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**The Psychological Stress Perspective –
A unifying view of accessibility in public transport and beyond**

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Abstract

Making public transport accessible to all is important because of its role in social inclusion and environmental sustainability. The UK public transport network is a complex system with a multitude of operators providing services on different scales with different vehicles. A single journey can put a variety of demands on a person wishing to travel and these demands that can exclude people from using public transport take many different forms. A range of physical, sensory, cognitive, and emotional factors effect how people with different of abilities, ages, genders, ethnicities and socioeconomic status use public transport. This complexity makes the task of assessing access to the system problematic.

This paper proposes that all the factors that contribute to people's non-participation in public transport and other human systems can be regarded as stressors. Psychological stress theory provides a language to explain exclusion and a unifying perspective with which all accessibility barriers can be viewed in the same way. A method called Human System Stressor Analysis (HSSA) has been devised to identify, assess and compare stressors that are found in a system.

An example of HSSA being applied to public transport use is provided. This was used to identify an opportunity for a product design solution and led to the design of a journey planning kiosk. An understanding of psychological stress was applied throughout the design process with two new tools used to inform design decisions: the Panic Matrix to generate empathy and STUD Tables (Stressors as a function of Time, Uncertainty and Difficulty) to compare alternative solutions.

The AUNT-SUE (Accessibility and User Needs in Transport for Sustainable Urban Environments) project is currently developing a tool that applies the stress perspective to journey accessibility assessment. This tool is intended to model journey stress for a range of individual people in the HADRIAN (Human Anthropometric Data Requirements Investigation and Analysis) database. Finally it is suggested that the psychological stress perspective could be used as a unifying measure throughout ergonomics, the potential benefits and problems with this approach are discussed and opportunities for further research to establish its validity and practicality are identified.

Keywords: Accessibility, Stress, Transport

1. Public Transport and the Ongoing Accessibility Problem

Public transport is important because it is the most environmentally sustainable way to provide everyone with the freedom to travel. It is particularly important for people with low socio-economic status or disabilities for whom public transport can be liberating. To fulfil its potential it must be accessible to all, as emphasised by Tony Manwaring, the CEO of UK disability organisation Scope (2005a): “*Disabled people will not achieve equality until they are able to travel freely*”. The UK public transport network is a complex system with different vehicles providing services on different scales run by a multitude of private sector companies. A single journey can involve different vehicles, interchanges and ticketing systems and walking through different environments to get to and from services. This all places a range of physical, sensory, cognitive and emotional demands on people. These demands vary with individual characteristics and circumstances, and this combination of system complexity with the multivariate demands that participants experience makes the task of assessing and improving access to public transport problematic. Despite improvements that have been made in recent years there is still great concern that public transport needs to be more inclusive. Scope’s ‘Time to Get Equal’ poster campaign calls for an end to discrimination faced by disabled people on public transport (Scope, 2008). This is an indication that access means more than just the practical possibility of using transport. Many people, whether disabled or not, find using public transport stressful to the extent that they choose to avoid it. This leads to the theory that making public transport more inclusive depends on making it less stressful.

2. Psychological Stress Theory

Stress is defined as the transaction between a *stressor* and a *response* (Cassidy, 1999). The related term *distress* describes any negative emotional state including that induced by stress. Prolonged or frequent exposure to stress can cause chronic distress and psychological and physiological illness. Stressors are anything that could put a person at risk of failure or harm. Any event, whether experienced physiologically or psychologically, can be a stressor (Cassidy, 1999). Although major life events such as bereavement can be regarded as stressors; frequent smaller stressors known as *daily hassles* (e.g. being stuck in traffic or spilling a glass of milk) are the best predictors of psychological problems. In addition to events, stressors can be ambient; a feature of a person’s environment that they perceive as negative (e.g. heat, noise or things that are visually unpleasant). Stressors can also be anticipatory; the prediction of a future stressor is itself a stressor (e.g. the possibility of missing a deadline or nerves before giving a performance). The response is the way a person alters their stressed state and takes the form of an ordered *coping mechanism*. Coping mechanisms have three stages; *physiological response, cognition and behaviour* (Cox, 1981). The physiological responses prepare the body for action in a number of ways including release of adrenaline, increased heart rate, blood pressure and blood glucose levels. Cognition then is the person’s attempt to determine the source and severity of the stressor, and if it is sudden or hard to identify this stage may not be effective. Finally a person carries out a behavioural process to alleviate their stress which is less likely to succeed if cognition was not effective. Cox (1981) cites Lazarus, a prominent author on stress, who described the behavioural process as taking two forms; *direct action* and *palliation*. Direct action deals with the stressor and can take the form of preparation against harm, aggression (*fight*) or escape (*flight*). Inactivity (*freeze*) occurs when a person is unable to take direct action due to a feeling of hopelessness. Palliation deals with emotional distress by using thought processes or physical control to promote relaxation. The complexity of life and the number and variety of stressors encountered mean that our coping mechanisms often fail. If this is the case we need environmental resources to aid coping. These might be uplifts which counteract the distress or help from other people. However, if a

person does not find a way to cope their physiological stress response continues, leading to exhaustion and collapse. Stress affects different people differently. Every person has a different resistance to becoming stressed and capacity to cope with stress. People are subjected to stressors of different severity, frequency and duration depending on their lifestyle. People at the bottom of society economically are most distressed because they are more likely to face persistent hassles without access to resources that could help them cope. Distress levels also vary with age with anxiety highest in young adults and depression highest in old age. The absence of control, or powerlessness, is considered the most distressing social factor (Mirowsky & Ross, 1989). Travel is a known contributor to the stress that many people encounter daily. Costa et al. (1988, quoted in Cassidy 1999, p.50) found increases in psychological and physical illness in commuters. It has been shown that it is not distance, but 'impedance to travel' that has a direct link to stress; i.e. a person travelling a long distance on a mainline will be less stressed than someone travelling across a city with several changes.

3. Stress and Accessibility

The widely advocated social model of disability recognises disabled people as 'equals who face unequal odds', and while there is no suggestion that disabled people are any less able to cope with stress; they are likely to encounter more stressors when using public transport. Difficulty getting onto a bus is a stressor. Attempting to take in information from departure screens or announcements at a station is a stressor. These accessibility issues are commonly regarded in terms of usability by ergonomists, but could equally be regarded in terms of stress. Using this stress perspective means we can go on to describe all problems that people experience in public transport using the same language. Missing a train, being delayed and getting lost are all stressors. Noise, crowds and unpleasant surroundings are all stressors. Given that travel is an intrinsically stressful activity, contemplating a journey is an anticipatory stressor. Avoidance of public transport can be seen as a 'flight' response to this stressor. Similarly the anger directed at transport companies in Scope's 'Time to get equal' campaign can be seen as a 'fight' response to the unequal level of stress that disabled people experience when using public transport. Conversely, the full potential of public transport to be uplifting and liberating for all would be realised if the stressors could be eliminated. This stressor elimination theory need not be limited to public transport. It is proposed that access to all human systems may be made fully inclusive by the elimination of stressors.

4. Human System Stressor Analysis (HSSA)

In order to put stressor elimination into practice a formal method for the identification, assessment and prioritisation of stressors is needed. The method that is proposed here was inspired by Failure Mode and Effect Analysis (FMEA), a tabular method used by designers and engineers to predict and prevent product failure. Human System Stressor Analysis (HSSA) requires an analyst to complete a table in order to generate priority values for each stressor in a system. The first column of the HSSA table (Table 1) is the *Stressor*. The analyst then lists *Sufferers* who by circumstance or disability may have unequal exposure to the stressor. These columns are followed by *Outcomes* and *Causes* with the causes attributed to the system, not the sufferer. By completing these columns the analyst demonstrates that they understand the stressor and can then go on to rate its *Occurrence* and *Severity*, the product of which is the *Stress Value*. HSSA is likely to be used to analyse existing systems which may already have some solutions in place intended to enable people avoid the stressor. These *Current Solutions* are included in the table and rated on their *Effectiveness* and *Availability*, the product of which is the *Solution Value*. Finally, the *Stressor Value* is divided by the *Solution Value* and scaled up to give the *Stressor Priority Value*. Table 1 shows the table with

three public transport stressors that demonstrate how event based, ambient and anticipatory stressors can be analysed in the same way.

Stressor	Sufferers	Outcome	Cause	O C C	S E V	Stressor Value	Current Solutions	E F F	A V A	Solution Value	Stressor Priority Value
Difficulty getting on and off vehicle	People with physical disability or frailty, people with awkward luggage	Physical strain/pain or failure to travel.	Step up into vehicle and narrow doors	6	7	42	Assistance from staff and fellow passengers	4	6	24	1.8
Not knowing if vehicle goes to the required destination	All, especially those with cognitive and sensory difficulties	Missed vehicle or getting on wrong vehicle	Lack of or poorly conveyed information.	8	5	40	Departure screens, announcements, vehicle labelling, asking staff.	4	7	28	1.4
Overcrowding	All	Reduced coping capacity	Enclosed spaces too small, not enough vehicles	9	3	27	First class coaches and passenger lounges	6	1	6	4.5

Table 1 – HSSA Table Example

5. Design for Stress Reduction

HSSA was developed as part of a design project in order to identify an opportunity for a product solution. The brief that was chosen was to design a product that reduces anticipatory stressors by providing users with a way to plan their journey and get a printout of times, vehicles and destinations from a dedicated kiosk at the point of travel. The final design is shown in Figure 1. Given that this product was intended to enable people to eliminate stressors from their journey it is important that using it is not stressful. To that end, two tools were created to help design-out stressors. The first of these is the Panic Matrix (Figure 2), a simple diagram intended to generate empathy with users who are least able to cope.



Figure 1. Journey Planning Kiosk Design

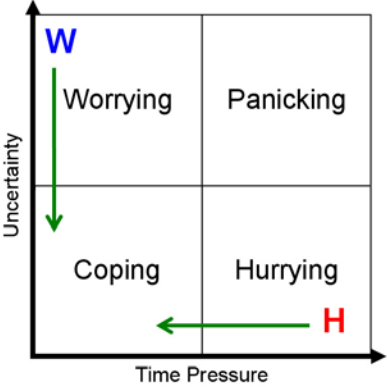


Figure 2. The Panic Matrix

People who come to use the product could be anywhere on this matrix with a combination of uncertainty and time pressure depending on their personality and circumstances. A poorly designed product will add to these stress levels and take them into the panicking area of the matrix, at which point you can expect a fight, flight or freeze reaction to the product. A well designed product should reduce their stress level by providing an uplifting interaction. The designer should consider two users; the worrier (W) and the hurrier (H). The worrier has low

confidence, cognitive ability and experience. The hurrier needs to use the product quickly because they are running late. Optimising the design for worriers and hurriers means that all users have the best chance of coping with the product interaction. Considering users in this way was particularly useful when designing the onscreen process and graphics. The second tool, STUD Tables (Stress as a function of Time, Uncertainty and Difficulty) was developed to compare user input mechanisms for the journey planner. A STUD table (Table 2) should only include comparable alternatives that fulfil the same function. Rating the time taken to use each option, uncertainty in how it functions and physical difficulty of operation is a good way to analyse of the strengths and weaknesses of alternative solutions. These can then be compared to intended users and circumstances to select the best solution. The overall stress rating produced also indicates of whether an option is likely to be a stressor.

Device	Time (Min: 1, Max: 5)	Uncertainty (Min: 1, Max: 5)	Difficulty (Min: 1, Max: 5)	Stress Rating
Touchscreen	1	5	2	10
Navigation Buttons	4	1	3	12
Aligned Buttons	2	3	3	18
Mouse	3	2	4	24

Table 2 – STUD Table Example

For the Journey Planning Kiosk it was essential to enable use by worriers and hurriers and as such both navigation buttons and touchscreen were provided as alternative ways to use the product. Using STUD Tables to analyse the physical and touchscreen keyboards prompted the invention of a keyboard to combine the best properties of both. These examples demonstrate how STUD Tables are not just useful in selecting an option, but can also prompt innovation.

6. Ongoing Application of The Psychological Stress Perspective

One of the many tools currently being developed in the AUNT-SUE (Accessibility and User Needs in Transport for Sustainable Urban Environments) project is a Journey Stress Calculator. This tool makes use of data collected about 103 individual people for HADRIAN (Human Anthropometric Data Requirements Investigation and ANalysis). The aim is to comprehensively model the stress that each individual will encounter on any given public transport journey. The results should improve understanding of what makes journeys stressful, why one journey is more stressful than another and indicate practical measures that may be taken to eliminate stressors from public transport. Another outcome from AUNT-SUE will be an Inclusive Journey Planner prototype (Porter et al., 2006). The Panic Matrix and Stud Tables will be used to inform the design of the prototype which will be used to provide guidance for future improvement of internet journey planners.

7. Conclusions

The stress perspective is appealing as it provides a way of unifying and quantifying the effects of physical, cognitive and emotional barriers in the use of products and systems. Because stressors can make a system inaccessible without being absolute barriers; stress theory can explain why people may avoid systems or products that they are capable of using. Stress affects everyone with its impact on physical and psychological health and is something that designers can empathise with. Most importantly in this work, the stress perspective is sympathetic to the social model of disability, as it considers what is wrong with the system, not what is wrong with the person. However, this approach does have some problems. Comprehensive identification of stressors in a system may be difficult and the quantification of stress in the proposed analysis tools is largely subjective. Also, the difficulty of measuring

stress and attributing it to stressors means that practitioners need a good understanding of stress theory and the language that goes with it.

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