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How well can we Memories? Finding an App with Customized Touch Gesture on Smartphone

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Abstract. Smartphones have become the hub of people lives, on average, smartphone users have around a hundred apps installed on their devices where the number is ever growing. Approaches have been propose to allow user fasting access a small number of apps via the user-self defined gesture shortcuts. However, when the number of installed app keep increasing, can we still able to memories all these shortcuts remains unclear. Thus, it becomes more and more crucial to make sure the similar approaches can be applied for finding any target of our installed apps among a rather lager number of installed apps. In this paper, we conduct a study to understand the memorability of user-defined gestures when being used to access 15 frequently used mobile apps by 33 participants. Our results show that: (1) participants have achieved over 90% recall rate with their self-defined gesture shortcuts and (2) for those apps that users did not recall their gesture shortcuts successfully, there is a strong correlation between the mobile app icon design and the gesture creation.

Keywords: gesture-based interaction, mobile computing, touch gesture, mobile search, memorability

1. Introduction

Smartphone has become the hub of people lives due to the enormous number and type of apps available in app stores to support their daily tasks [13]. In the UK, two thirds of adults now own smartphones and use them for nearly 2 hours a day to support their daily activities [9]. On average, smartphone users have around 100 apps installed on their devices and this number is ever growing [14,2]. Thus, there is an increasing need for enabling fast access to these apps [5]. With only system defined mechanisms such as searching (via keywords) and browsing (through app list), this task is now becoming more and more challenging [11]. For example, when searching for an app, a user needs to specify the name of the app [15,12,10]. when browsing the app list to locate an app, the user needs to rely on the system supported display order and organization methods even though they can decide which order/method to use [1,4]. Recent studies have found that allowing users to create their own gesture shortcuts to access system functions such as camera, copy and paste and data items (e.g., contacts) on smartphones is more efficient and convenient with higher recall rate than relying on system defined methods [6,7,8]. Could user defined gesture shortcuts also be used to locate a mobile app other than system functions? The answer may be yes, however, it is unclear whether they can recall these gesture shortcuts successfully. For example, users are provided relatively common and homogeneous system functions (e.g., common file operations, connection configurations etc.) regardless which smartphone they are using while they are free to choose any mobile apps to install and use [3] - sometimes they can even install a number of similar apps for the same purpose (e.g., note taking).

In this paper, we present an exploratory study to understand the memorability of user defined gestures when they are used to access mobile apps. Specifically, we aim to answer the two questions:

1. Can users recall their self-defined gesture shortcuts for accessing mobile apps successfully?
2. If not, what are the main reasons that prevent them from recalling their self-defined gestures?

The paper proceeds in the following order. First, the method is discussed. Second, the experimental design is explained. Third, results are presented and discussed. Then, implication and limitation are provided. Finally, the conclusion is drawn.

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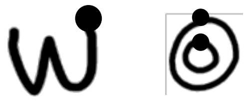
2. Method

2.1. Gestures Capture And Mapping

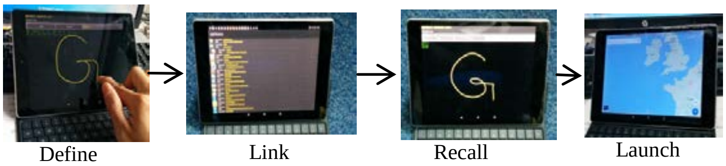
In order to capture user defined gesture shortcuts, an Android app called Agile Search was developed to allow users to create gestures and define them as shortcuts to access specific mobile apps. The app was implemented using Google's gesture recognition algorithm, which supports both unistroke and multistroke gesture recognition as shown below in Figure 1.



Unistroke Multistroke

Fig 1: Examples of uni-stroke and multistroke gestures

The work-flow of the app is given in Figure 2. All gestures created will be stored locally as PNG files.



Define Link Recall Launch

Fig 2: "Agile Search" Work-flow: (i) Define: draw a gesture as shortcut for an app; (ii) Link: associate the shortcut with the app; (iii) Recall: re-draw the gesture defined earlier; (iv) Launch: open the app

2.2. Measurement of Gesture Recall Rate

Through Agile Search, if a user is able to launch an app by redrawing the gesture shortcut he/she created earlier, it is considered as a successful recall, or an unsuccessful one otherwise. Therefore, a user's recall rate can be calculated as the proportion of correct gesture shortcut pairs the user created using the following formula:

User's recall rate = correct pairs / 15 * 100%

2.3. Gesture Creation Reasoning

To increase the recall rate, it is important to study and understand the reasoning behind user's creation of gesture. A previous study has noted that users tend to use different cues to create gesture shortcuts to access system functions/settings [3]. These cues can be differentiated into three types: name based cues, system icon based cues, and function based cues. Here four reasoning categories are defined based on the ways mobile apps are displayed and organized as well as their purposes:

1. Visual cues related to mobile app icons. For example, a user draws an elephant as a shortcut for Evernote app.
2. Textual cues related to mobile app names. For example, a user draws "A" as a shortcut for Amazon app.
3. Functional cues related to the functionality/purpose of a mobile app. For example, a user draws a car as a shortcut for a sat navigation app.
4. Other cues where the relation with a mobile app is not clear. For example, a user draws a star to launch an email client app.

Some cue examples are given in Figure 3.

Visual cues Textual cues Functional cues Other cues

Fig 3: Examples for different types of cues

2.4. App Sampling

The first step of our study is to select apps for experiment. Given a large number of apps installed in smartphones, it's impractical to ask users to create gesture shortcuts for each app. To study the recall rate and establish common ground for unsuccessful recalls, it is important to choose those apps commonly used by participants (of the experiment). To obtain the apps, a user survey was developed, in which users were asked to select the apps they use for at least once a day from the list including 40 apps provided. Total 60 students responded to the survey. Eventually 15 apps, share-used by 33 students were selected, as given in Figure 4. These 33 students were also invited to participate in the experiment later.

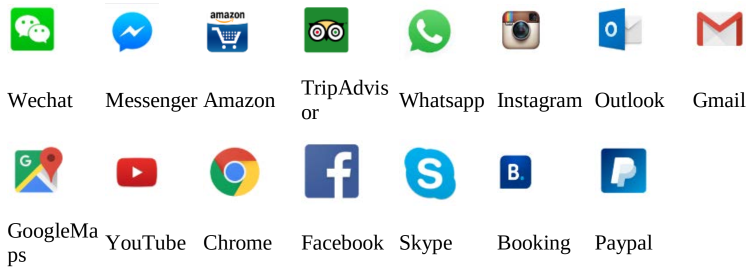


Fig 4: Apps selected for experiment

2.5. Experiment Design

The purpose of our experiment was to understand users' recall rate of their defined gestures that can be used as shortcuts to access frequently used apps so a repeated test was considered. That is, participants were first asked to define gesture shortcuts for the 15 apps (Figure 4), with the name and icon of each app being provided. Then they were asked to do the same task again after 24 hours of completing the task.

2.6. Testing Device

Agile Search was pre-installed on a Google Nexus 9 tablet to avoid compatibility issues and for the convenience of gesture collection. Although tablets are very popular among smartphone users, participants were still given enough time to play around with the tablet to minimize device familiarity issues.

2.7. Participants

As mentioned in 2.4, 35 students who nominated 15 frequently used apps in common were invited to take part in this experiment. These participants, 25 males and 10 females, are all students in the University studying different subjects including Banking and Finance, Tourism, Management, Psychology and Computing. They are all active smartphone users for over 3 years and own at least one smartphone.

2.8. Procedure

Participants were briefed the purpose of the research and asked for the consent before running the experiment. They were also asked to familiarise themselves with the device first if they reported they had not used Nexus 9 before. After that, they were given a demonstration session where the researcher demonstrated how to use the app. A 15-minute self-practice session was then offered to the participants to help them practice. When they were ready to do the test, they were asked for giving oral confirmation. In the test, they were given the list of 15 apps with name and icon displayed and asked to create gestures as shortcuts for each of them. After the test, they were asked to complete a questionnaire to tell the cues they used when creating gestures for these apps based on the cue categories in 2.3. After 24 hours, they were asked to complete the same test following the same procedure.

3. Results and Discussion

3.1. Recall Rate

In total, 33 participants created 495 pairs of gesture shortcuts for the 15 sample apps with an average recall rate of 90.5%, indicating gestures were the same in 448 pairs. The detailed recall rate breakdown for each participant is shown in Figure 5 where only 3 participants had less than 80% recall rate. This suggests that most participants could recall their gesture shortcuts successfully.

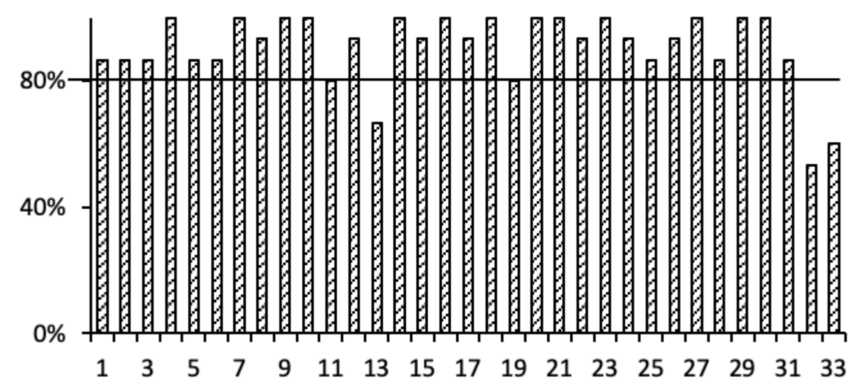


Fig 5: Gesture shortcuts recall rate overview

3.2. Resasoning Distribution

According to the questionnaire, 33 participants created 457 pairs of gesture shortcuts out of 495 pairs for the 15 sample apps based on the same reasoning. This suggests that no matter what reasoning participants used to define gesture shortcuts for apps, their recognition of apps tended to be consistent. The reasoning distribution for each app is shown in Figure 6. It is obvious that textual cues (app's name) and visual cues (app's icon) were more dominant than functional cues and other cues. Moreover, the number of participants who relied on visual cues to create gestures was increasing when the app's icon design style is more abstract.

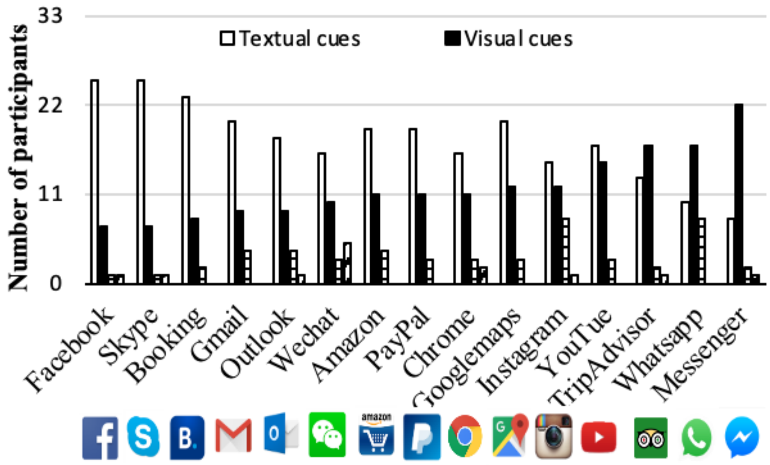


Fig 6: Gesture shortcuts reasoning distribution across apps.

3.3. Apps With Different Gestur Shorcuts By The Same Participants

The recall rate shows participants were able to recall their self-defined gestures created for most apps as they created the same gestures for these apps in the repeated task. However, there were still a number of apps where they created different gestures. In order to identify such apps, a confusion matrix (Table 1) was established where:

1. A True Positive (TP) case was defined when a correct gesture shortcut pair was found for an app which was created by a participant using the same cue (e.g., name);
2. A False Negative (FN) case was defined when a wrong gesture shortcut pair was found for an app which was created by a participant using same cues (e.g., name);
3. A False Positive (FP) case was defined when a correct gesture shortcut pair was found for an app which was created by a participant using different cues (e.g., name and function);
4. A True Negative (TN) case was defined when a wrong gesture shortcut pair was found for an app which was created by a participant using different cues (e.g., name and function);

Note in this experiment, we were more interested in those apps where FN and TN cases were found rather than those with FP cases as FP cases did not affect recall. This is because participants still created the same gesture shortcuts in the repeated task.

Table 1: Confusion matrix for the experiment

	Correct pairs	*Wrong pairs*
Same cue	True positive 420	False negative 28
Different cues	False positive 28	True negative 19

3.4. Apps With Wrong Gestur Shorcuts Created With The Same Reasoning

28 pairs of gesture shortcuts (FN) were found in 13 apps where Chrome recorded indicating 5 participants created different gestures for the app using the same cues (Figure 7).

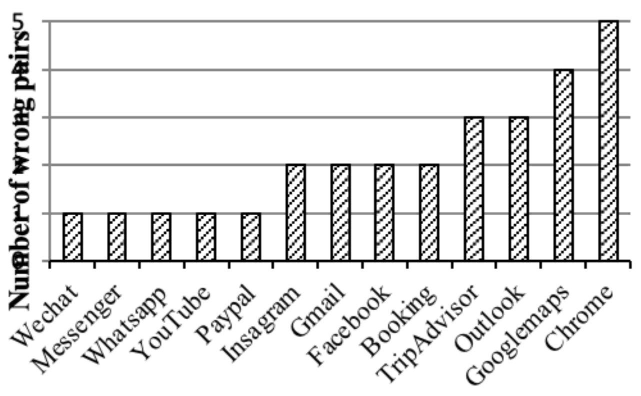


Fig 7: Distribution of 28 pairs of false negative gestures

The Figure 8 below gives a detailed percentage breakdown of cues the participants used to create the gesture shortcuts.

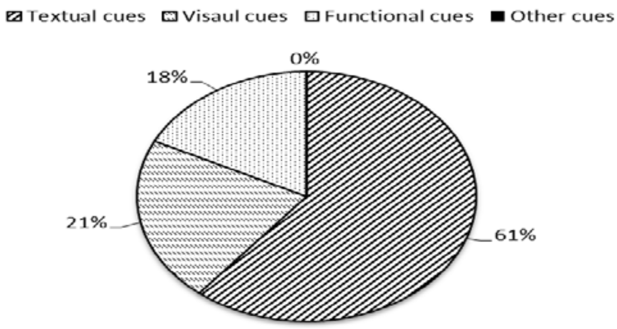


Fig 8: Distribution of cues used for creation of wrong pairs (%)

It can be seen that majority of them were the textual cues. A Chi-square equally test was done to examine whether the number of wrong pair create with same cue is equally distributed based on three different reasoning, and the result (see Table 2) denied this hypothesis by P=0.009< 0.05. Moreover the result also confirms that the gestures created rely on the textual cues were more likely to result in a wrong pair than visual cues. The reason behind this difference could be that the textual cues are harder to recall than visual cues according to Picture Superiority Effect [9].

Table 2: Chi-square equally tests of creation reasons distribution for wrong pairs with same cue. a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 9.3.

	Reasoning of Creation
Chi-Square	9.500a
df	2
Asymp. Sig.	.009

The Figure 9 shows all gestures created using the textual cues for each app. For example, a participant first used the letter “C” for Chrome and then “G” (24 hours later).

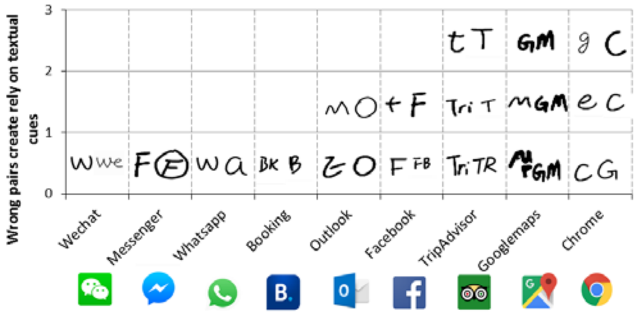


Fig 9: Wrong pairs of gesture shortcuts created using the textual cues

It can be seen from Figure 8 that over 20% of wrong pairs were created based on the visual cues. To take a close look the Figure 10 shows these wrong pairs. For example, a participant first used "one circle" for Instagram then "two nested circles" the second day. According to a work focused on icon classification 6, icon can group into different categories based on its concreteness degree from abstract to concrete. The error might be because the visual cues that an icon presents are quite vague for participants to refer. Thus the icon more abstract the participant are more likely to fail recall the gesture correctly based on its visual cues.

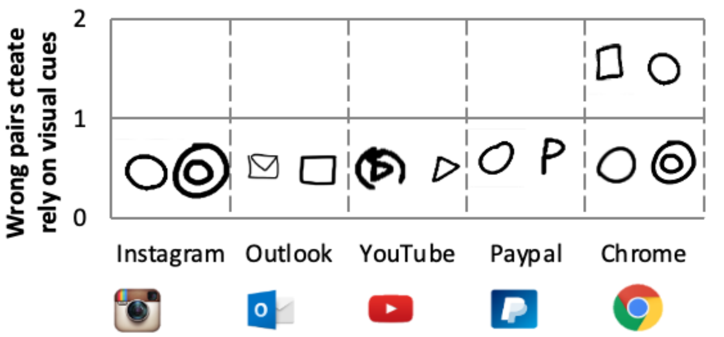


Fig 10: Wrong pairs of gesture shortcuts created using the visual cues

3.5. Apps With Wrong Gestur Shorcuts Created Different Reasoning

There were 19 pairs of gesture shortcuts (TN) found in 12 apps where Paypal, Google Maps and Chrome recorded the highest number of pairs indicating 3 participants created different gestures for the app using different cues for each, as shown in Figure 11.

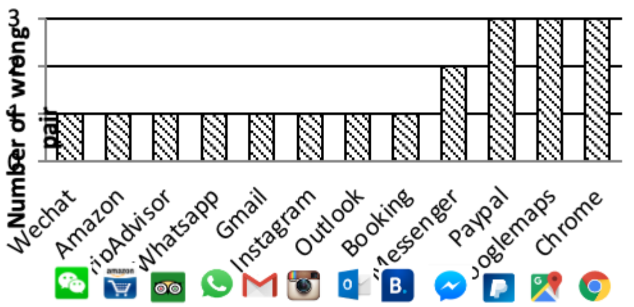


Fig 11: Distribution of 19 pairs of true negative gestures

Figure 12 gives a detailed breakdown on the distribution of 19 wrong pairs created using different cue combinations. It can be seen that 42% of them (8 pairs) were created based on textual cues (app's name) and visual cues (app's icon) while 32% of them (6 pairs) were created based on visual cues and functional cues (app's functionality).

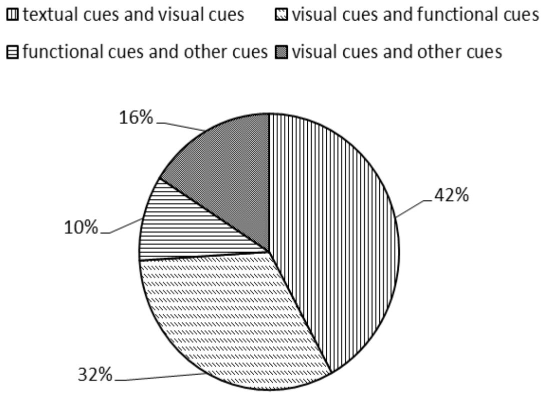


Fig 12: Distribution of wrong pairs of gesture shortcuts created using different cues combination (%)

Figure 13 shows 8 pairs of gesture shortcuts created using the textual cues and visual cues, where within one pair gesture the first one is based on textual cues and the second on visual cues.

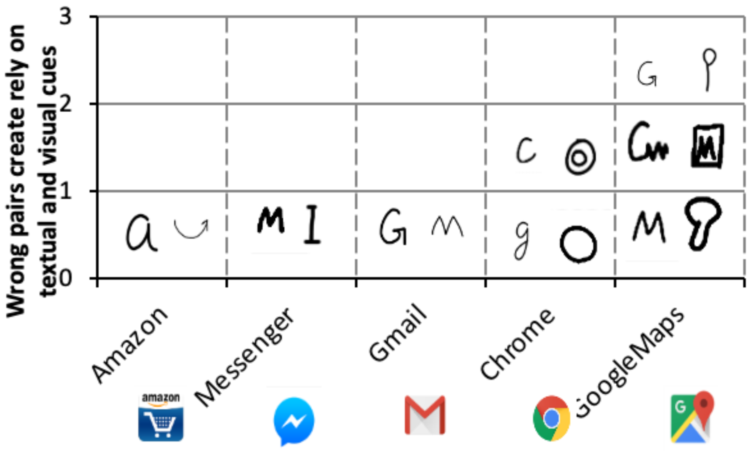


Fig.13: Wrong pairs of gesture shortcuts created using functional cues and visual cues across apps

The wrong pairs of gesture shortcuts created using the combination of the functional cues and visual cues are given in Figure 14. Within each of 6 pairs, the first used the functional and the second was based on the visual cues.

Fig. 14: Wrong pairs of gesture shortcuts created using functional cues and visual cues across apps

Obviously, since the gesture shortcuts were created based on different cues, they can be quite different thus hard for user to recall. For example, the letter 'A' was first drawn for Amazon app based on the textual cues, but later using the visual cues the shortcut became "◡".

4. Implication

From Table 1 it can be seen quite clearly that, if the gesture shortcuts are created using the same cue, the recall rate is very good (93.8% = 420/448). It's much higher than that if different cues are applied for creation (59.8% = 28/47). And the detailed breakdown of wrong pairs of gestures as shown in Figure 13 and 14 has shown that it is hard for user to recall the previous gesture shortcuts because the second shortcuts could be quite different due to creation with different cues. This suggests that, while self-defining the gesture shortcuts to locate an app effectively, user should try sticking to the same cue, being textual, visual or functional.

5. Limitation

This exploratory study has a number of limitations due to the controlled environment the experiment has.

First, the time interval for running the repeated task was set to 24 hours for all participants. This does not seem to represent the real life scenario very well as in reality, users may be able to launch an app using their self-defined gestures more often. Therefore, different intervals based on user's actual app use behaviors need to be considered in future experiments to obtain a more accurate understanding of their memorability of self-defined gesture shortcuts.

Second, the list of sample apps used in this experiment was mainly chosen as a result of balancing the number of apps and the number of participants available for the experiment. Although the list of apps presents sufficient degree of complexity and diversity in terms of functionality and design style, it is worth to establish a more comprehensive list of apps to further validate the findings.

Third, the sample apps in this exploratory study were the most frequently used apps by participants. It remains unclear whether such findings can be applied to infrequently used apps as users may have more memorability issues with these apps.

Last, in this exploratory study, our analysis was mainly focused on cues that were clearly identified such as visual cues, textual cues and functional cues. Although "other cues" was also used, we did not look into these cues due to the very small number of incorrect gesture pairs presented. In the future, we may also look into this category when more sample apps are used in the experiment.

6. Conclusion

This paper is focused on locating an app using user-defined gesture shortcuts. A repeated test is used to explore the memorability of the shortcuts in this research. Especially the wrong pair gestures were considered in this paper and find out that firstly, those gesture pairs created with the same reasoning the recall rate is significant effect by the creation reasoning, and the textual information lead to a worse recall rate. Secondly, the gestures created based on different cues were hard for participant to recall after 24 hours. Based on these findings the recommendation for a memory friendly gesture shortcut and the limitation of this research is given.

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