The Effect of Multimodal Feedback Presented via a Touch Screen on the Performance of Older Adults

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Abstract. Many IT devices – such as mobile phones and PDAs – have recently started to incorporate easy-to-use touch screens. There is an associated need for more effective user interfaces for touch screen devices that have a small screen area. One attempt to make such devices more effective and/or easy to use has come through the introduction of multimodal feedback from two or more sensory modalities. Multimodal feedback might provide even larger benefits to older adults who are often unfamiliar with recent developments in electronic devices, and may be suffering from the age-related degeneration of both cognitive and motor processes. Therefore, the beneficial effects associated with the use of multimodal feedback might be expected to be larger for older adults in perceptually and/or cognitively demanding situations. In the present study, we examined the potential benefits associated with the provision of multimodal feedback via a touch screen on older adults’ performance in a demanding dual-task situation. We compared unimodal (visual) feedback with various combinations of multimodal (bimodal and trimodal) feedback. We also investigated the subjective difficulty of the task as a function of the type of feedback provided in order to evaluate qualitative usability issues. Overall, the results demonstrate that the presentation of multimodal feedback with auditory signals via a touch screen device results in enhanced performance and subjective benefits for older adults.

Keywords: Multimodal User Interface, Multimodal Feedback, Multimodal Interaction, Older Adults, Touch Screen.

1 Introduction

According to a news item in USA TODAY (June 21, 2007), touch screen phones are poised for rapid growth in the marketplace. In addition to Apple’s iPhone®, many international electronics companies have recently launched touch screen phones as new cutting-edge user interfaces. The shipment of touch screens is projected to jump from less than 200,000 units in 2006 to more than 21 million units by 2012, with the bulk of the components going to mobile phones. USA Today quoted a maker of touch
sensors as saying that: "This new user interface will be like a tsunami, hitting an entire spectrum of devices". Unlike input devices such as the computer mouse that require translation from one plane of movement to another, that require extra space, and can have substantial summative movement time between different parts of the screen, touch screen user interfaces have a one-to-one relationship between the control and display, and often no additional training is necessary for their efficient use. Accordingly, touch screens are now being used extensively in a variety of application domains owing to the intuitiveness and ease of direct manipulation in use. Touch screens will also be beneficial to various user groups, in particular, for older adults (i.e., for those aged 65 and older), who may not be familiar with the recent developments in electronic devices, including complicated functions and structures and also have age-related degeneration in memory, sensory perception, and other aspects of cognitive and motor processing [1]. What is more, as the number of people over the age of 60 is expected to reach 1 billion by 2020, representing 22 percent of the world’s population (according to 2006 UN world population prospects), they are likely to become a major group amongst IT consumers.

Meanwhile, previous research has suggested that one of the most important factors determining the usability of touch screen interfaces is the size of menu buttons on the screen. It has been shown that touch screens only provide significant benefits to users when the size of the buttons is made sufficiently large [2, 3]. However, although some applications involving touch screen interfaces, such as information kiosk displays and ATMs, have sufficient space on the screen, others such as mobile phones and PDAs have only limited screen space. Considering that various devices with multiple functions in the IT industry are focused on the miniaturization of portable smart phones including mobile phones and PDAs, the limitation of the screen space represents one of the most important challenges in the field of mobile user interface design. Moreover, this spatial limitation of touch screen devices may constitute a greater constraint for older adults than for younger adults. Consequently, researchers have attempted to integrate information from different sensory modalities in order to overcome the spatial limit of visual information displays. For instance, Gaver (1989) proposed that auditory confirmation might provide a more obvious form of feedback for users than only visual feedback [4], while Akamatsu and Sato (1994) demonstrated that tactile or force feedback can be effectively linked to information provided via a visual display, to give users the advantage of faster response times (RTs) and a more extended effective target area [5].

What is more, certain types of multimodal feedback can enhance performance in direct manipulation tasks consisting of a series of ‘drag-and drops’ using a mouse, while lowering self-reported mental demand [6]. In this context, the present study was designed to provide empirical evidence regarding the benefits of multimodal (or multisensory) interfaces specifically for older adults. We investigated this issue using a touch screen device, asking whether multimodal feedback can help older adults overcome the constraints of screen space in a dual task situation. RTs, error rates, and subjective ratings of type of feedback were measured.

We conducted an experiment with older adults comparing unimodal (visual), bimodal (auditory + visual, tactile + visual), and trimodal feedback (auditory + tactile + visual) in response to button click events while participants dialed a series of numbers into a touch screen mobile phone. We investigated whether different combinations of