Cultural Similarities and Differences in User-Defined Gestures for Touchscreen User Interfaces

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Abstract

As the first phase of a two-phase project, the International Usability Partners (IUP; http://www.international-usability-partners.com/) conducted a study in nine different countries to identify cultural similarities and differences in the use of gestures on small, handheld, touchscreen user interfaces. A total of 340 participants in the study were asked to define their own gestures for 28 common actions like "zoom" and "copy" on a custom-constructed gesture recorder that simulated a handheld touchscreen device. Actions were described pictorially by showing participants a "before" screen and an "after" screen to clarify the exact context for each action.

Initial analysis suggests four primary findings. The first is that there is generally a high level of agreement across cultures. One exception, however, is the use of symbolic gestures; Chinese participants created significantly ($p < .01$) more symbolic gestures (e.g. letters, question mark, check mark) than participants from other countries. The second finding is that experience with gesture-enabled devices influenced the gestures that participants created for the following

actions: back, forward, scroll up, and scroll down. The third finding is that when a gesture to elicit an action was not immediately identifiable, participants generally tapped on the screen to bring up a menu. The final finding is that there is higher agreement on actions that can be performed through direct manipulation and lower agreement scores on actions that are more symbolic in nature.

Phase two of this research effort will be to present the most common three to five user-defined gestures for each action to a large number of participants and ask them to select the gesture that they believe to be the most intuitive gesture for that action.

Keywords
User Experience, Gesture-Based User Interfaces, Multi-Touch Devices, Cultural Differences

ACM Classification Keywords
H.5.2 User Interfaces; H.1.2 User Machine Systems: Human Factors

General Terms
Design, Human Factors

Introduction

In *Designing Gestural Interfaces* Dan Saffer states the following regarding gestural interaction design: "We've entered the era of interactive gestures. The next several years will be seminal years for interaction designers and engineers who will create the next generation of interaction design inputs, possibly defining them for decades to come … We have an opportunity that comes along only once in a generation, and we should seize it" [4].

As Saffer indicates, the upcoming years are important for gestural interaction design. One reason is that touchscreen displays that support gestures are being integrated into an ever increasing number of devices. A second reason is that technology has evolved to the point that it is no longer the major limiting factor; the opportunity exists to define gestural interactions based on what is most efficient and natural for people and not on what can be sensed and processed by technology.

The literature contains much research on gestural interaction with devices. Some examples of more comprehensive reference texts include a book chapter by Nielsen *et al.*, which provides a summary of gesture technologies, taxonomies, human factors, and design guidelines [5], and Saffer's book, which includes design patterns and methodology related to gestural interaction design [4]. There are also a number of papers related to specific aspects of gestural interaction. For example, work by Wobbrock *et al.* examines user-defined gestures [6], a paper by Wu *et al.* proposes principles for multi-touch multi-hand gestures [7], and an article by Morris *et al.* identifies issues for cooperative gestures [2].

There is also research on the relationship between nonverbal communication and culture. Gesture is one form of nonverbal communication. For example, research has determined that there are cultural differences in frequency, rhythm, viewpoint, and description of motion [1]. In addition, it has been determined that emblems are strongly associated with culture; emblems convey a simple meaning without the aid of speech [3]. For example, a thumbs-up sign in the United States and England means OK, but it is considered to be an insult in many other countries.

As indicated above, there is research on gestural interaction and the relationship between nonverbal communication and culture. There is, however, little research on how gestural interactions on a touchscreen display vary by culture. The study described in this paper is intended to address this research area and provide insight regarding preferred touchscreen gestures by culture.

This paper describes a global study conducted by the International Usability Partners (IUP; http://www.international-usability-partners.com/), an established network of 12 independent usability companies based in 12 different countries who have joined to provide user experience services worldwide. The study involves collecting, classifying, and analyzing user-defined gestures for 28 common actions on a small, handheld, touchscreen user interface from 340 participants in 9 different countries.

The overall goal of this study is to provide insight to designers who are defining gesture sets for multi-cultural users of touchscreen interfaces.

Achieving this goal involves addressing the following research questions:

- What gestures are made for common actions on a touchscreen user interface?
- Which gestures for common actions on a touchscreen user interface vary by culture?
- Does experience with touchscreen devices affect what gestures are made and does that vary by culture?

Method

The IUP Research Team designed the study to ensure consistency among all participating member organizations. Each member organization conducted the study in its respective country and then sent all data to the IUP Research Team for analysis and reporting. Participants in the study made gestures for common actions like zoom and copy on a custom constructed gesture recorder that simulated a handheld touchscreen device.

Participants

Member organizations in the following 8 countries recruited 40 participants each: China, Finland, France, Germany, India, Spain, the UK, and the US. The member organization in Italy recruited 20 participants; Italy was dropped from several analyses due to the smaller sample size.

The participants were native speakers of the language of the country and between 20 and 60 years old. The participants used computers at least 3 times a week for purposes other than browsing the internet. Roughly half of the participants per country were male and half were female. Additionally, half of the participants per country owned a touchscreen device and half did not have experience with touchscreen devices.

The participants were compensated for participating in the study. Each session averaged between 20 and 30 minutes.

Materials

The IUP Research Team created images to describe actions to participants and a device for recording gestures.

"Before" and "After" Screens

The IUP Research Team defined the following 28 actions and asked the participants to make gestures with which they would perform these actions on a touchscreen user interface: multi-select, move object, delete, scroll down, scroll up, continuous scroll, stop scroll, open menu, open folder, close folder, accept/verify, home, help, zoom in, zoom out, magnify, rotate image, pitch, save, print, minimize, back, forward, cut, paste, undo, redo, and copy.

Describing an action verbally or with text could influence participants or lead to country effects due to translation differences. As a result, these actions were described pictorially by showing participants a "before" screen and an "after" screen to clarify the exact context for each action. The instruction for the example in Figure 1 would be as follows: "Please perform a gesture with which you would select different items at once."

Figure 1: Example "before" and "after" screens for the multi-select action.

Gesture Recorder

To record the gestures for later analysis, the IUP Research Team constructed a gesture recorder (Figure 2) that consisted of three parts: base, neck, and camera.

The base was designed to simulate a handheld touchscreen device. It consisted of an opaque plastic body and a removable transparent acrylic plate. Moderators inserted the printed versions of the "before" screens under the plate. Participants performed gestures on the screen after dipping their finger(s) in powdered charcoal. The charcoal left a trace of the gesture, which could be referenced in pictures and video in later analyses (Figure 2). The base could be held or placed on a surface.

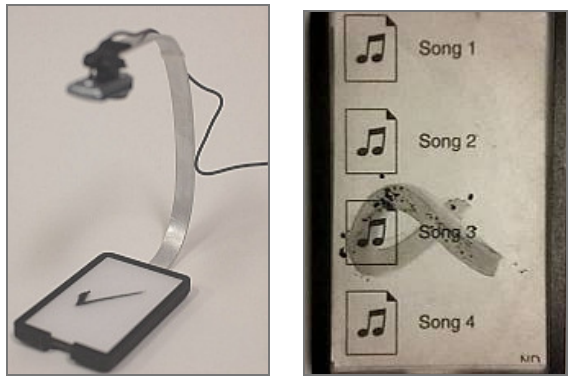

Figure 2: Gesture recorder (left) and an example "delete" gesture (right)

The neck, which was made of 3mm thick aluminum, secured the webcam to the base, managed the webcam's cable, and maintained a consistent camera position to record the gestures.

The camera was a USB webcam that was capable of recording video at a 640x480 resolution at 10 frames per second.

Protocol
Each session consisted of one moderator from an IUP member organization and one participant. The moderator began each session by welcoming the participant and explaining the general setup including the "before" and "after" screens and the gesture recorder. The moderator then asked the participant some questions to warm up the participant and establish the extent of the participant's experience with touchscreen devices. Thereafter, the moderator led the participant through an example action to familiarize the participant with making a gesture on the gesture recorder. Then for each of the 28 actions, the moderator inserted the "before" screen in the gesture recorder base, showed the participant the "before" and "after" screens, asked the participant to create a gesture that would result in the "after" screen, discussed the created gesture with the participant, and cleaned the display of the gesture recorder base. The moderator concluded the session with general discussion about the gestures that the participant made.

Data Reduction
For data analysis, the IUP Research Team defined a taxonomy for describing gestures. One example category used in the taxonomy was whether the gesture was a symbolic gesture (e.g. a question mark) or a direct manipulation gesture (e.g. tapping or dragging an object).

After collecting data, each moderator reviewed the video and described each gesture according to the taxonomy. To promote consistency, the moderators created an online gesture glossary that contained pictures and textual descriptions of unique gestures. If a participant made a gesture that was in the glossary, the moderator simply referenced it. If a participant made a unique gesture that was not yet in the glossary, the moderator created a new entry, thereby making that new gesture available to all subsequent moderators to reference.

Results
The data analysis is still in its early stages. The IUP Research Team has run initial analyses that suggest a few trends and provide general insight.

A primary finding is that there are few cultural differences in the gestures that participants created for individual actions. While there are small differences between countries, the majority of the time participants from different countries generated similar gestures for individual actions. Thirty-eight gestures were used at least 40 times across the entire study; a chi-square test for each gesture comparing frequency counts for the 8 countries (excluding Italy) indicates that none of the gestures was used more in one country than another ($p > .1$). This finding is good news for designers of products with a user base covering the countries in this analysis. The major exception to this general finding, however, is related to the use of symbolic gestures. An 8x2x2 ANOVA for Country (excluding Italy) x Gender x Experience indicates that China uses more symbolic gestures than all other countries ($p < .01$).

Another finding is that experience with gesture-enabled devices did influence the gestures that participants made for the following actions: back, forward, scroll up, and scroll down. For example, for the scroll down action, approximately 70% of owners of existing devices that use a swiping motion to scroll swiped up to scroll down. In contrast, about 50% of participants who own devices that use arrow keys or scroll bars swiped down to scroll down.

A third finding is that despite the request by all moderators for participants to create gestures that did not require a menu, many participants still requested a menu when they had difficulty thinking of a gesture. By far, the preferred action for requesting a menu was to tap the screen.

Lastly, there was a clear trend towards higher agreement scores on actions that could be performed through direct manipulation and lower agreement scores on actions that were more symbolic in nature. A Jaccard agreement score was created for each action. For example, the top three agreement scores for direct manipulation actions were move (0.91), rotate (0.55), and stop scroll (0.48). The top three for symbolic actions were accept/verify (0.46), delete (0.26), and back (0.25). The average agreement score for direct manipulation actions was 0.35 and the average for symbolic actions was 0.18.

The results presented here focus on user-defined gestures for small handheld devices. The response set was constrained only by the participants' imaginations. Phase two of this research effort will focus on determining which gestures are the most preferred for which actions and whether preference varies by culture.

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