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Design of instructions for evacuating disabled adults

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ABSTRACT

We investigated how the design of instructions can affect performance in preparing emergency stair travel devices for the evacuation of disable individuals. We had three hypotheses: 1) Design of instructions would account for a significant portion of explained performance variance, 2) Improvements in design of instructions would reduce time on task across device type and age group, and 3) There would be a performance decrement for older adults compared to younger adults based on the slowing of older adult information processing abilities. Results showed that design of instructions does indeed account for a large portion of explained variance in the operation of emergency stair travel devices, and that improvements in design of instructions can reduce time on task across device type and age group. However, encouragingly for real-world operations, results did not indicate any significant differences between older versus younger adults. We look to explore ways that individuals with disabilities can exploit these insights to enhance the performance of emergency stair travel devices for use.

1. Design of instructions for evacuating disabled adults

According to the Bureau of Labor Statistics (2015), 17.1% of persons with disabilities were employed in 2014. Demographically, 53% of people with disabilities were younger than age 65 (Bureau of Labor Statistics (2015)) and those individuals may well be employed by organizations that occupy high-rise buildings. Furthermore, there is a direct correlation between aging and the disability population. The 'graying of America' is resulting from the baby-boomer generation reaching the age of retirement as well as the elderly who are also living longer (Howden and Meyer, 2011). With older adults consisting of a large part of the workforce, many of whom have disabilities, there is a greater chance that they will be involved in emergencies that occur on the job. One such type of circumstance may well involve emergency evacuation (Ward, 2012).

In emergency evacuations, one of the most vulnerable and difficult populations to evacuate prove to be persons with disabilities. In the case of the 2001 World Trade Center, the evacuation of persons with disabilities slowed the progress of descent, according to 51% of the individuals in Tower 1 and 33% of the individuals in Tower 2 (Shields et al., 2009). A common procedure when preparing for evacuation of people with disabilities is to establish areas of refuge. An area of refuge may be a stairwell that has been reinforced to withstand a fire for an hour or more. The strategy is to give first responders time to get to that individual with the disability without having the individual impede the able-bodied evacuation. The problem with areas of refuge is that innately human beings do not want to leave that individual behind. In the case of September 11th, although there were areas of refuge for people with disabilities, all individuals with disabilities decided to fend for themselves instead of waiting for first responders (Shields et al., 2009). What this tells us is that there needs to be a system in place that doesn't rely on the area of refuge but rather takes an active approach in facilitating evacuation. Part of this system necessarily includes the use of assistive technologies, designed for emergency evacuation. This mandates an ergonomic evaluation of the corresponding instructions designed to facilitate their use.

1.1. Purpose of the research

Our purpose here then is to examine how the design of instructions contributes to novice users' understanding of assistive technology for emergency evacuation situations. In an emergency situation it is likely that individuals assisting with an evacuation will not have previous knowledge of, or experience with, such assistive technology. Clark and Lyons (2010) have developed

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recommendations to help support all novice learners. Their recommendations are applicable here and help found our own evaluation of this specific context. They opine that:

- Instructions should focus attention to key information to accomplish the task. In an evacuation, sensory systems may be overloaded. Research demonstrates that through providing salient signals and indications you can assist in reducing cognitive load.
- To help improve performance, instructions should use relationships that help individuals transfer knowledge from their previous experience.
- Instructions should provide feedback for both correct and incorrect actions so that error can be eliminated. This guideline echoes Norman's recommendation of using feedback to improve interface design (Norman, 2002).
- Effective instructions use graphics to provide step-by-step instructions to users. Step-by-step instructions provide scaffolding, which can help with comprehension.

1.2. Evacuation support for persons with disabilities

Many organizations have begun to improve their preparations of evacuating persons with disabilities through the use of "buddy systems". A buddy system pairs one individual with a disability with a group of volunteers known as buddies who are to assist in the event of an emergency. The volunteers within the buddy system get the individual out of harm's way as efficiently as possible. In an evacuation, the process is expedited through the use of assistive technologies. The formal definition of assistive technology is such: "*technologies, equipment, devices, apparatus, services, systems, processes, and environmental modifications used by the disabled and or elderly people to overcome social, infrastructural, and other barriers to independence, full participation in society, and carrying out activities safely and easily*" (Hersh and Johnson, 2008). Specific types of assistive technology used in evacuations by buddy systems are emergency stair travel devices. These help get the persons with disabilities down flights of stairs (Adams and Galea, 2011).

Extensive research on the use of different types of stair travel devices has been done assessing the impact on firefighters by Professor Steven Lavender and his colleagues at the Ohio State University. The researchers evaluated the use of carry-type, sled-type, and track-type descent devices. Their results included recommendations for shorter dimensions, integrated handles, and handle extensions which allow for ease of lowering and improved positioning for the individual performing the evacuation (Lavender et al., 2014, 2015; Mehta et al., 2015). The current research approaches the challenges of evacuation from a complementary perspective, in our attempt to assist with the preparation of these devices by novice users, including older adults.

Although older adults may not be ideal candidates to facilitate such evacuations, in true emergencies they may have to respond at a moment's notice as resources and personnel are limited. Therefore, these devices need to take into consideration the perceptual and cognitive processes of all adults, regardless of age. The most common scenario where such a situation may occur is in senior centers or assisted living facilities where the number of older adults needing assistance may well exceed the number of individuals to assist them.

1.3. Aging, stress and evacuation

Regardless of an individual's age, an emergency situation such as an evacuation involves stress (Hancock and Szalma, 2008; Hancock et al., 1995). Stress is the physiological response to situations and choices, each of which presents their own hazards and risks based on the action chosen. Research has shown that factors such as prior experience, effective coping skills, improved regulation of emotion (Hancock and Warm, 1989), and tolerance for negative affect lead to increased resilience by older adults in stressful situations (Southwick and Charney, 2012).

One of the most influential models of stress, which examines these factors, is the maximal adaptability model. Hancock and Warm (1989) developed this model of stress in the context of sustained attention although it applies across many capabilities. Variations in adaptability are represented on a continuum between two extremes of stress: namely, hypostress (under load) and hyperstress. Hypostress refers to a state of reduced information input that impedes performance. Hyperstress is typically characteristic of environments when the demand level of an individual is so high that they become incapable of performing efficiently (Hancock and Warm, 1989). Although older adults can show greater resilience to stress (Southwick and Charney, 2012) this is not always the case (Fozard et al., 1994). The goal, of course, is to sustain individuals at the most ideal state possible, also known as maximal adaptability. This can be accomplished by managing two different characteristics: information rate and information structure. Information rate is the temporal flow of activities in the environment, which in the case of an emergency, may be difficult to control. However, information structure relies on leveraging previous experience and common meanings to help reduce load in extreme environments (Hancock and Warm, 1989). It is here that clear procedures and concise instruction can exert their effect to turn incipient disasters into successful rescues.

2. Research design

Our work here thus investigates the impact of instructional redesign on the effective use of emergency stair travel devices. The research design consisted of an initial test, a pre-post evaluation that addressed the efficacy of an intervention in-between. The intervention was a redesign of operational instructions. The initial test served as a validation of all experimental measures. The pre-intervention study was conducted to establish a baseline of current device instructions. During redesign, focus groups were interviewed to provide input for graphical enhancements to instruction sets. The post-intervention study was a replication of the pre intervention study, with the new instructions added.

2.1. Experimental hypotheses

We explored whether improved design of instructions, through the use of graphical display, could improve task performance across age groups.

The three specific hypotheses were:

H1. : The design of instructions accounts for a significant portion of explained variance in the assembly of emergency stair travel devices as measured by a regression model including: spatial ability score, gender, age, mechanical ability, instructional glances, time on task and subjective workload scores according to the NASA-TLX.

H2. : Improvements in the design of instructions can reduce time on task across device type and age group.

H3. : There are performance decrements for older adults in comparison to younger adults based on the average cognitive slowing of information processing across age group (Fozard et al., 1994).