

Cultural differences and similarities in the use of gestures on touchscreen user interfaces

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User experience, gesture based user interfaces, multi-touch devices, cultural differences

Abstract

The International Usability Partners (IUP) have conducted a study in nine countries to identify cultural differences and similarities in the use of gestures on touchscreen user interfaces. Touchscreen-experienced and -inexperienced people performed gestures to trigger common actions, such as deleting an item or scrolling a page. A lo-fi prototype simulating a touchscreen handheld device was used to present “before” screen images that clarified the context of each action. Participants were then requested to make a gesture that would then result in the corresponding “after” screen image.

It can be concluded that the cultural similarities found in this study outweigh the differences. In many cases the participants from China, Finland, France, Germany, India, Italy, Spain, UK and USA generated similar gestures for individual actions. This finding is good news for designers of multi-touch user interfaces covering the countries in this analysis. However, there is one exception that should be taken into consideration when designing for a global audience. Chinese users created a significantly higher number of symbolic gestures (e.g. question mark, letter, check mark) compared to all other participating countries.

Considering the cultural variations in the results of each country, this work also presents a starting point for the creation of a gesture set for actions investigated in this study. It, however, strongly recommends further testing of this gesture set.

Introduction

Some believe we have entered a new era in interaction design (Saffer, 2008). For many years we have been using the mouse, pointstick, touchpad and of course, the keyboard. A new interaction convention is gaining popularity now, making use of the whole body. This convention is to interpret gesture-based body movements to control software, the most common of which is to recognize hand gestures on touchscreens. While mobile phones are the most popular products that use touchscreen hand gestures, there are many other products under development and on the market that use touchscreens such as ovens, refrigerators, laptops, automobiles, and insulin pumps. With the increased availability of touchscreens, the desire to enable gestures will follow.

There have been some early studies on gestural interaction with devices. Some reference texts include a book chapter by Nielsen, Moeslund, Storrang, and Granum (2008) which provides a summary of gesture technologies, taxonomies, human factors, and design guidelines and a book written by Saffer (2008) which includes design patterns and methodology related to gestural interaction design. Some studies on gestures have also been published. For example, work by Wobbrock, Morris, and Wilson (2009) examines user-defined gestures, a paper by Wu, Shen, Ryall, Forlines, and Balakrishnan (2006) proposes principles for multi-touch multi-hand gestures, and an article by Morris, Huang, Paepcke, and Winograd (2006) identifies issues for cooperative gestures.

It is also well-known that there are cultural differences in gestures used in nonverbal communication. Rehfeld, Jentsch, and Rodriguez (2004) have shown that emblems, gestures that convey a simple meaning without the aid of speech, are strongly associated with culture. 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.

While there is some research on gestural interaction and the relationship between gestural emblems and culture, there is, however, little research on how gestural interactions on a touchscreen display vary by culture. Yet, many of the products that enable gestures will be intended for a global audience. Designers have a definite need to know how understandable and universal gestures are, while the field is still young.

The International Usability Partners (IUP) have run a global study aimed at identifying the most common user-generated gestures for control of a touchscreen. The IUP is an established network of 12 independent usability companies based in 12 different countries (including Belgium, China, Chile, Finland, France, Germany, India, Italy, Spain, Sweden, UK, and USA) who have joined to provide user experience services worldwide. This research involved collecting, recording, classifying, and analyzing user-defined gestures for 28 common actions (like scroll, open, rotate, zoom in, cut, copy, paste) of 340 participants across 9 countries (China, Finland, France, Germany, India, Italy, Spain, UK, USA), totaling over 9,500 gestures.

The research questions can be summarized as follows:

- What are the common gestures users created for familiar software actions? These common gestures will give designers insight into users' first inclinations of how they would expect to interact with a gesture-enabled touchscreen.
- Are there any cultural differences reflected in the gestures users created?
- Is there a cultural influence in the generation of different types of gestures? Specifically, does culture influence the number of direct manipulation or symbolic gestures generated?
- Are there differences between people familiar with current touchscreen products enabling gestures and those unfamiliar with those products?

Method

To ensure consistency among all participating countries, the IUP Research Team aimed to keep the design of the study as simple as possible and piloted the study in two of nine countries first (US, Germany). The team then updated the study protocol with lessons learned and best practices afterward and provided it to the remaining countries.

Participants

Eight of the participating countries recruited 40 participants and one country recruited 20¹. The participants were segmented into two different user groups. The first group included people who did not own a touchscreen mobile phone and had limited mobile device touchscreen experience. Participants of this "novice" group were expected to be less influenced by learned conventions of current touchscreen user interfaces. With this group the IUP Research Team attempted to identify basic interaction principles rather than existing conventions. Designers wanting to identify new sets of users would be particularly interested in this group. The second group consisted of people who own a touchscreen mobile phone and represent the group of "experts". They allowed the IUP Research Team to identify trends being developed because of the experiences that people already have with products.

Stimuli set

The primary goal for each country was to gather a set of gestures that can be used to invoke *actions* in software. In this context, *actions* can be any simple task, such as deleting, copying, zooming, etc. Using Dan Saffer's (2008) set of actions described in his book "Designing

¹ The Italian sample consisted of 20 users and was dropped from several analyses due to the smaller size.

gestural interfaces” as a starting point, the IUP Research Team defined 28 actions relevant in a mobile usage context and asked participants to identify a gesture with which they would perform these actions on a touchscreen. Table 1 shows the 28 actions:

Table 1: Actions for which participants had to find a gesture

Actions		Actions	
1	Multi select	15	Zoom out
2	Move object	16	Magnify
3	Delete	17	Rotate image
4	Scroll down	18	Pitch
5	Scroll up	19	Save
6	Continuous scroll	20	Print
7	Stop scroll	21	Minimize
8	Open menu	22	Back
9	Open folder	23	Forward
10	Close folder	24	Cut
11	Accept/Verify	25	Paste
12	Home	26	Undo
13	Help	27	Redo
14	Zoom in	28	Copy

The study protocol relied very little on verbal communication for describing an action where the mere description itself could influence the participant’s gesture. The translation of that description across multiple languages would increase the chance of that occurring. Thus, 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.”

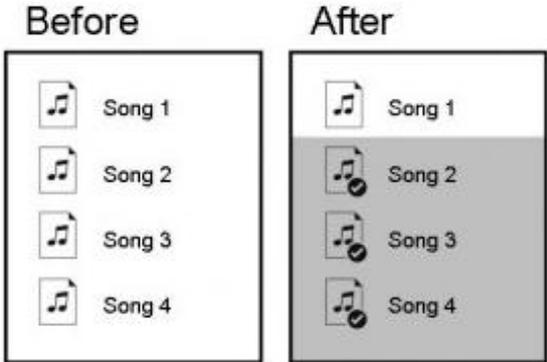


Figure 1: Example “Before” and “After” screen for action “Multi select”

Apparatus and procedure

Gestures were made using a custom-constructed rig representing a small touchscreen device (Figure 2 left). This lo-fi prototype allowed the “before” screen to be placed on the rig so the gesture could be made directly on the screen, while the “after” screen was shown separately. A webcam was mounted on a neck over a base where the gesture was performed. Every country used the same gesture rig for recording the gestures to ensure a consistent video output. Participants dipped their finger in powdered charcoal before each gesture so the gesture could be photographed later for record keeping (Figure 2 right). Each session lasted approximately 20 to 30 minutes.



Figure 2: Gesture rig for collecting and recording gestures (left) and an example gesture for the action “delete” (right).

Data analysis

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 or a direct manipulation gesture. Direct manipulation gestures are gestures that enable a user to directly manipulate an object on the screen, such as tapping and dragging objects. Symbolic gestures are gestures that assign a more abstract, but related gesture to a action, such as making an “X” to delete something or a “?” for help. The symbolic gestures were hypothesized to have the biggest potential for showing differences across cultures.

After collecting data, the researchers reviewed the videos and manually classified all 9520 recorded gestures according to this taxonomy. To promote consistency, the researchers 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 researchers to reference.

Results

Popular gestures

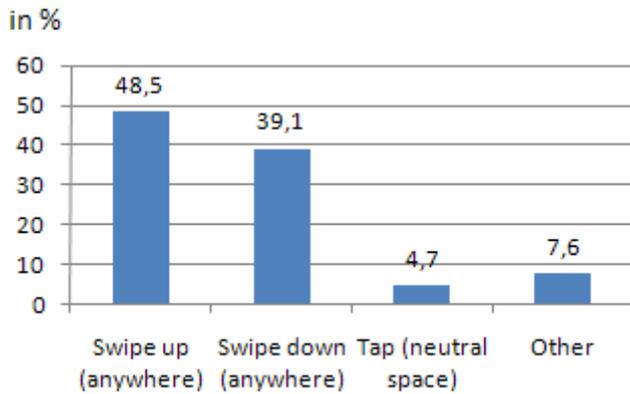
One of the primary questions of the IUP Research Team was what gestures did participants create the most frequently? To review the results, the IUP Research Team first sorted the data from most frequent to least frequent. The team then also looked at the individual results from each country. The table below represents these findings for a selection of actions, showing the overall percentages of the three most popular gestures and collapsing the rest of the gestures into the “other” category. For a complete list, please contact the authors.

Table 2: The most frequently used gestures (in %) for a selection of actions

Back (browser)											
<p>in %</p> <table border="1"> <thead> <tr> <th>Gesture</th> <th>Percentage (%)</th> </tr> </thead> <tbody> <tr> <td>Swipe left (anywhere)</td> <td>37,4</td> </tr> <tr> <td>Swipe right (anywhere)</td> <td>29,1</td> </tr> <tr> <td>Tap (anywhere)</td> <td>15,6</td> </tr> <tr> <td>Other</td> <td>17,9</td> </tr> </tbody> </table>	Gesture	Percentage (%)	Swipe left (anywhere)	37,4	Swipe right (anywhere)	29,1	Tap (anywhere)	15,6	Other	17,9	<p>Going back on a browser page was performed by a “swipe left” anywhere on the screen by more than a third of all participants. In fact, all (9 of 9) countries performed this gesture the most or second most.</p>
Gesture	Percentage (%)										
Swipe left (anywhere)	37,4										
Swipe right (anywhere)	29,1										
Tap (anywhere)	15,6										
Other	17,9										
Delete (e.g. delete a song from a list of songs)											
<p>in %</p> <table border="1"> <thead> <tr> <th>Gesture</th> <th>Percentage (%)</th> </tr> </thead> <tbody> <tr> <td>Drag object (anywhere)</td> <td>42,9</td> </tr> <tr> <td>Swipe object</td> <td>20,6</td> </tr> <tr> <td>X on object</td> <td>17,6</td> </tr> <tr> <td>Other</td> <td>18,8</td> </tr> </tbody> </table>	Gesture	Percentage (%)	Drag object (anywhere)	42,9	Swipe object	20,6	X on object	17,6	Other	18,8	<p>42,9% of all participants used the gesture “drag object” to delete a song. Again, in all countries, this gesture was among the top 2 performed gestures.</p>
Gesture	Percentage (%)										
Drag object (anywhere)	42,9										
Swipe object	20,6										
X on object	17,6										
Other	18,8										

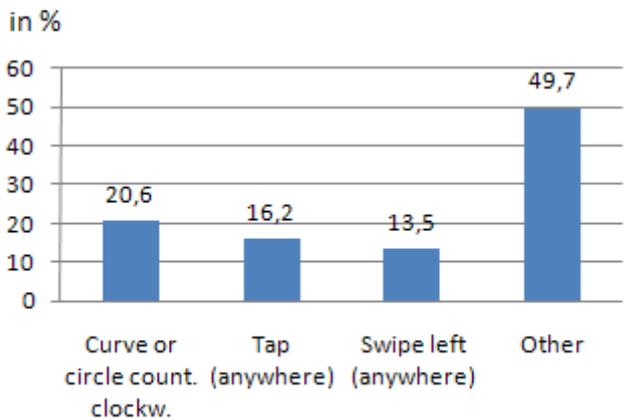
Help											
<p>in %</p> <table border="1"> <thead> <tr> <th>Gesture</th> <th>Percentage (%)</th> </tr> </thead> <tbody> <tr> <td>Tap (anywhere)</td> <td>38,2</td> </tr> <tr> <td>Question mark (anywhere)</td> <td>24,7</td> </tr> <tr> <td>Press and hold</td> <td>10,3</td> </tr> <tr> <td>Other</td> <td>26,8</td> </tr> </tbody> </table>	Gesture	Percentage (%)	Tap (anywhere)	38,2	Question mark (anywhere)	24,7	Press and hold	10,3	Other	26,8	<p>The most common gesture to access help from the home screen was “tapping anywhere” on the screen (38,2%). All countries also used this gesture the most or second most.</p>
Gesture	Percentage (%)										
Tap (anywhere)	38,2										
Question mark (anywhere)	24,7										
Press and hold	10,3										
Other	26,8										
Multi select											
<p>in %</p> <table border="1"> <thead> <tr> <th>Gesture</th> <th>Percentage (%)</th> </tr> </thead> <tbody> <tr> <td>Swipe objects</td> <td>47,4</td> </tr> <tr> <td>Tap objects consecut.</td> <td>25,6</td> </tr> <tr> <td>Tap objects simultan.</td> <td>5,0</td> </tr> <tr> <td>Other</td> <td>22,1</td> </tr> </tbody> </table>	Gesture	Percentage (%)	Swipe objects	47,4	Tap objects consecut.	25,6	Tap objects simultan.	5,0	Other	22,1	<p>Almost half of the participants used the gesture “Swipe across multiple objects” to select multiple items (e.g. 3 songs in a list of songs). 9 of 9 countries used this gesture the most or second most.</p>
Gesture	Percentage (%)										
Swipe objects	47,4										
Tap objects consecut.	25,6										
Tap objects simultan.	5,0										
Other	22,1										
Open menu											
<p>in %</p> <table border="1"> <thead> <tr> <th>Gesture</th> <th>Percentage (%)</th> </tr> </thead> <tbody> <tr> <td>Tap (anywhere)</td> <td>32,1</td> </tr> <tr> <td>Press and hold object</td> <td>30,3</td> </tr> <tr> <td>Multi tap (anywhere)</td> <td>21,5</td> </tr> <tr> <td>Other</td> <td>16,2</td> </tr> </tbody> </table>	Gesture	Percentage (%)	Tap (anywhere)	32,1	Press and hold object	30,3	Multi tap (anywhere)	21,5	Other	16,2	<p>Opening the context menu for an object (e.g. a song in a list of songs) was mostly attempted by “tapping anywhere”. 8 of 9 countries had this gesture among the top 2 performed gestures. 1 of 9 countries preferred the gesture “multi tap anywhere” in order to trigger the context menu.</p>
Gesture	Percentage (%)										
Tap (anywhere)	32,1										
Press and hold object	30,3										
Multi tap (anywhere)	21,5										
Other	16,2										

Scroll down



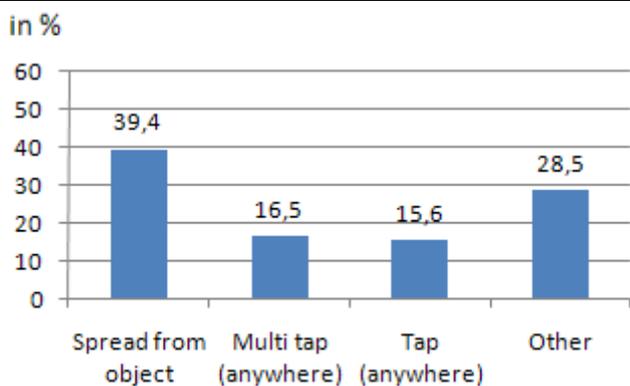
When scrolling down a page, 48,5% of all participants performed a “swipe up” anywhere on the screen. This was the most or second most popular gesture in 8 of 9 countries. The remaining country chose “swipe left or right in neutral space” as the most preferred one.

Undo



The relatively large “other” category (49,7%) reflects the low agreement of gestures on this action. 20,6% of all participants performed a “curve or circle counter clockwise” in order to undo their last command. 6 of 9 countries used this gesture the most or second most. 3 of 9 countries used “tap anywhere” in combination with the “letter X”, “multi tap” or the gesture “swipe left” the most or second most.

Zoom in



The dominant gesture to “zoom in” a map was to spread two or more fingers from the object. 8 of 9 countries used this gesture the most or second most. The UK did not perform this gesture at all, but used “multi tap anywhere” and “tap anywhere” to the same extent.

Types of gestures

Table 3 shows a ranking of the most frequently used gesture types across all actions and countries. Gestures performed by less than 40 participants were not included in this table.

Table 3: Types of gestures used

Type of gesture	Amount of gestures	% of all recorded gestures
Swipe	3095	32,50%
Tap	2132	22,40%
Multi tap	1020	10,70%
Circle, curve or loop	710	7,50%
Press and hold	495	5,20%
Letter/word other than X	279	2,90%
Spread	247	2,60%
Pinch (any # of fingers)	163	1,70%
X	107	1,10%
Check mark	98	1,00%
Question mark	84	0,90%
Release press and hold	61	0,60%
Swipe and hold	52	0,50%
Simultaneous press and hold and swipe	40	0,40%

More than half of all recorded gestures were swipes and single taps. The frequent usage of the “tap” gesture reflects the observation that participants imagined a button or context menu to trigger the required action with a tap, especially when they had difficulty thinking of an appropriate gesture. This was the case despite the request by all moderators to create gestures that did not require a softkey.

Cultural differences

A primary finding, based on a visual inspection of the results, is that there are few cultural differences in the gestures that participants created for individual actions. As shown in Table 2, in many cases the top overall gesture was either the first or second most generated gesture for all of the individual countries, demonstrating the similarity of the countries’ data. The research team found no pattern to any of the differences that was explainable as based on culture (aside from the pattern described below). While there are small differences between countries, the majority of the time participants from different countries generated similar gestures for individual actions. This finding is good news for designers of products with a user base covering the countries in this analysis.

However, there is one exception to this general finding. The IUP Research Team conducted a statistical analysis² and found that China created more symbolic gestures than all other countries ($p < .05$). Germany used more than France and Finland, while India and the UK also used more than Finland. One possible explanation for the significant difference in the use of symbolic gestures between China and all other countries might be the unique script in China. Figure 3 below graphically shows these results.

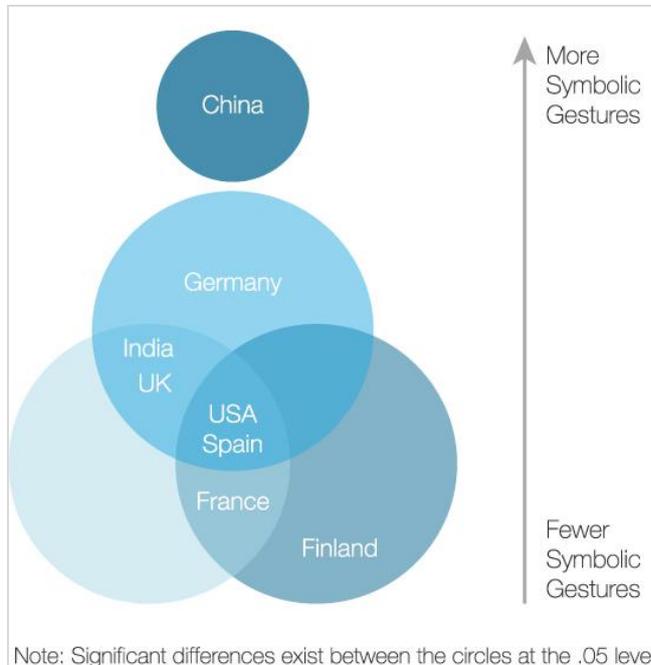


Figure 3: Usage of symbolic gestures by country

To put these results in a context, it should be noted that in total, 91% of all gestures were classified as direct manipulations and 9% of all gestures were symbolic in nature.

The significantly higher amount of symbolic gestures performed by Chinese users compared to all other countries raises the question of whether designers for global products should enable the entry of symbolic gestures or selected Chinese characters for the Chinese market. Since symbolic gestures were used so little overall, the IUP Research Team came to the conclusion that this finding has a relatively small impact for global design, but might be interesting for local design in China, e.g. designers could create symbolic gestures with more confidence of their acceptance.

² An 8 x 2 x 2 ANOVA analyzed the differences in the use of symbolic versus direct manipulation gestures shown by 8 Countries (China, Finland, France, Germany, Finland, India, Spain, UK, USA), 2 Genders (Male, Female), and 2 levels of Experience (Expert, Novice). This analysis showed the main effect of Country was significant ($p < 0.01$), as was the interaction between Country and Gender ($p < 0.05$). A least significant difference test was used to further analyze the main effect of country to determine which countries differed from the others.

Experiential differences

As mentioned earlier, 40 people participated in the study in every country (excluding Italy), 20 of which were novices to touchscreen interfaces and did not own a touchscreen device and 20 of which were experts and did own a touchscreen handheld device. An examination of the dataset found novices and experts were very similar in the gestures they created, with one primary exception.

Ownership of gesture-enabled devices did influence the gestures that participants made for the following actions: back, forward, scroll up, and scroll down. These actions are directional in nature (people tended to view the “Back” action as retrieving a page to the left of the visible page and the “Forward” action as retrieving a page to the right of the visible page). Swiping up to scroll down is a behavior found in most touchscreen devices that do not show scroll bars and that are “finger-driven” touchscreen interfaces. Swiping down to scroll down is a behavior found in most non-touchscreen devices (those that use navigation keys) and in touchscreen interfaces that do show a scroll bar, most commonly found on “stylus-driven” touchscreen interfaces.

In the end, we found that those participants who own a finger-driven touchscreen phone were more likely, in general, to swipe up to Scroll Down, swipe down to Scroll Up, swipe left to go Forward, and swipe right to go Back. In contrast, those participants that did not own a finger-driven touchscreen were more likely to adopt the opposite behavior. For example, for the scroll down action, approximately 70% of owners of existing devices that used a swiping motion to scroll swiped up to scroll down.

Local and media exposure of touchscreen devices likely impacted a few participant responses as well. Users who did not have a touchscreen would sometimes perform gestures they had either seen on a friend’s phone or had seen in advertising for a multi-touch phone like the iPhone. In cases like these, it’s arguable as to whether the gestures performed were naturally instinctive, but it did demonstrate that the gestures users were exposed to felt natural enough for them to reproduce them from memory.

Discussion

Gesture set

This study aims at helping designers understand how users expect to interact with a gesture-enabled touchscreen. One additional, but important, way to examine the results is to use the data to suggest a gesture set for the 28 investigated actions. Table 4 below presents a starting point for the creation of a gesture set. This initial approach is offered with a few caveats:

- These gestures were collected independently. At times, similar, or even the same, gestures were created for dissimilar actions. In creating this starting point gesture set, the authors applied tradeoffs that assigned the most frequently generated gestures to the most frequently used actions. At times, this resulted in assigning a gesture to the less frequently used actions that was not the gesture generated by the most participants.
- Gestures are interdependent, and a gesture set needs to be evaluated as a complete set. This starting point gesture set has not been evaluated as a complete set and it should before it is used in a product.
- These data were collected with a lo-fi prototype instead of an interactive touchscreen device to focus on the user's intuitive behaviour unaffected by the system's response. As a result, there was no system feedback to the user so users were unable to learn and adapt based on the system's response.

For some actions below, two proposed gestures are presented. One gesture is designed to open a context sensitive menu. Participants consistently requested these for some actions, and they are particularly useful for novice users. However, a second gesture is also presented and is aimed at the more experienced user who would like a shortcut for frequently used actions without requiring access to a menu.

Table 4: Cross-cultural gesture set

Actions	Proposed gesture
Accept/Verify	Check mark on object
Back	Swipe right anywhere
Close folder	Tap object
Continuous scroll down	Swipe up repeatedly anywhere
Copy	Press and hold object (to open context menu) Shortcut: letter C anywhere (needs to be localized)
Cut	Press and hold object (to open context menu) Shortcut: Flick object (goes to clip board)
Delete	X on object (multi stroke gesture)
Forward	Swipe left anywhere
Help	Question mark anywhere
Home	Press and hold anywhere (to open context menu) Shortcut: Simultaneous tap anywhere with 3 fingers
Magnify	Spread from object
Minimize	Swipe diagonal

Move object	Drag / Swipe object
Multi select	Sequentially press and hold object, then swipe across multiple objects
Open folder	Tap object
Open menu	Press and hold object
Paste	Press and hold anywhere (to open context menu) Shortcut: Carat where the user wants the item to be
Pitch	Simultaneous press and hold object and swipe any direction
Print	Press and hold anywhere (to open context menu) Shortcut: Letter P (needs to be localized)
Redo	Simultaneous press and hold anywhere and curve or circle clockwise
Rotate image	Curve or circle clockwise on object
Save	Press and hold anywhere (to open context menu) Shortcut: Letter S anywhere (needs to be localized)
Scroll down	Swipe up anywhere
Scroll up	Swipe down anywhere
Stop scroll	Tap anywhere
Undo	Simultaneous press and hold anywhere and curve or circle counter clockwise
Zoom in	Spread from object
Zoom out	Pinch with any # of fingers on object

As mentioned above, this starting point gesture set needs to be tested before it is implemented. While it represents the results of the most favorable tradeoffs based on the data collected, there are still instances where the suggested gesture was a very low frequency gesture generated by a particular country. For example, only 1 of 40 people in Finland performed the question mark gesture for help, and no participant in the UK performed the spread gesture for zoom in. Testing this gesture set would tell the researcher if these gestures are easily learned and thus adaptable to by the population, or if that population needs to be treated differently.

Conclusion

The International Usability Partners (IUP) sponsored a research study to examine the cultural influence on touchscreen gestures meant for handheld devices. The study collected and examined the user-generated gestures for 28 actions of 340 people across nine different countries. The results presented herein give insight to designers of users' first inclinations of how they would expect to interact with a gesture enabled touchscreen interface. Examination of the detailed results gives further insight into the influence of culture on that

first inclination. While nine countries did participate in this study, there are many other countries that are the target market for global products enabling touchscreen gestures and designers should be careful not to generalize these results beyond the countries represented in this research.

Acknowledgements

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