could represent a significant cause of resistance to new technologies among technophobes, despite the perceived usefulness of a device (Min, Kalwani and Robinson, 2006).

3.1.3 Personal inertia

Personal inertia involves “a state of primary motivational impairment” that operates independently of cognition or emotional situation (Marin, Biedrzycki and Firinciogullari, 1991, p. 146). It disinclines an individual from “devoting time and effort to activities of interest” (p. 151). In the transportation context, personal inertia has been characterised as a non-deliberate and goal-directed tendency to repeat certain transport-related behaviours (Wood and Neal, 2007; Sommer, 2011). Thus, an inertial person might regard having to use a new transportation assistive technology as “too much bother” and to require “too much costly thinking” (Yanamandram and White 2006, p. 169). Repeated transportation past behaviour can result from situation-related factors (e.g., cost of travel mode), personal attributes, and psychological considerations (Kitamura and Hoorn, 1987, Cherchi and Manca, 2011, Jain, Johnson and Rose, 2020). Past behaviour can generate experiences which gradually create a traveller’s rational preference for the status quo (Gal, 2006). Habits develop that enable an individual to avoid the cognitive effort needed to evaluate transport alternatives (Lally, Van Jaarsveld, Potts and Wardle, 2010; González, Marrero and Cherchi, 2017). Because inertia encourages a person to maintain the status quo, it can increase resistance to innovation (Polites and Karahanna, 2012; Seth et al., 2020). An inert individual might not care about various present or future alternatives even when new information and superior alternatives are available (Gal, 2006).

4. Conceptual model

Research is needed to evaluate the magnitudes of the effects of the above variables on innovation resistance and hence on willingness to accept new assistive technologies. Although past studies have examined the role of self-efficacy in device adoption, this has not occurred for transportation self-efficacy. Likewise, personal inertia has not been considered as an explanatory variable in the transportation assistive device adoption context; nor has technophobia. Accordingly, a new model was created to identify significant inter-relations between these variables, innovation resistance, and hence willingness to accept new assistive technologies. The model tested in the course of the investigation is shown in Figure 1. Three personal traits are presumed to determine a person's tendency to reject innovation. High transportation self-efficacy is posited to affect innovation resistance both directly and through the mediating influence of technophobia, which itself is presumed to affect innovation resistance. Personal inertia is hypothesised to have a negative influence on innovation resistance, which in turn helps determine the degree to which a person will accept new transportation technologies. In addition, past literature has identified three specific *beliefs* (see 4.1 below) likely to influence technology acceptance, i.e., device safety, device complexity, and the effect of the use of the device on a person's self-image. The model includes standard controls (age, gender, and income) plus one covariate: perceived usefulness (a variable that appears in many models of innovation adoption, see Venkatesh, Morris, Davis, and Davis [2003]). Research of this kind is important because, although many studies have covered possible reasons for the low take-up of devices, rates of non-adoption remain stubbornly high and several issues concerning the matter remain unresolved.

4.1 Specific beliefs

4.1.1 Device safety

A problem with assistive devices for people with visual disabilities is that devices do not monitor a user's surroundings to check for suspicious people who might try to steal from them (Ahmed et al., 2017). Visually impaired individuals cannot fully perceive their immediate environments, possibly causing anxieties vis-à-vis physical security and safety (Hakobyan, Lumsden, O'Sullivan and Bartlett, 2013). People with visual impairments cannot recognize unsafe situations and, if they are robbed or assaulted, they cannot describe to police officers the visual characteristics of assailants. Hence, people with visual impairments make attractive targets for street crime (Ahmed et al., 2016). Body cameras and glasses have been devised that photograph all the people surrounding an individual and which can be set to "normal" or to "safety" mode, the latter collecting images at very short intervals (Hakobyan et al., 2013). The devices are designed to make them less obvious to potential attackers (Azenkot et al., 2011).

4.1.2 Device complexity

Assistive device usability is influenced by the complexity of the skills needed to operate a device and the depth of cognitive activity required (Wittich, Southall and Johnson, 2016). Rogers (2003) defined technical complexity as "the degree to which an innovation is perceived as relatively difficult to understand and use" (p. 15). Complexity, according to Rogers (2003), is negatively correlated with rate of adoption because a complicated and/or confusing innovation takes longer to achieve acceptance. Device complexity could involve a confusing interface design, inconsistent layout of buttons or other tactile elements, or an excessive number of repetitive routines and sub-routines (Khan, Khusro and Alam, 2018). However, as new assistive devices tackle increasingly complex tasks, so device complexity intensifies (Fruchterman, 2003). Individuals have different tolerances for the complexity of devices (Hellman, 2007); some people could be overwhelmed by complex controls whereas others might enjoy the complexity of multiple interfaces. Complex devices require training, which could take a protracted period and require considerable effort (Lahav et al., 2018). Also, according to Mukherjee and Hoyer (2001), the perceived complexity of a technical innovation is associated with a higher perception of risk of breakdown during use. This could overwhelm some individuals, leading to non-adoption.

4.1.3 Effects of device use on self-image

Acceptance of assistive devices by people with visual disabilities may be impaired by the fact that devices are usually connected with the user's outward appearance, and possibly therefore with self-esteem (Shinohara, 2010; Srimathi and Khan, 2019). Parette and Scherer (2004) reviewed a large amount of literature which reported that people with disabilities often felt stigmatized by the use of assistive technologies. Individuals did not want to be seen as “disabled and vulnerable” or as “deviant” or different from others. McGrath and Astell (2017) noted how disability is frequently equated by the non-disabled with notions of helplessness, dependence, and incompetence. Consequently, people with disabilities might worry about their own self-image, with how others perceive them, and may have a strong desire to “fit in”. Certain assistive devices could threaten self-perceived ability to fit in with non-disabled communities, even when the devices greatly improve a disabled person’s quality of life (Spafford, Rudman and Leipert, 2010). Fear of stigmatisation resulting from the use of assistive devices could lead people with visual impairments to reject devices (Hersh, 2013). The desire to maintain a self-image consistent with self-reliance, competence, and control can limit the use of technologies which would otherwise facilitate independent living (McGrath and Astell, 2017).

4.2 Perceived usefulness

Davis (1989) argued that users’ attitudes towards using a new technology is significantly influenced by its perceived usefulness, defined as the degree to which an individual believes that using a particular technology (a new computer system in Davis' study) will enhance the person's "performance" (p. 324). This occurs, Davis (1989) continued, when the use of the technology is seen as advantageous. According to Davis (1989), devices are unlikely to be accepted if people do not believe that they will improve performance.

5. Materials and methods

A sample of 319 people with severe visual impairments completed an online questionnaire covering the various components of Figure 1. Table 1 lists the characteristics of the respondents. The questionnaire is summarised in the Appendix to the paper, together with the literature sources from which items were adapted. Study participants were assembled in 2022 by a commercial data collection company (Qualtrics), which possesses a panel of sight impaired individuals who have computer software that converts text appearing on a computer screen into speech or onto a Braille printer. A quarter of the sample members in employment used public transport at least once a week. Other participants used public transport about once every 3.5 weeks. On average the participants made shopping and recreational trips once or twice a week. Twenty-one participants had been offered an assistive device (mostly involving electronic canes or GPS-related devices) and had refused it; 16 had bought or been given a device and had subsequently stopped using the device (usually an electronic cane, screen reader, voice assistant or GPS device).

Five examples of new assistive technologies were presented to the sample members, who then completed the remainder of the questionnaire. The five examples were chosen during an online "imagination workshop" assembled for a previous study (Authors ZZZ) that was attended by three experts in city transport planning employed by local government authorities, three managers of fundraising charities that deal with visual disability and who expressed interests in transportation (approached via emails to relevant charities), two academics specialising in disability, two disability health care workers, two representatives of manufacturers of transportation mobility equipment for people with visual disabilities, and two senior managers of associations representing people with particular types of disability. Workshop participants were asked to conduct a “mind simulation” of future transportation assistive devices most likely to help people with visual disabilities. Members were placed into two groups, each containing participants with the same mix of functional backgrounds. Participants were instructed to state their vision of ideal future transportation assistive technologies, to proffer ideas however fanciful or currently unrealistic they might initially appear, and to suggest how new devices might overcome problems. What kinds of new assistive devices would, in the opinions of a group’s members, people with visual disabilities want to own and operate? The workshop lasted just over two and a half hours, ending with a plenary discussion. Supplementary email correspondence with additional comments was received after the event.

Consequently, the following text appeared in the survey questionnaire.

“We want to find out what people like yourself think and feel about new and highly advanced technological devices that are being developed with the aim of assisting people with visual disabilities. To give you the idea of what we mean please consider the following examples. Assume that government grants are available to cover nearly all of the cost of a device and that you would not have to contribute more than [at current UK prices in 2022] about 50 pounds (see end note 2).

Each of the following is currently under experimental development by a manufacturer and should be available within the next ten to 20 years. For each device, around six hours of (free of charge) training is required. Then a period of gradual adaptation to the device is needed to enable the wearer to interpret transmitted messages correctly.”

1. A backpack that uses AI and connects to (i) a camera worn on a blind person's outer clothing and (ii) a device that scans a person's immediate environment using a new radio wave technology. The system converts images of detected objects into signals that create sensations in each of the wearer's hands that guide the user through transportation terminals such as airports, bus and metro stations, shopping malls, etc., and which warn the user of obstacles, road crossings, stairways, and so on.

2. A metal Swoosh Cap that contains sensors which, via infrared rays, enables the wearer to walk on pavements by detecting people and objects up to ten meters away and which, via a small microphone located within the cap, translates the features and locations of obstacles into sounds audible only to the wearer. A small camera in the front of the cap scans and reads, for instance, railway and airport arrival and departure boards and informs the wearer. The cap is powered by a small battery pack worn around the user's waist and is attached to the hat through a thin wire located under the wearer's clothes.

3. A helmet that contains electrodes which send electrical signals directly into the wearer's head and a camera that scans the person's immediate surroundings. The helmet creates a soundscape of the individual's environment, monitors and understands the environment, and informs the wearer of obstacles, stairways, etc. Inputs are received by the wearer through sensations experienced as sounds occurring in various parts of the user's head. The device is connected to a GPS system that will guide the person through journeys on pavements, on any form of public transport and within transport terminals.

4. A lightweight four-wheeled robot on the end of a short rod that will accompany and steer an individual when walking on pavements and within shopping malls, buildings, transport terminals, etc. and will provide information on obstacles verbally via ear plugs worn by the user. The robot moves independently using a camera and sensors that detect obstacles. A

message will instruct the user to lift the robot whenever stairs are encountered. The robot includes a laser mapping system which determines the best route for its user and contains a periscope that will read bus and railway arrival and departure boards, and so on.

5. Smart glasses worn by a blind individual and which, without an internet connection, will guide the person while walking on pavements, through transport terminals and shopping malls, etc., and will scan the faces of nearby people and identify their moods. If appropriate the wearer will be warned through an earpiece of the nearby presence of a person appearing to be in an angry mood. The wearer can turn on an option whereby the person will hear of points of interest while walking, e.g., “on your left is a restroom”. The glasses are powered by a small battery within the glasses themselves and link to a global positioning system.

These devices were deemed to be of interest to the survey respondents as they represent recent advances in wearable assistive devices for people with visual impairments and because they have the capacity to enhance people’s quality of life in ways not previously possible. In principle, the devices offer greater personal freedom and flexibility than in the past and can help visually disabled individuals to live more active and independent lives (cf. Bhowmick and Hazarika, 2017). Each device is able to provide rich information for obstacle avoidance, object recognition and navigation.

6. Results

6.1 Estimation of the model

Items for three of the variables shown in Figure 1 (inertia, technophobia, and safety) were left-skewed and failed normality tests. Hence the model was estimated using the method of partial least squares. The estimated loadings of the (reflective) indicators of each latent variable are shown in the Appendix. All the loadings exceeded the acceptability threshold of .5 (Hair, Hult, Ringle and Sarstedt, 2017). Control variables were entered into the inner model experimentally and discarded if they were insignificant irrespective of any particular configuration of other variables. Two controls survived this process: household income and the period for which a person had been visually impaired, both exerting positive influences. Gender and education level failed to influence willingness to accept. The results of the estimation of the inner model of Figure 1 are shown in Table 2. All variance inflation factors were below 3.0, indicating the absence of damaging multicollinearity. In all cases the correlations of items within constructs exceeded the values of correlations between the constructs, indicating discriminant validity.

Personal inertia, concerns for the safety of devices, and possible negative effects on self-image failed to exert significant influences. Otherwise, the model depicted in Figure 1 performed well, showing a distinct and significant connection between the trait of innovation resistance and the sample members' willingness to accept new assistive devices. Hypothesised linkages between transportation self-efficacy, technophobia and innovation resistance were confirmed.

7. Discussion and conclusion

Understanding the most significant (and insignificant) influences that drive device adoption should help manufacturers and support organisations to focus their promotional campaigns in ways that encourage acceptance of new transportation assistive products. This is an important matter given the rapid pace of developments in assistive technology for people with severe visual impairments. Personal inertia failed to exert a significant influence on innovation resistance, indicating that innovation could be valued equally by inert as well as by animated people. Gilbert (2005) observed how (i) individuals with high personal inertia could still be flexible in their attitudes and behaviour, and (ii) inertness can be driven by habit rather than lack of interest. A tendency towards inertia might result from people experiencing lower levels of stress when thinking about innovations and/or believing they will not have to master fresh skills in order to operate new assistive devices (see Moradi, Jafari, Doorbash and Mirzaei, 2021), or from not expecting innovations either to be radical or to upset the status quo (Heidenreich and Kramer (2015). Dibrov (2015) found that personal inertia influenced innovation resistance only at very low levels of the latter. Thus, according to Ahrne and Papakostas (2001), inertia need not imply unwillingness to change. The insignificance of inertia suggests that there is little point in manufacturers and support organisations seeking to promote new devices specially among inert individuals, who are likely to respond in ways similar to other segments of people with visual disabilities.

The insignificance of the "effects on image" variable was possibly due to people with severe visual impairments not having seen, physically, how the wearing or using of an assistive device might cause sighted individuals to stigmatise a visually impaired wearer or user. Mani and Chouk (2018) suggested that certain kinds of innovations have specific product personality attributes. Unfavourable mental associations with these attributes could create unfavourable mental images of these innovations, which some people may regard as incongruent with their self-identity. However, a long-term visually impaired individual is unlikely to have a mental image of a "typical user" of a particular sort of innovation because the person will not have seen typical users physically. Again, there would be little utility in emphasising image-related factors in messages promoting new devices.

Length of impairment was more important than a person's age where willingness to accept new technologies was concerned due perhaps to the likelihood that, for many people, the longer they have been visually disabled the greater their exposure to and/or experience of useful assistive technology (Verza, Carvalho, Battaglia and Uccelli, 2006). A study completed by Squires, Williams and Morrison, 2019) found that disabled people's acceptance of assistive technologies increased as their medical conditions progressed. Pawluk, Adams and Kitada (2015) noted that some individuals who are currently blind will not have been blind for all their lives and would have been able to see clearly or partially before they became visually impaired. This, Pawluk et al. (2015) continued, may have affected how they think about being blind, leading to differences in attitudes towards assistive devices between (i) people who were blind from birth or early childhood, and (ii) people who had become blind later in life. The former group were more likely to read Braille fluently and to be comfortable with tactile diagrams, etc. Accordingly, individuals blind for long periods are likely to be more receptive to device adoption campaigns.

Doubts concerning device safety were insignificant perhaps because the participants assumed that, nowadays, any assistive device manufactured by a reputable company will have passed numerous safety checks. Also, people with severe visual impairments inevitably have to rely on sighted people to get around, and thus may not themselves have been personally exposed to unsafe products. Hence, individuals without sight might be less aware of risks associated with particular devices. As regards the control variables, gender did not affect willingness to accept assistive devices significantly, implying that visually impaired males and females may have had comparable experiences of technology-related matters during their education and early life activities (cf. Wilkowska, Gaul and Ziefle, 2010). The education levels of the participants failed to significantly influence the participants' willingness to accept new technologies. This may be due to conditions of visual impairment impacting people in much the same ways regardless of their schooling and other education. Moreover, people blind from birth or early childhood would probably have received special schooling which would have been similar in content and nature for all the individuals involved. Household income significantly determined willingness to accept new assistive devices, possibly because financially better-off people are better able to afford to purchase technical devices and consequently will have greater experience of them (Carlson and

Ehrlich, 2006). Also, household income might be related to a person's employment status, and an individual with a paid job may have a greater need for assistive devices. As income was the only significant control it was the only control retained in the final regression.

7.1 Use of the final model

When promoting new assistive devices, manufacturers and visual disability support organisations should recognise the existence of segments of people who possess specific characteristics. Personal inertia, self-image and safety issues did not emerge as important causal variables, so promotional campaigns need not include material concerning these matters (cf. Rees, Ennals and Fossey, 2021). Transportation self-efficacy exerted highly significant influences on both technophobia and innovation resistance. Thus, charities, state agencies and other support organisations might consider implementing measures that could encourage transportation self-efficacy, given that the latter is known to be heavily associated with (i) willingness to change (Skarin et al., 2019) and (ii) self-confidence when using new modes of transport (Schreder, Siebenhandl and Mayr 2009). According to Block et al. (2010), levels of self-efficacy among people with visual disabilities can be improved substantially via training, which could be provided by state and charitable organisations (see Crudden et al., 2016). As a means for dealing with this issue, Hagen, Gutkin, Wilson and Oats, 1998) suggested the use of recorded verbal stories that report successful behaviour relating to new assistive technologies among people who are blind and hence reduce anxiety where new devices are concerned. (Today this can also be achieved through digital media/social media.) More generally, Bandura (1977) proposed a number of ways of improving personal self-efficacy, including vicarious experience (telling a person how others have successfully completed a task), provision of mastery experiences (having a person practice step-by-step tasks that increase in level of difficulty), and appointing role models to champion a system for learning how to complete specific tasks.

There is a strong case for seeking to decrease the technophobia that appears to exist in many people with visual impairments, considering that "technology can be both a source of liberation and an agent of exclusion for disabled people" (Gregor, Sloan and Newell, 2005 p.283). Fear and ignorance of new technology can, according to Nimrod (2018), constrain the quality of life and satisfaction with life of a person with a disability. Technophobia significantly connected with innovation resistance among the members of the present sample. Manufacturers and disability support organisation devote large amounts of fiscal and personnel resources to the development and introduction of new assistive devices for people with visual (and other) impairments, so it is essential that (sometimes casual) feelings of technophobia do not inhibit acceptance (cf. Scherer, 2002; Gregor et al., 2005). By succumbing to technophobia, individuals cut themselves off from all the benefits that new assistive technologies can provide (Sherrill, Wiese, Abdullah and Arriaga, 2022).

Suggested treatments for technophobia include the provision of hands-on experience of, initially simple, technical devices to create incremental learning; "planned exposures" to new assistive devices which aim to "reduce unhelpful emotional responses to technology and evoke helpful perspectives and behavioural flexibility towards technology" (Sherill et al., 2022 p. 550). Planned exposures should target specific technological stimuli and situations that elicit avoidance, "starting with more manageable tasks and then gradually progressing to more challenging tasks" (p.551). Hence, technophobic discomfort should reduce over time and the technophobes receiving the exposures should gradually realise that they are more technically competent than they first imagined (Brosnan, 2002).

Visual disability support organisations could design and deliver effective exposures, and experienced users of a new high-tech device could be recruited to guide and encourage technophobes to try a new product. Exposure, in conjunction with conversations with a trusted mentor, may help a technophobe to recognise irrational negative thoughts and to become more comfortable and confident with devices during actual day-to-day use. Conversations with a mentor might arouse a technophobe's curiosity, reduce the "psychic distance" between the person and an existing user of new devices, and encourage the individual to want to feel part of the future. The unique personal benefits of a new technology to a person can be communicated in this way.

7.2 Limitations and areas for future research

Only people with severe rather than less problematic visual impairments participated in the research. Applications of the present model to less severely visually disabled individuals and to people with ambulatory or intellectual disabilities would be useful in order to identify and then explain any differences in the results with the outcomes to the current study. The sample size was modest, and many participants had voluntarily joined a list of questionnaire respondents operated by a commercial market research company. These individuals took part due to interest in the topic and/or in return for small rewards from the research company for completing a certain quota of questionnaires. To check for possible bias in the panel questionnaire responses the data was examined for evidence of casual and/or random questionnaire completion, no such evidence emerging. Specific personal trait variables were examined, and the questionnaire items were adapted from prior literature. Thus, the impacts on innovation resistance of alternative and/or additional trait variables and of different measures of variables, need to be explored. Another area for future research is an examination of how technophobes and people high on innovation resistance respond to various forms of informative and persuasive promotional messages intended to secure acceptance of new assistive technologies.

Five particular examples of assistive devices were offered to the participants. These were obtained from a workshop comprising a certain collection of interested parties. A different set of workshop members might have suggested alternative examples. Nevertheless, the workshop participants were drawn from functional areas highly relevant for the investigation and were experts in their respective fields. It is unlikely, therefore, that the examples included in the present study would differ substantially from the sorts of example proposed by other collections of experts. Further matters for future research are how manufacturers view the issue of non-adoption, what if anything they do to measure rates of non-adoption, and what activities (if any) they undertake to deal with the problem?

APPENDIX. THE QUESTIONNAIRE

(Outer loadings from the PLS estimation are shown in parentheses alongside each reflective item.)

General

Apart from factual queries all items were scored using five-point agree/disagree scales. Participants confirmed that they had visual impairment serious enough to make activities reliance on sight impossible.

Demographics and general: Household income and age categories, gender, education level, health (good/bad)

How long have you been visually impaired: less than 3 years; 3 to 5 years; 6 to 10 years; 11 to 20 years; more than 20 years?

Are you: employed; unemployed; retired; a student; other?

What is the frequency (daily, weekly, fortnightly, monthly, less than once a month, never) of your:

(a) Work trips, (b) shopping trips, (c) recreational/social trips, (d) use of public transport?

What mobility aids do you use? Please state all that apply: See Table 1 above

Have you ever been offered an assistive device and chose not to use it? Yes/No. If “Yes” what was the device?

Have you ever bought or been given an assistive device and later on had decided not to use it?

Transportation self-efficacy (informed by Schwarzer and Jerusalem, 1995; Van Beuningen, De Ruyter, Wetzels and Streukens, 2009) (value of first eigenvalue of a principal components analysis of the items, lambda = 4.88, Cronbach’s alpha = .88)

The following relates to your journeys using public or private transport outside your home and beyond its immediate surroundings.

(a) Getting around the city/town in which I live is something I can easily cope with (.81, T = 30.81)

(b) I am sure I can overcome any problem I might experience while travelling (.77, T = 27.29)

(c) I do not regard transportation to be a difficult problem for me (.84, T = 36.88)

(d) I feel confident about using public transport (.81, T = 37.69)

(e) I get a sinking feeling whenever I have to travel beyond my home (.58, T = 21.00)

(f) I do not feel that I am a person who needs a great deal of assistance of assistance in order to travel outside my home (.80, T = 35.55)

Technophobia (adapted from Sinkovics et al., 2002) (lambda = 4.48, alpha =.89)

(a) I experience deep feelings of fear at the prospect of having to use new equipment or technology (.84, T = 45.34)

(b) I try hard to avoid the use of new equipment or technology (.85, T = 44.99)

(c) I feel nervous and uncomfortable when I use new equipment or technology (.89, T = 53.52)

(d) I find new technologies to be intimidating (.83, T = 44.58)

(e) I worry about making mistakes when using new equipment or technology (.79, T = 37.35)

(f) I am a true technophobe where new equipment or technology is concerned (.90, T = 60.82)

Personal inertia (adapted from Marin, 1991) (lambda = 4.0, alpha = .85)

(a) Getting things done on time is not at all important to me (.69, T = 29.92)

(b) I have to confess that I am less concerned about issues relating to my daily routines than I should be (.84, T = 35.90)

(c) In general, I am a person who is not particularly interested in making the effort to do new things or try new things (.79, T = 30.01)

(d) To be honest I am a person who prefers to have someone to tell me what to do each day rather than having to decide for myself (.88, T = 53.52)

(e) I accept that I really should put more effort into getting things done (.84, T = 50.00)

Perceived usefulness (adapted from Adams, Nelson and Todd, 1992) (lambda = 3.39, alpha = .79)

Devices and technologies of the type described would:

(a) enable me to get around and use transport much better than at present (.85, T = 44.44)

(b) enable me to get around and use transport much more quickly than at present (.88, T = 56.67)

(c) give me greater control over my transportation activities (.70, T = 23.99)

(d) make my transportation activities a lot easier than at present (.77, T = 31.12)

(e) overall be very useful for all my transportation needs (.80, T = 45.66)

Willingness to accept new transportation assistive devices (adapted from Gagnon et al., 2012; Teo, 2019) (lamba = 3.99, alpha = .90)

(a) I intend to use new technology devices of the nature of those described whenever they are available (.88, T = 60.06)

(b) I will only use new technology devices of the nature of those described if they become absolutely necessary (reverse scored) (.83, T = 50.29)

(c) I intend to be a heavy user of new technology devices of the nature of those described (.78, T = 34.40)

(d) I am not at all keen on using new technology devices of the nature of those described (reverse scored) (.85, T = 46.99)

(e) I am always willing to adopt new technology devices of the nature of those described (.76, T = 30.28)

Innovation resistance (adapted from Heidenreich and Handrich, 2015) (lambda = 5.8, alpha = .80)

(a) I greatly prefer to use the same old assistive devices for people with visual disability than to try new and different ones (.77, T = 14.99)

(b) I would probably resist trying a new assistive device such as those described even if I thought the device would be good for me (.80, T = 19.44)

(c) If I were to be asked to try a new assistive device such as those described I would probably feel stressed and uncomfortable (.70, T = 11.87)

(d) I would actively avoid new assistive devices such as those described (.68, T = 8.5)

(e) The assistive devices that are currently available are fully satisfactory and there is no need to introduce new ones (.84, T = 23.31)

(f) In my opinion the number of innovatory new devices becoming available is too high and the pace of introduction of new devices is much too rapid (.69, T = 9.74)

(g) I generally consider the introduction of new devices such as those described to be a good thing (reverse scored) (.86, T = 20.55)

Safety (adapted from Parasuraman, 2000; Cao et al., 2021) (lambda = 3.88, alpha = .80)

(a) I would really worry about the safety of new high-tech devices such as those described (.78, T = 20.44)

(b) Revolutionary new technology as in the devices described is usually a lot safer than critics lead people to believe (reverse scored) (.88, T + 34.66)

(c) It can be very unsafe to switch to using new high-tech devices such as those described (.79, T = 17.93)

(d) There are many hidden dangers associated with using new high-tech devices such as those described (.69, T = 13.36)

(e) Generally speaking, it is safe to operate new high-tech devices such as those described (.90, T = 34.25)

Complexity (adapted from Fischer, Reuter and Riedl, 2021; Jilke, 2021) (lambda = 4.0. alpha = .9)

(a) I think I would find it too complicated to operate new high-tech devices such as those described (.77, T = 45.11)

(b) I could easily learn how to operate new high-tech devices such as those described (reverse scored) (.72, T = 33.80)

(c) I feel that high-tech devices such as those described will be very confusing (.80, T = 44.61)

(d) High-tech devices such as those described are generally so complicated to use that they are basically useless (..70, T = 13.03)

(e)It would take me far too long to figure out how to use new high-tech devices such as those described (.82, 25.97)

Self-image (adapted from Sirgy et al., 1997) (lambda = 4.45, alpha = .80)

(a) Using new high-tech devices such as those described is fully consistent with how I regard myself (.89, T = 45.03)

(b) I am happy to have a personal image of someone who likes to use new high-tech devices such as those described (.80, T = 28.12)

(c) Using new high-tech devices such as those described would reflect "who I am" (.78, T = 23.16)

(d) People similar to me would welcome the availability of new high-tech devices such as those described (.68, T = 12.15)

(e) I like to identify with people who have visual impairments and who will enjoy using new high-tech devices such as those described (.83, T = 50.00)

(f) Using new high-tech devices such as those described certainly fits-in with my self-image (.74, T = 36.77)

End notes

1. In the UK and in most other countries a person becomes "registered blind or partially sighted" when a consultant ophthalmologist confirms that activities reliant on sight become impossible or when sight loss severely interferes with daily life (WHO, 2015). UK ophthalmologists issue Certificates of Vision Impairment to blind or partially sighted individuals, who may then register with local government and receive many financial and support benefits. However, registration is not compulsory for Certificate holders. In 2021 340,000 people were registered as blind or partially sighted (see NHS Digital [2021] for information on registration data and procedures).

2. The figure of £50 was selected as it represented the approximate value of the weekly standard disability allowance (SDA) available to people with severe visual impairment (£2600 in 2023, i.e., £54 a week) *in addition to* all other sources of an individual's income. SDA is available regardless of a person's total income or housing situation. £50 was chosen so as not to make the cost of a device a prohibiting factor and hence to isolate the influences of the variables included in the model.

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Ethical considerations

Ethical approval for the study was obtained from the Research Ethics Review Panel of Kingston University (2021/44) on 29 October 2021. Open University ethics approval (HREC/4171/Vijaygopal) was given in December 2020 for the imagination workshop and in February 2021 for the Qualtrics survey. Qualtrics is approved for data collection from disabled people by both the authors' universities and assumed full responsibility for data collection. Panellists voluntarily register with Qualtrics and provide the company with personal data (to which the researchers had no access). Informed consent was obtained from all subjects. The company operates a double opt-out policy.

Conflict of interest

The authors declare no conflict of interest.

TABLE 1. CHARACTERISTICS OF THE SAMPLE

Age (mean average number of years)	39.8
Gender (% female)	50.6
Education (% with a university degree)	9.9
Income:	
% self-defined as better off than most others	11.5
% self-defined as worse off than most others	55.5
General health other than disability (% self-defined as good)	64.9
How long the person has been severely visually impaired:	
% less than 5 years	11.2
% more than 11 years	54.1
Employment (% working)	27.1
Mobility:	
White cane (%)	46.4
GPS system (%)	11.5
Digital voice recorder (%)	22.4
Wearable voice only device (%)	9.2
Other	10.5
Transportation self-efficacy (mean average of 6 items)	2.8

Technophobia (mean average of 6 items)	2.2
Personal inertia (mean average of 5 items)	2.2
Perceived usefulness (mean average of 5 items)	3.3
Innovation resistance (mean average of 7 items)	3.0
Willingness to accept new technology assistive devices (mean average of 5 items)	3.8

TABLE 2. INNER MODEL ESTIMATION

	Technophobia	Innovation Resistance	Willingness to Accept New Transportation Assistive Devices
Transportation Self-efficacy	-.37 (3.34)*	-.29 (2.55)*	
Technophobia		.39 (3.37)*	
Personal Inertia		.09 (0.09)	
Innovation Resistance			-.39 (4.11)*
Safety			-.11 (1.45)
Device Complexity			-.28 (2.86)*
Effects on Image			.10 (1.00)
Perceived Usefulness			.42 (5.12)*
Household Income			.25 (2.24)*
Period for which the Person has been Visually Impaired			.29 (3.00)*
R-Square	.14	.38	.47

*T-values in parentheses. *Indicates significance at the .01 level or below.*

FIGURE 1. THE MODEL