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# Mobile Without Fear: Personal Control, Information, and Communication Support in ICT-Mediated Urban Public Transportation

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In the lives of anxious users of public transportation, being mobile without fear depends on personal control of physical mobility, clear information concerning mobility-related choices, and communicative connectivity while traveling. In the study presented here, qualitative interviews and accompanied mobility walks with vulnerable passengers affected by anxiety disorders revealed the need for information and communication technology (ICT)-mediated route planning with attention to mobility justice, usability, and sensitive implementation in everyday practice. Taking an interdisciplinary perspective integrating communication science, psychology, and traffic planning, the study revealed potential solutions to problems involved in addressing people's needs in future public traffic planning and mobility-related communication.

*Keywords: anxiety, mobile communication, ICT route planning, mobile passenger support, urban public transport*

Because today's digital planning and positioning systems combine previously separated geographical, physical, and media spaces (de Souza e Silva & Sheller, 2015) to create hybrid environments, using locative media for the everyday use of urban public transportation has great significance (Ng-Chan, 2015). Once passenger assistance and recommendation tools (e.g., apps) became the first point of contact for information seeking and individual route-planning (Firth, 2019), urban sociability (Sutko & de Souza e Silva, 2011) was identified as an all-encompassing change in media in urban contexts (Krajina & Stevenson, 2019; Tosoni, Krajina, & Ridell, 2019).

However, public transportation, especially in urban areas, can pose a challenge to people with anxiety disorders and consequently lead to their reduced use or avoidance of certain forms of mobility (Götzenbrucker, Griesbeck, & Preibisch, 2022). Not only studies on mental illness and passenger anxiety (Risser, Lexell, Bell, Iwansson, & Ståhl, 2015) but also studies in the context of digital planning tools have revealed that people with anxiety disorders generally experience situations involving mobility as being

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overwhelming. Those affected rarely have the alternative of driving a car or a private vehicle because of the influence of medication. Therefore, the use of public transportation by vulnerable groups with special mental disorders is important for three reasons (Hauger et al., 2019): for meeting daily needs (e.g., therapist and doctor appointments), for integrating (e.g., social activities), and for mastering daily tasks (e.g., work mobility and shopping). For that reason, the interconnectedness of media technology, mobility, and identity (Elliott & Urry, 2010) requires new perspectives on equal access, connectivity, and usership. To ensure freedom of movement and mobility justice, planning has to begin among the "people," not the system (Sheller, 2018), to avoid the reproduction of social inequalities.

Involving an interdisciplinary team of communication scientists, psychologists, mobility planners, and experts in public transportation operators in the city of Vienna, Austria, the Mobility Without Fear study has examined the perceived use and potential of communication in general and of information and communication technology (ICT) in particular to enable route management in public transportation before and during travel for people with anxiety disorders. In that context, *anxiety disorders* can be defined as a diverse set of mental conditions encompassing not only everyday anxieties, fears, and phobias but also obsessive-compulsive disorder, phobic anxiety disorders, panic attacks, and post-traumatic stress disorder, which often occur in combination with other mental illnesses (Kasper et al., 2018). We also recognize that anxiety is influenced by social constructs and shaped within one's environmental context.[1]

Against that backdrop, this article explores vulnerable groups' need for personal control, information, and communication in being mobile using public transportation, and examines the practical and impractical operations of technology services from a user-driven perspective. In our study, inspired by a participatory design, we used a combination of sensitive qualitative research methods to probe what vulnerable, anxious passengers feel in situ on the move and what they see with their own eyes. Qualitative interviews in voluntary settings and accompanied mobility walks with passengers affected by anxiety disorders revealed rich experiences far beyond what survey data can capture.[2] In turn, this article offers insights into future adaptations and developments in public transportation for vulnerable passengers in urban settings.

## A Note on Public Transportation in Vienna

A small country in the middle of Europe, Austria is home to 9 million citizens, including the 2 million people who live in its rapidly growing capital, Vienna (Statistics Austria, 2024). Vienna's dense, highly developed public transportation network, used by nearly 2 million passengers, consists of five metro lines, 29 tram lines, and 127 bus lines, including 24 night lines, as well as e-scooters, bicycles, and e-car-sharing services. The network extends in concentric circles from the city center into inner and outer districts and into the suburbs. Underground lines are diagonal and connect opposite districts; S trains operate in a circular structure; trams primarily connect inner and middistance districts; and buses operate primarily in the outer

[1] International Classification of Diseases (F40 for phobias).

[2] The DIGNITY survey on inclusive digital mobility points to groups at risk tend to be excluded from digital mobility services (Goodman-Deane et al., 2022).

districts (Figure 1). Those services are part of a larger concentric system of transportation zones operated by the Eastern Region Transport Association that integrates the rural areas surrounding the city.

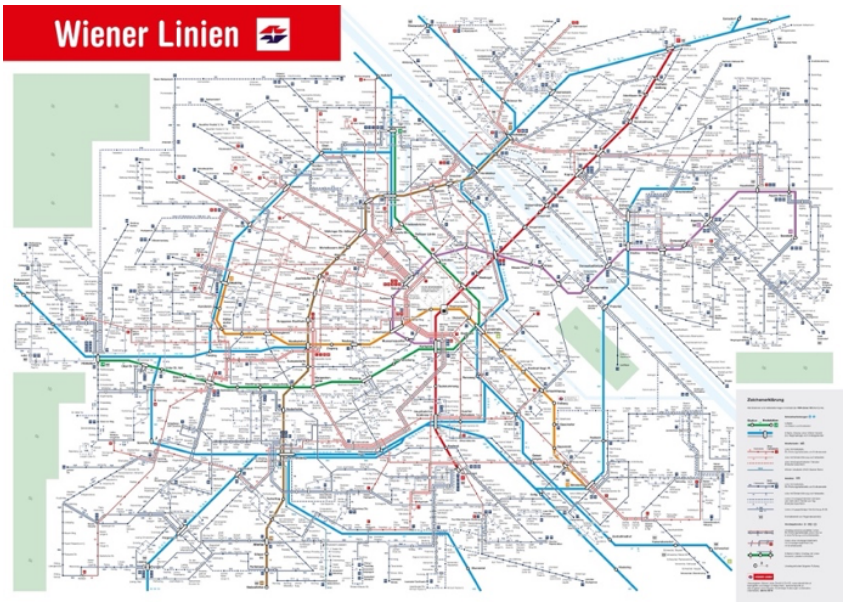


***Figure 1. Map of Vienna's public transportation system. Copyright (2022) by WienerLinien. Reprinted with permission.***

Accessible infrastructure—for example, lifts, low-floor vehicles, Braille guidance systems, and sign-language avatars—albeit highly developed, is primarily designed to compensate for physical disabilities. Although such infrastructure may help people with phobias, anxieties, and obsessive-compulsive disorders, it does not explicitly support their needs (WienerLinien, n.d.-b). Meanwhile, ICT services such as mobility planners (e.g., Wienerlinien.at, Scotty, Vor.at, AnachB, WienMobil, and Google Maps) are already in use but operate in different, somewhat inefficient ways for the vulnerable group targeted in our study, whereas specifically designed services remain in development.

Therefore, the support currently provided by WienerLinien could be expanded in three ways: increasing the passenger's control over their travel situation, providing (real-time) information about the travel-planning process both before and during trips, and offering conversation-based communication support during trips.

## Neglect of Anxiety Disorders in Studies on Barriers to Mobility

Despite widespread discussion about physical barriers to mobility in public transport, the state of research on psychological barriers to mobility remains poor (Hauger et al., 2019). The few papers that address psychological barriers to mobility focus on age-related limitations for mobility (Chiatti, Westerlung, & Ståhl, 2017; Sundling, Berglund, Nilsson, Emardson, & Pendrill, 2014), including ones related to dementia (Bell, Wolf-Eberl, & Posch, 2018; Gaber, 2020) and the consequences of stroke (Carlstedt, Iwarsson, Ståhl,

Pessah-Rasmussen, & Månsson Lexell, 2017; Ståhl & Månsson Lexell, 2018). Meanwhile, mental disorders not related to age and their impact on public mobility remain marginalized. The literature also lacks real-world references and user-oriented approaches such as those emphasized by Risser et al. (2015).

In that vein, except for the fear of flying (Schindler, Abt-Möstedt, & Stieglitz, 2017) and of driving a car (Fischer, Heider, Schröter, & Taylor, 2020), anxiety in the context of public mobility has rarely been studied. Although psychological and medical studies focus on dementia, Alzheimer's disease, stroke, cognitive impairment, and brain trauma in relation to disability, the social sciences typically explore passenger anxiety in public transportation. In that way, several factors have been identified as contributing to anxiety, including crowding (Mohd Mahudin, Cox, & Griffiths, 2012; Tirachini, Hensher, & Rose, 2013), lack of control, safety concerns, and fear of getting lost. A rare study on anxiety in relation to London Underground (Kim & Gustafson-Pearce, 2016) additionally lists antisocial behavior, noise, late-night travel, long wait times, and disruption as the most common anxiety-provoking situations. Specific strategies have been suggested to cope with such situations, including planning ahead, carrying familiar objects, avoiding triggers, and practicing distraction. Studies on gender and social class (Hanson, 2010) in relation to anxiety experienced on public transportation have also shown that limited resources and fewer options to avoid public transportation and crowded environments in cities are major sources of stress.

Along those lines, published work on concrete solution proposals remains scant. To improve the mobility of people with dementia, Schlingensiepen and colleagues (2015) developed wearables that can inform users (i.e., people with dementia) of their whereabouts. Other work, by comparison, emphasizes practices. For instance, Alaribe (2015) has presented a training module for young people with intellectual disabilities that supports their use of public transport; Campos and colleagues (2016) developed a website to overcome the fear of flying; and Bentz and colleagues (2021) launched an app to practice dealing with the fear of heights. A virtual avatar—a sign-language interpreter—has also been developed for Vienna's public transportation system (Schnieder & Tschare, 2015). At the same time, Li, Lin, and Chib (2021) found a wealth of literature addressing the increasing invasiveness of wearable technology and calling for more privacy and data security in response. They note a lack of transdisciplinary research on that topic as well, considering that most such studies have been tech-driven, rarely monitored social interaction, and not explored the lived experiences of anxious passengers.

## Lack of Mobility Justice for Anxious Passengers

In general, access and connectivity to mobility (Dangschart, 2011), along with the usefulness and usability of technology, are critical for the adoption of mobility services. Resources such as income, education, and media literacy, as well as traits such as gender and ethnicity, are relevant factors of influence. A literature review (Durand, Zijlstra, van Oort, Hoogendoorn-Lanser, & Hoogendoorn, 2022) has validated determinants of inequalities in mobility because of age, gender, income, ethnicity, rural residency, and impairment as intersectional factors of disadvantage. In addition, digital divides (Graham, 2011) and information gaps concerning media literacy continue to make using technology challenging for older and marginalized people, as shown in the cases of mobile health services (Fox & Connolly, 2018). Mental health issues related to anxiety disorders could also be barriers to the use of technology.

The concept of mobility justice (Sheller, 2018), involving several factors, pays attention to "the social construction of appropriate forms of mobility for differently positioned people" (van Holstein, Wiesel, & Legacy, 2022, p. 148) to overcome the dominance of movements by privileged people—that is, primarily White, masculine, able-bodied people. Expanding on that concept, special needs and mechanisms of inclusion for intellectually disabled people have been revealed, including training for situational control during travel, transit apps, beacon technology (i.e., small devices using wireless technology to pinpoint a location and offer content based on it), information support (Bigby et al., 2019), support staff, and "single problem, single answer" settings.

With reference to those findings but going beyond sociodemographic factors, in what follows we discuss three key factors of mobility justice in relation to anxiety disorders—control (i.e., having personal control of mobility), information (i.e., digital information support before or while being mobile to reduce stress and uncertainty), and communication (i.e., feeling accompanied and supported by staff and passengers)—for a rich understanding that can create awareness among providers and support participatory modes of design.

## Personal Control, (Digital) Information Support, and Communication in ICT-Mediated Mobility

Our qualitative study addressed acutely anxious users of Vienna's public transportation system, with special focus on communication media and route-planning systems under the unique constraints of the COVID-19 pandemic which has had an additional impact on preexisting anxieties. In earlier work, the PHOBILITY study (Hauger et al., 2019) focused on people with preexisting anxiety and obsessive-compulsive disorders who use (public and private) transportation, and identified three key concepts of ICT-mediated mobility support: personal control of mobility, adequate information, and opportunities for communication.

First, concerning *personal control of mobility* for corporal, intellectual, and emotional convenience, Goffman (1971) has described the personal use of public spaces by defining eight territories of the self, all of which refer to prototypical problems that people confront in public spaces (pp. 28–41). We have used those categories to analyze anxiety-inducing experiences in public transportation.

The category *personal space* refers to the distance that people consider to be appropriate to separate themselves from others, usually determined by the size of the room, the number of people, and the situation. In that context, a *stall* represents a claim of ownership over a privileged space (e.g., a seat on public transportation) that can be claimed. The *use space*, by contrast, is the space that people need to perform an activity (e.g., viewing and watching time tables) and is located in front of the person's activity. A *turn*, meanwhile, determines the arrangement of interactions in which something can be claimed (e.g., while entering a vehicle). The *sheath* describes the skin and all objects close to the body (e.g., clothing) that represent the smallest possible personal space used as boundaries in relation to others, and *possession territories* are items such as hats, smartphones, backpacks, and pets that can be used as markers to temporarily claim stalls (e.g., by occupying adjacent seats). Beyond that, the *information preserve* determines the accessibility of information and includes the entire possession territory, sheath, and biography of a person (who defines transgressions as, for example,

starting at the sheath). Last, the *conversation preserve* determines when someone can or cannot be addressed by others.

Although some territories are not clearly distinguishable, insights into the dimensions of the problem of using public transportation can be outlined. In our study's context, ICTs are conceived as contributing to enriching social contacts, preventing social isolation, and facilitating integration, especially for the vulnerable group studied (Bradley, 2017). Increasing an individual's autonomy, also increases their freedom of choice. Thus, ICTs may have the potential to empower individuals by using emotional control over space and environmental challenges and by providing predictability.

Second, *(digital) information support for mobility* refers to the use and adoption of technology, a context in which "digital interface competence" (Goodman-Deane et al., 2022, p. 429), usability, accessibility, and functional capacity are relevant preconditions (Carlsson, 2004). In particular, the perceived usefulness of ICTs in serving personal needs in a specific travel situation is relevant. For instance, information, from simple countdown displays on platforms to complex route-planning apps, can serve as an anchor for concrete travel information when planning journeys in advance or while on the move (Bigby et al., 2019). From the (user-driven) travel-chain perspective, different stages of a journey can be analyzed and conceptualized as usefully supported by ICT services. For a journey to be successful, each link in the travel chain has to be completed (Lavery, Davey, Woodside, & Ewart, 1996, p. 183), regardless of the increased complexity of traveling (Currie & Delbosc, 2011).

Third and last, *communication and conversational mobility* for feeling accompanied and safe involves conversational assistance. It includes not only communication using mobile devices but also an increased focus on static, location-based media in the context of mobility. Connectivity, coordination with peers, and being "always on" have been reported as needs that (young) passengers have while traveling (Hepp, Berg & Rotisch, 2014, p. 206). Moreover, unintended accessibility and reduced environmental awareness because of smartphone calls are perceived as being negative factors.

To bring that communicative mobility research framework (Berg, 2017, p. 292) into our study's focus, we considered that all types of media in a city (i.e., Vienna) can support passengers' communication needs (e.g., city screens and countdown displays). In particular, smartphones are powerful mediators of "polymedia environments" (Madianou & Miller, 2013) that support highly individual mobility-related needs and enable passengers to manage their mobile lives more easily. According to the media repertoires approach (Hasebrink & Domeyer, 2010), socioeconomic status is also a relevant factor in media literacy, one whose absence makes it difficult for the deprived to cope. In our study's case, people with anxiety disorders often experience difficulties in maintaining employment and earning an income, which can lead to lower levels of media literacy.

Considering all of the above, our research inquired into the causes and effects of anxiety when vulnerable passengers use public transportation. Based on our prestudy's findings as well as the literature, the following research questions (RQs) pertaining to people with anxiety disorders remain unsatisfactorily answered:

*RQ1: Which passengers' needs for personal control in mobility-related situations can be identified?*

*RQ2: How can (digital) mobility-related information (e.g., on websites, on apps, or on-site) help passengers to alleviate their anxiety?*

*RQ3: How can communication, conversation, and human interaction support the mobility of anxious passengers?*

## Combining Qualitative Interviews and Mobility Walks

Our empirical study was based on a qualitative method involving participants in careful, responsible ways in an approach that is necessary to address the special needs of people with anxiety disorders. Ethical standards for academic research integrity (All European Academies [ALLEA], 2017), which demand not only the anonymization of personal and interview data but also safe, separate storage of all study-related data, were strictly followed. The study was approved by the Research Ethics Committee, and all participants received coherent information, provided their informed consent, and were notified of their right to withdraw from the study during each phase of the study.

Personal interviews with people affected were conducted to gather rich information to obtain a deep understanding of personal anxieties. Our strategic sampling (Misoch, 2019, p. 196) was performed with the support of self-help groups and targeted people with different forms of anxiety disorders and with as many diverse sociodemographic characteristics and mobility styles as possible (e.g., living autonomously or with assistance, living in different areas of Vienna, and using several types of public transportation at various times, for various purposes, and of various intensities).

All interviewers were trained to conduct interviews, and the interview guide that we used was created in collaboration with psychologists. Moreover, the mode of the interviews was adapted to individual preferences in relation to taking breaks, having questions repeated, and engaging in small talk as needed. A psychologist was always available during the interviews, and voluntary follow-up conversations were offered and accepted by most interviewees. Furthermore, interviewees could freely choose their mode of participation (i.e., physical or online) at all stages of the study. The choice of mode of interview, and the specific interview procedure were important criteria for creating a sensitive study design (Götzenbrucker et al., 2022).

| Name (gender, age) | Preferences | Channel | Mobility walk |
|---|---|---|---|
| Lukas (m, 19) | uses public transport to visit friends and family | telephone | |
| Paula (f, 23) | uses public transport regularly; prefers cycling in summer & rush hour | Zoom | |
| Rafael (m, 28) | infrequent panic attacks (1–2 per month); has started taking public transportation more frequently | Zoom | |
| Sarah (f, 30) | walks whenever possible; retreat zones essential when using public transportation | Skype | |
| Katharina (f, 35) | uses public transportation (bus) to get around her neighborhood | Skype | |
| Inge (f, 37) | regularly uses public transportation for work | Zoom | |
| Nicole (f, 42) | uses public transportation to get around her neighborhood; uses cabs for longer distances | telephone | |
| Christoph (m, 43) | prefers to walk and stays in his neighborhood; rarely uses public transportation | Zoom | |
| Renate (f, 49) | prefers to use a car or cab (because of COVID-19) | telephone | garage walk |
| Regina (f, 56) | only uses public transportation for work | telephone | work-walk |
| Gerhard (m, 58) | uses public transportation for work, but prefers cabs | in-person | |
| Klaus (m, 59) | regularly uses public transportation; practice essential | Zoom | home-walk |

***Figure 2. Participants by gender, age, preferences in using public transportation, and mode of interview.***

Before interviewing people with mental disorders, 17 flash interviews were conducted with people who experience everyday anxieties about public transportation. After pretesting the interview guide and following the principle of saturation, we conducted 12 qualitative, semistructured, problem-centered interviews (Kruse, 2015). The seven women and five men interviewed were 19–59 years old (Figure 2) and chose between being interviewed in person, over the phone, or using videoconferencing tools (e.g., Zoom). Each interview lasted 60–80 minutes.

The interview guide contained questions in simple, comprehensible language about personal experiences with and feelings about being mobile using public transportation in Vienna. To ensure quality, privacy, and anonymity, only audio-recordings were made (i.e., not computer recordings), and all transcription was performed exclusively by the researchers. In compliance with the conditions of the university's Research Ethics Committee, all recordings were deleted after the study ended. Questions were asked in the most sensitive ways possible, and ample time was reserved for listening to interviewees' descriptions and stories (Figure 3).

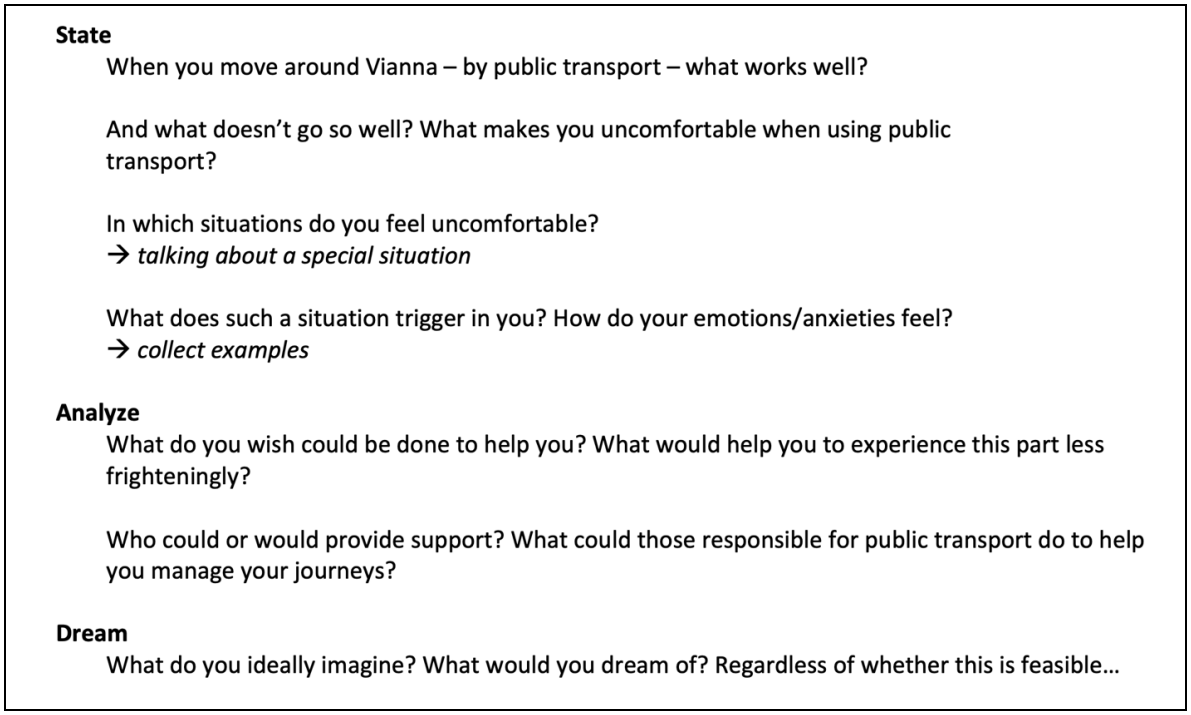


***Figure 3. Dimensions and examples of questions asked in the interviews.***

In addition, three accompanied mobility walks were taken following the principles of sensitive ethnography (Kusenbach, 2021). The aim of that method was to capture positive experiences with mobility to take the person and their experiences, emotions, and ideas seriously and place them at the center of a walk in the field being studied. The participants were treated as experts of their situations and given immersion in the place (i.e., emplacement), and the movement of the body in space (i.e., embodiment), such eye-level research (i.e., equality), was considered to be relatively authentic. The natural go-alongs (Evans & Jones, 2011, p. 850) were chosen to reflect daily routines and were determined by the participants. In contrast to the interviews, all mobility walks accompanied by researchers took place in person at times without pandemic-related restrictions and lasted two to three hours. Most often, walks to work and home, as well as a local inspection of underground parking, were taken.

In total, our transcripts comprised more than 600 pages of text, observation protocols, and more than 60 photos of specific walk situations. For data analysis, qualitative content analysis according to Kuckartz (2018) and using MAXQDA was applied, which enabled a deep investigation of the extensive body of transcripts. In the first step, the main categories were created, and in the second, the subcategories were inductively derived from the material. To ensure intercoder reliability, three researchers coded parts of the interviews in parallel and discussed the correlations, after which, codes and interpretations were fine-tuned.

## Results: Anxious Passengers' Needs for Support With Problem Solving in Situations Involving Mobility

Before analyzing and pointing to (technical) solutions that are expected to be useful, we present the mentioned problems, perceptions, and needs of anxious passengers. The interviewees described states of mind, identified shortcomings, analyzed the reasons why and the circumstances involved, and proposed both current and future solutions.

### Unsatisfactory Control of Mobility

In response to RQ1, a key need of people affected by anxiety disorders is a perceived control over mobility (e.g., enough personal space), largely in terms of vehicle capacity, infrastructure, physical perception, and encounters with other passengers. Overcrowding during rush hours was described by participants (e.g., Renate, Sarah, Katharina, and Nicole) as being highly problematic despite the convention that transportation arrangements require a general declaiming of personal space.

Participants also expressed the need for mobility free from mental barriers in attitudes about following an "unwritten order" or "row position" in the flow of passengers when entering or exiting a vehicle, and structure and exclusion were likewise welcomed by some participants. The order, or taking of turns, may be mandated by rules and control over "logistics" and "how to enter" (i.e., as reported by Gerhard and Sarah), by security, by ticket class (e.g., first class on trains), based on status and/or group membership (e.g., women and older adults), or by recommended behavior with respect to infrastructure, including elevators (i.e., as reported by Inge), escalators in stations, and in vehicles themselves. When traveling, Gerhard reported deliberately choosing the section of the vehicle that he knows from experience will have fewer people to manage turn taking (Goffman, 1971): "I know, on the U3, the middle section doesn't make sense if you get off at Western Station" (Figure 4a). In view of the inherent limitations of personal space on public transportation, only the sheath remains as the last line of defense: "I wear a leather coat like armor on the subway" (Gerhard).

Using public transportation entails strategies to protect claimed space and demand distance by using one's possession territory to, for instance, erect "barricades" on side seats (Gerhard) to "keep away" suspicious people (Lukas). Locations to retreat to should a panic attack arise, including public restrooms, are used as safe spaces, even though they are otherwise perceived as unpleasant places to stay (i.e., as reported by Sarah and Paula). If such spaces are absent, then building entrances and park benches can also

serve the same function. Thus, places of retreat or escape serve as stalls and are a central component of strategic travel that makes the situation controllable (Figure 4c).

Most participants described have a space in the vehicle, usually a seat, that they prefer out of habit, as in Gerhard's case; a spatial distance from other passengers, as in Sarah's case; the ability to be barricaded easily, as in Klaus's case; being reserved for certain groups of people, as in Inge's and Renate's case; or its close location to an exit, as in Paula's case. If that stall is occupied, then some participants reported preferring to wait for the next vehicle. The stall is thus closely connected to the use space and taking turns. The use space can be (re)designed by leaving the visual axis free or guaranteeing a view through a window (i.e., as described by Regina), to park equipment such as carts correctly (i.e., as described by Sarah), or leaving space to enter and exit the vehicle (i.e., as described by Gerhard).

Katharina described protecting her conversational preserve by averting and covering ("stonewalling") to avoid being spoken to. Interestingly, she reported not feeling disturbed by foreigners, whose conversations are foreign and thus unintelligible to her. Renate described not wanting to be spoken to whatsoever, while Lukas described donning headphones. In general, promoting "civil inattention" (Goffman, 1971, p. 385) to anxiety disorders can afford a greater range of mobility to passengers affected by anxiety.

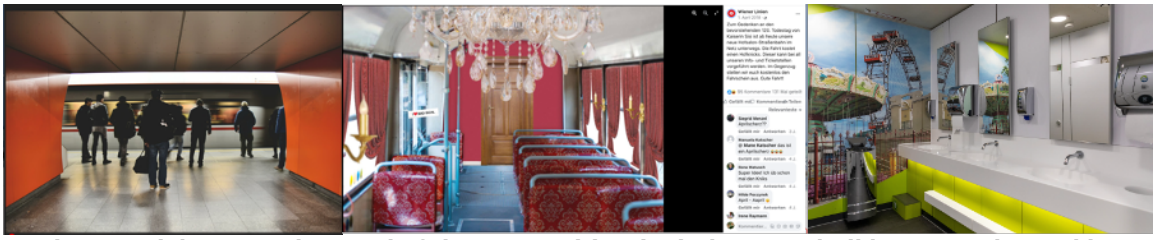

***Figure 4. (a) Personal control of the row position (Spitaler, 2022), (b) space enhanced by virtual reality: Copyright (2018a) by Traktor. Reprinted with permission, and (c) finding retreats: Copyright (2019) by Robert Peres. Reprinted with permission.***

During a panic, Paula cannot talk to other people or ask for help but instead uses her disability ID card. Few people resort to that form of using their information preserve, for concern about revealing too much information about oneself is far greater. Regina, by contrast, mentioned how she and others do not dare to sit in seats for handicapped passengers because their impairment is invisible. The possibility of receiving help from other passengers and employees in an emergency situation is also dubious.

The equipment that makes public mobility possible (i.e., possessional territory) is important for supporting one's navigation and offering additional strategies. Klaus, Regina, and Inge reported moving through the city with printed-out routes, and Klaus and Regina in particular described their mistrust of technology and proclaimed that printouts are the sole solution. Inge also preferred printouts for their disposability when traveling or for orientation in city districts unfamiliar to her. "Looking after the right path" (Klaus) is easier on paper than operating with a smartphone app. Klaus also reported writing notes on his printouts and did so before the accompanied mobility walk as well. A printed map is easy to carry and

provides security, because "you can hold it in your hand during the trip and look at it several times" (Regina). Inge "always [prints] before riding an unknown route."

By comparison, smartphones cannot be used properly in stressful situations, for they carry with them the fear of loss because of theft or low data rates, network failure, and, as Klaus reported, damage to the device while traveling. Only a few interviewees stated using their smartphones (i.e., Katharina, Paula, and Rafael) or a combination of printouts and navigational cues (i.e., Nicole). Paula, for her part, described using her smartphone to search for public toilets when she needs a safe space, and to that end, she looks for fast-food restaurants because they are easier to find than public restrooms.

Personal equipment is also used for distraction. As someone suffering from post-traumatic stress disorder, Sarah described trying to distract herself by playing with her smartphone, reading a book, or listening to music to manage her mood and reduce the need to interact with other passengers. Alternatively, she looks out the window. In her view, even imaginary windows can create an illusion of free sight (i.e., use space), free adjacent seats (i.e., a stall), or being on the surface. Paula speculated that future virtual reality technology can be used to aesthetically enhance spaces in vehicles and increase convenience (Figure 4b).

Altogether, passengers with anxiety disorders described using a range of strategies to ensure their public mobility. However, their strategies should be understood as stopgap solutions in an environment that is not adapted to their needs. Public restrooms are converted into safe spaces; seats are occupied by self-created barriers; other passengers are blocked out by equipment brought from home; and orientation is provided by self-assembled slips of paper. To satisfactorily support passengers in controlling their personal needs and emotions surrounding mobility on public transportation to allow positive passenger experiences, ICT tools could be a viable way forward, provided that inequalities in mobility are addressed by improved digital literacy.

### Challenging ICT Services in Planning Before and During Trips

Participants were not concerned about using communication technology (e.g., route planners or videoconferencing) in general or about data protection or violations of personal rights. On the contrary, they were more worried about using their smartphones in crowded places, if not damaging or losing them in confusing situations, especially while traveling. Because electronic services are perceived as being helpful in preparing personal mobility travel chains before traveling, the participants described checking departure times and vehicle occupancy as well as special environmental features (e.g., exits, restrooms, and quiet zones). In addition, given the notable difference between using smartphone apps or route planners before and during trips, routine journeys were characterized as needing to be distinguished from nonroutine journeys and exceptional situations. For example, incidents and disruptions require improvisation, because alternatives need to be found to continue the journey. Thus, in specific situations and environments, ICT has to be understood as ambiguous: not only empowering but also challenging, overwhelming, and restrictive.

### Ambiguous Mobility-Related Information

In response to RQ2, (digital) mobility-related information, both before and while traveling, is assumed to be a crucial dimension for enhancing the convenience of passengers with anxiety on public

transportation. Because the information dimension is formed in advance by digital (in)equalities and divides, especially because of age and socioeconomic status (Durand et al., 2022), the perceived usefulness of the promoted services is dubious as well.

Precisely planning trips ahead helps to mitigate anxiety and is primarily performed for two reasons: to provide certainty about the duration of a trip (e.g., because of a fear of being late) and ensure orientation (e.g., because of a fear of losing one's bearings) and to be prepared for alternative routes in challenging situations. Those problems are rather individualized and depend on the type of anxiety disorder. For example, certain means of transportation and/or types of stops are avoided, sometimes long journeys are difficult, and some passengers do not want to change trains, whereas others need breaks and kiosks or toilets on the way.

The more precisely that a journey can be adapted to one's needs, the easier using public transportation is. Interestingly, although participants reported preferring to have various travel options, they described rarely using adaptable features in the planning tools to address their preferences (e.g., "Exclude means of transport" or "Minimize train changes") despite their needs. Christoph, a 48-year-old, for instance, described avoiding tunnels in advance, even though in-app information about all lines with tunnels is missing from his planning tools. Sarah, by comparison, reported excluding underground lines because she has problems with "going below the city surface."

Participants additionally criticized the availability of in-app information as impermanent and stressed the use of websites for backup, where queries and results remain in the system "overnight":

> When I look the day before, I always look more at wienerlinien.at than on my phone. . . . Yes, because the website just stays that way . . . until the next day, and the app will delete it at some point, then you have to re-enter it. Because then I often have longer trips and then I like to look at it again and again. (Katharina)

Alternative route information is also sometimes needed to, for instance, compensate for "long intervals or long wait times" (Inge) or to choose specific vehicle types, as Regina stated. Countdown displays on the platform or in the app (Figure 5a) also provide relevant real-time information by showing the departure times of two vehicles in advance, thereby enabling passengers to avoid overcrowding.

Concerning Inge's problems with orientation, ICT-assisted travel should make it easier to find underground station exits—for example, using previews on vehicle screens (Figure 5b), in stations or in the app, that visualize the surface of an underground station (e.g., images of buildings, monuments). Navigational cues, including station signs, were also characterized as being essential for identifying underground exits because they provide "small hints that you can remember" (Inge).


***Figure 5. (a) Information on platforms (i.e., countdown display); Copyright (2014) by Johannes Zinner. Reprinted with permission, (b) information on vehicle screens; Copyright (2013) by Johannes Zinner. Reprinted with permission, and (c) information imagined using virtual reality; Copyright (2018b) by Traktor, reprinted with permission.***

The route planners regularly used by the participants are Google Maps, Scotty, Wienerlinien.at, Vor.at, and WienMobil, which they sometimes use in combination to compare routes. Google Maps was the most commonly reported, for it makes footpaths clearly visible and the satellite version can be used to obtain a highly accurate picture of one's surroundings:

> I used to go through the streets on Google Maps with Street View . . . so that I could virtually look around the area where I'm going . . . to see if the environment is also visually represented realistically. If you see there's a bakery, there's this and that. (Rafael)

Participants who reported not planning routes themselves (e.g., Lukas and Nicole) were supported by their caregivers, who plan their routes online and print them out. Because of preplanning activities, online tools and route-planning apps were described as rarely being used during trips. Beyond that, routine journeys were well known. Nevertheless, "to be on the safe side, Google Maps is available on the phone" (Katharina). That service was especially appreciated by younger participants because it shows the location and displays the directions for traveling on foot. As with Scotty, its localization and navigation functions enable users to find their way around, even in stressful situations, but it lacks current information about interruptions in transportation services. Knowing about such disruptions in advance would allow passengers such as Rafael to reconsider and revert to their already well-oiled personal traveling habits.

Some participants expressed a fear of losing connection in general, because (data) access reduces nervousness by compensating for uncertainties. Conversely, others were critical of the confusing instructions that they obtain when using technical apps during trips:

> I've already tried using Google Maps to orient myself on foot outside, and it doesn't work at all. . . . When I turn around and look in a different direction, the app takes too long to adapt, and then I walk in the wrong direction. What's difficult is the reorientation. . . . And then there's an insane amount of stress. . . . I can no longer keep an eye on my surroundings to see if someone is standing in front of me. (Renate)

Information about changing vehicles (e.g., Inge's concern was "Where exactly is the bus stop for the right direction?") and about the various exits from subway stations was described as being particularly

important by all participants. On top of that, infrastructure such as restrooms and spaces to retreat to should clearly be signposted and provided in the apps.

From the participants' perspective, only a few tools meet the requirements of clarity and unambiguity, whereas others lack intuition and convenience. Searching using Google Maps or Google Earth was considered to be helpful, and its completion function in particular improves results used to easily locate paths and places. The participants stressed its usability for route planning and environmental overviews of aspects such as shopping areas, spaces to retreat to, and ways "to imagine what it will look like there" (Paula). It has also been described as operating as a "mirror world" (Smart, Cascio, & Paffendorf, 2007). By contrast, the WienMobil app needs to know the person's exact address to start a search.

In sum, ICT services (should) enable strategic mobility by providing usable information (Schnieder & Tschare, 2015) such as pretrip information about tunnels (e.g., London transport providers launched a map highlighting all tunnels) or valid information for rerouting if the original plan is not feasible. Planning tools could be optimized to find and follow routes to and from a station by combining city maps, stops, and walks, which can stimulate cognitive mapping (Mikunda, 2005). Implementing pictorial symbols or signs (e.g., in apps and Internet service printouts) displaying specific path types (e.g., corridors, escalators, passages, and steps) to exits or retreats on platform and station screens could reduce anxiety as well.

In-trip orientation calls for in-time information (Bigby et al., 2019) and stable data networks in stations and vehicles. In addition, smartphones in general can be inconvenient for people with anxiety, for the orientation functions are confusing when the services are not aligned to the north. Smartphone screens were generally perceived by participants to be too small to display complete contextual information; as a consequence, usability in finding directions from a location is low owing to deficits in digital competence (Durand et al., 2022). Ideally, previously found alternative routes should be saved in advance and designed to be retrievable.

### Assistive Communication, Conversation, and Connection

Last, in response to RQ3, communication and conversation options are considered to improve anxious passengers' convenience in mobility. Some participants preferred asking other people for directions when necessary. Lukas, for instance, described calling his mother on the phone for "live navigation" when he is disoriented: "I have her in my ear the whole time, and she just tells me the way." Youth workers also discussed clients who use WhatsApp chats while traveling and not only for distraction but also to be guided to exits, find their bearings in stations, and change vehicles with the help of friends. Some participants also complained about limited data volume because of exhausted funds and the constant lack of WiFi on public transportation.

When disruptions occur along a trip, the stress experienced by people with anxiety is higher than that of ordinary passengers. Their strategies in such situations include waiting until things move on again; alternatively, they follow other people or ask for help on-site (Figure 6a) or via a phone call or (sign-language) avatar (Figure 6b). Sarah reported experiencing stress during disturbances and being unable to

manage even low-threshold communication opportunities: "Those are extreme cases. . . . That's the point where I usually switch off completely, simply because I'm overwhelmed."

In light of the aforementioned issues, the participants put forth several potential solutions. Inge suggested an easy-to-establish telephone contact (i.e., conversational "personnel navigation") that offers her exactly the help that she needs. Accompanying services were also proposed and could be arranged using apps. Other participants additionally requested more human interfaces (e.g., trained service staff in stations and on board, as in Figure 6c) or human SOS "buddies on board" via call or in the app, and even robot assistants on platforms to supplement the security staff.

Stickers worn by drivers or conductors (e.g., "Please feel free to speak to the train driver") or even passengers could also convey a safer atmosphere in the context of public transportation. Training or assistive technology—for example, in virtual reality environments—was mentioned by participants as another possible solution.

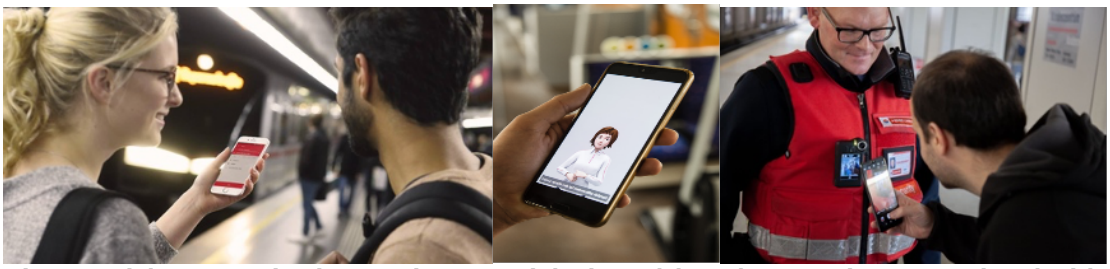

***Figure 6. (a) Communication on-site; Copyright (2017) by Johannes Zinner. Reprinted with permission, (b) avatar assistance (Jantzen, 2021), and (c) friendly service staff; Copyright (2018) by Robert Peres. Reprinted with permission.***

In sum, using smartphones and apps during trips is generally perceived as being too stressful, not only in nonroutine travel situations (i.e., during disruptions or incidents) but also on crowded platforms and in heavily occupied vehicles (Mohd Mahudin et al., 2012), because passengers with anxiety disorders have to concentrate on coping with the situation while traveling. Some even need medication before or during their journeys, which leaves no cognitive resources for them to deal with complex systems or opportunities for simple information or communication. In the future, distraction based in virtual reality (Bajorunaite, Brewster, & Williamson, 2021) or imagined safe spaces could help, as could simulating essential clues—for instance, "soccer stadium" (Figure 5c).

Although Hepp, Berg, and Roitsch (2014) have investigated urgent needs for connectivity among youth, nomophobia (Han, Kim, & Kim, 2017) has increased not only because of the indispensability of devices but also because of insufficient battery or the loss of or damage to the smartphone.

Our results highlight a lack of in-depth understanding about and public awareness of anxious passengers in public spaces beyond ICT. Actions such as campaigns to raise awareness against providers of intellectual (van Holstein et al., 2022, p. 159) or nonphysical disabilities are urgently needed and were

described by Renate as "first aid for the soul." To begin, training measures for the transportation operator staff, specifically in identifying and managing passenger anxiety, have been developed.

## Concluding Remarks on the Anxiety-Reducing Potential of ICT in Public Transportation in Urban Settings

Mobility competence, as a basis for participating in urban social life, depends not only on the usability and accessibility of planning and communication tools but also on their sensitive implementation in everyday practices, as well as on personal communication needs and information requirements.

As shown in our examples, the potential of ICT to support people with anxiety disorders on public transport includes (1) simplifying personal control of physical mobility, (2) strategic mobility planning through (digital) information, and (3) social communicative support during journeys. Technical services complement but do not replace the maps, station plans, and interfaces that already exist in stations and at stops.

Only through the personal experiences of vulnerable passengers can reciprocal injustices in the mobility system be reduced and equalized. ICT-based assistance causes inequalities; the older, financially weaker, and more vulnerable that passengers are (Goodman-Deane et al., 2022), the more likely technology is to not support mobility-related situations. Moreover, infrastructure is developed on the basis of user data, and if older, disadvantaged, and vulnerable passengers are not present in said data, then they remain "invisible to planners as well as self-learning algorithms" (Durand et al., 2022, p. 46). As a result, mobility justice can be realized only through participatory design involving those groups.

Examples of existing technological advancements in public transportation in Vienna beyond and around our research project include extra vehicles and call services, including (self-)tracking and reporting: White Cab is a "single problem, single answer" taxi service run exclusively by women for women; or an on-demand carpooling service used largely by young citizens (WienerLinien, n.d.-a). These projects are based on the intersection of digital planning, support, and personal needs of control but are still in need of improvement.

On the level of information, several route planner apps including position data, route mapping, and route recommendations have been established in Vienna, including WienMobil, Scotty, and AnachB. Although based on rich, inclusive, real-time information (Bigby et al., 2019), those services still do not bring comprehensive benefits to travelers. Strategies by WienerLinien for bringing adequate data to Google Maps (e.g., marking public infrastructure accurately on maps) have somehow not been purposeful. By contrast, OpenStreetMap offers detailed, innovative information about street lighting and useful infrastructure along one's route, which other planning tools lack. However, because features that address impairments or language barriers (e.g., Vienna's sign-language avatar) are in testing or not being developed further, sustainable solutions for vulnerable passengers remain missing.

Vulnerable passengers' communication and conversational needs to be supported by staff on trains and platforms are under discussion. Because (digital) accompaniment can already be realized via position

data, phone-call based support services for people who are not digitally equipped or adequately trained are in development based on preexisting models (https://heimwegtelefon.net/) that match the European Union's data security policies. Moreover, a code of conduct for staff and passengers has been developed by WienerLinien, sensitivity campaigns on diversity (e.g., "Vielfalt") have been launched, and a passenger advisory board to foster participatory design options has been established. Broadband and wireless Internet access on vehicles as well as on underground transportation are costly and therefore waiting to be fully realized. Infrastructure such as loading areas and electric charging stations on trains are on their way to comprehensive implementation.

Above all, our research has shown that current ICT planning tools lack utility and usability, which leads to operational insecurity for the population that we studied. Such shortcomings call for a thorough rethinking of the tools' impact and potential for improvement. Being mobile means having the freedom to make mobility-related choices in dynamic transportation situations that ensure mobility justice (Sheller, 2018) for all citizens.

In terms of communication, (technologically mediated) conversational assistance in particular might empower vulnerable passengers' mobility choices before and during trips because of the accompanying help in situ. Human interfaces are required, not only in travel situations but also for coping with mobility-related demands in general. In line with the concept of usability (Carlsson, 2004), all stages of a public transport journey should be as predictable as possible for passengers with anxiety disorders and meet the requirements of user-centered design.

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