Current Status of User Experience of the Keyboard on Smartphones: An Overall Questionnaire Analysis

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Abstract. The present status of the user experience of the keyboard on smartphones (UXKS) remains ambiguous because of the fast-changing developments of smartphones. This study adopted an online questionnaire (N = 866) to explore users' current experience, habits, and preferences towards specific objects, including large smartphones and the dual-task input when interacting with their smartphones and the keyboards. The results concluded the user profile of UXKS, and found that users were suffering from long-time use of large smartphones. Additionally, the dual-task operation has become common, with increasing numbers using type or swipe keyboards while driving and walking in particular. The study could provide research objects and basis for organizations and corporations to enlighten future studies on the optimization of the smartphone keyboard design under various scenarios.

Keywords: Smartphone keyboard · User experience · Human-computer interaction

1 Introduction

As a consequent method of human-smartphone interaction, keyboard input is becoming an increasingly ubiquitous and integral part of modern lives. Moreover, with the vast user base of smartphones expanding, it has got millions of users [1–4]. For instance, China Internet Network Information Center's latest statistics [5] have shown the scale of China's smartphone users reached 986 million, and the Sogou Mobile Keyboard had 473 million daily average users in 2020 [6]. Therefore, the optimization of keyboard input design has become a popular topic of psychological and ergonomic research and a key mercantile point for corporations and companies.

User experience of the keyboard on smartphones (abbreviated as UXKS) could be defined as the effectiveness, efficiency, and subjective experience of the input method used by a specific user in a specific environment for a specific purpose under a single input task, as well as the mutual influence of the input task and other tasks [7–9].

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Nevertheless, the current status of UXKS in the 2020s remains unknown, for the fast-changing development of smartphones and keyboards.

The larger-sized phones may be an important point affecting UXKS. With the boom of screen technology, 5.5-in. and above smartphones taking up nearly 80% of 2021's first season's sales in the smartphone market, indicating a growing manufacturing trend toward larger screens [10]. Although the enlarged screen aimed to improve users' viewing experience, it has changed the gravity, size, and weight of smartphones, which may not correspond with the physiological structure of the hand and lead to poor input effectiveness, efficiency, and subjective feelings like discomfort in hand, including muscle pain, tenosynovitis, arthritis, etc. [11–14].

Another important perspective of UXKS involves the interaction between the use of keyboard input and other tasks (the dual-task operation), including the impact of input tasks on other tasks. With the amount of instant messaging app users soaring, keyboard input tasks may collide with various scenarios like having a meeting or class, walking, or even driving. In particular, although China prohibits the use of mobile phones while driving, this behavior has been repeatedly banned, which brings a lot of risks to driving safety [15, 16]. As of the end of 2020, the number of motor vehicles in China was 372 million, and the number of motor vehicle drivers reached 456 million [17]. According to statistics, using smartphones while driving has been one of the main reasons for traffic accidents, and more than 1/5 of the accidents are caused by texting messages on smartphones while driving [18–20]. Therefore, typing under a dual-task scenario is also an inseparable aspect of the research on the UXKS.

Despite abundant existing research on smartphone keyboard use, few have deeply explored UXKS from users' perspectives. Users' experience, habits, and preferences towards specific objects such as big-sized phones, traditional Qwerty layout, and dual-task input scenarios in daily smartphone use are still unknown and needed to be further investigated. The purpose of this study is to mainly concentrate on the current status of UXKS in China by an overall questionnaire analysis, and also to test whether the applications of input methods under the single task and those under the dual-task context are both important research objects for the human-smartphone interaction research.

2 Method

2.1 Procedure and Participants

This study launched an online questionnaire on Credamo (Creator of Data and Model, a professional research and modeling integrated data platform). A sample of 926 Chinese participants was recruited, and all of them had registered as users with real names. Sixty participants were excluded from the analysis for providing inconsistent or irrelevant responses. Therefore, 866 participants (321 females; aged from 16 to 58, $M = 26.47$, $SD = 5.72$) were included in the current study (mean answering time = 218.83 s, $SD = 177.65$).

This study was approved by the Ethics Committee of the Department of Psychology at Tsinghua University.

2.2 Design of the Questionnaire

The questionnaire consisted of 22 items in 4 parts: demographic statistics, users' experience and habits when interacting with their smartphones, users' experience and habits when using smartphone keyboards, and users' experience of the dual-task operation on smartphones. The main items include users' smartphone size, average daily usage time, hand discomfort and diseases caused by smartphone usage and its reasons, keyboard input preference (gestures, methods, and layouts), and scenarios and frequency of keyboard input under the dual-task condition. The whole list of items is shown in Appendix.

2.3 Data Analysis

We used SPSS 23.0 to analyze the data. First, we sorted the data from all aspects with visualizations. Second, a hierarchical multiple regression analysis on the keyboard satisfaction score was carried out.

3 Results

3.1 Demographic Statistics

Among the 866 the copies of effective questionnaire, 112 are left-handed (13.05%), 591 are right-handed (68.24%), and the rest are ambidexters (18.82%). 163 of them are in Guangdong Province (18.82%), 68 in Shandong Province (7.85%), 63 in Jiangxi Province (7.27%), 63 in Henan Province (7.27%), etc.

3.2 User Experience of Smartphones

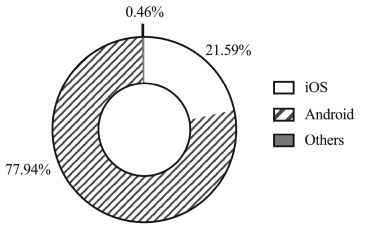
Figure 1 shows a comprehensive view of the user experience of smartphones.

The distribution of users' smartphone operating systems is shown in Fig. 1(a). Android system users (675, 77.94%) account for the majority of all the users.

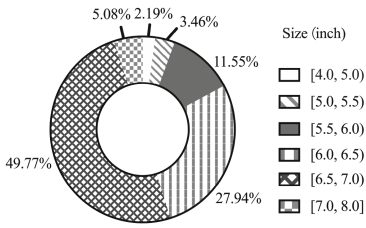
As shown in Fig. 1(b) and 2(c), the size of users' smartphones are large (M = 6.31 in., SD = 0.55), and their usage time reaches 6.95 h per day (SD = 2.58) on average. 82.79% of users are using smartphones larger than 6.0-in., and 65.59% of users are using smartphones for more than 6.0 h per day.

After using the smartphone, 849 participants (98.04%) feel discomfort in hand (frequency M = 0.39, SD = 0.22), as shown in Fig. 1(d). Among those, there are 509 participants (59.95%) who have pains in the thumb and thenar eminence, 295 participants (34.75%) who have discomfort between the thumb and the index finger, 376 participants (44.29%) who suffer from wrist discomfort, and 5 participants (0.59%) have other discomforts, like little finger discomfort.

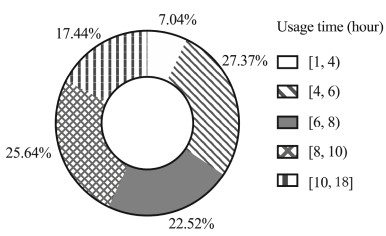
265 participants (30.60%) suffer from hand diseases, as shown in Fig. 1(e). Among those, 223 participants (84.15%) suffer from thumb tenosynovitis, 133 participants (50.19%) have carpal tunnel syndrome, and 4 participants (1.51%) have other diseases like hand muscle strain and fatigue.



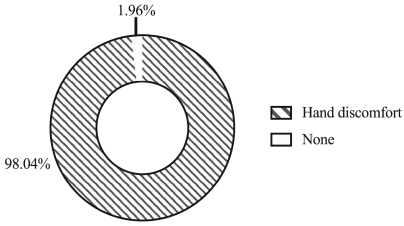
(a) Users' smartphone operating system.



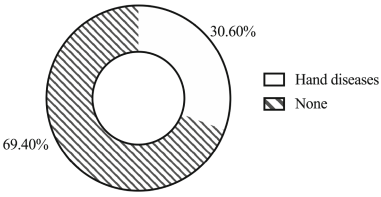
(b) Users' smartphone size.



(c) Users' average daily smartphone usage time.



(d) Users' self-report hand discomfort from smartphone use.



(e) Users' self-report hand diseases from smartphone use.

Fig. 1. The comprehensive view of the user experience of smartphones.

The reasons for hand discomfort and diseases that participants report are as follows: the large size of smartphone screen (37.41%), the heavyweight of smartphones (43.30%), using the smartphone for too long (77.37%), more requirements on sophisticated hand and finger movements while playing games on smartphones (42.73%), and lacks ergonomic design of mobile App interface (such as keyboard, game interface, etc.) (23.21%).

3.3 User Experience of the Keyboard on Smartphones

Figure 2 shows a comprehensive view of the user experience of the keyboard on smartphones.

During the daily use of the smartphone, the users have a mean frequency (i.e., input frequency) of 0.57 (the range is from 0.00 to 1.00, $SD = 0.22$) to do text input, i.e., when a user uses a smartphone, more than half of the time they are interacting with keyboard input.

Users mainly use three typing gestures in different environments and scenarios, including two-handed typing (548 participants, 63.28%), one hand holding the phone while the other hand typing (471 participants, 54.39%), one-handed typing (293 participants, 33.83%). Among them, 366 participants (42.26%) prefer typing with both hands, 302 participants (34.87%) prefer holding and typing, and 198 prefer one-handed typing (22.86%), as shown in Fig. 2(a).

The input method software commonly used by users include Sogou input method (345 participants, 39.84%), Baidu (125 participants, 14.43%), iFLYTEK (122 participants, 14.09%), Apple (107 participants, 12.36%), Huawei (100 participants, 11.55%), QQ (40 participants, 4.62%), Google (17 participants, 1.96%), and other input methods (10 participants, 1.15%) like Mi, OPPO, or Vivo input methods.

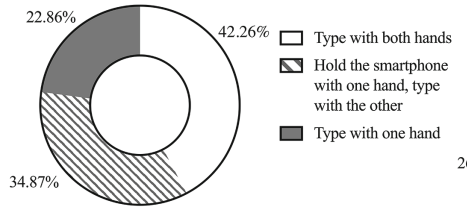
Users mainly use four input methods in different environments and scenarios, including type (603 participants, 69.63%), swipe (661 participants, 76.33%; including 454 participants for handwriting input), voice input (558 participants, 64.43%). Among them, 502 (57.97%) prefer type input, 230 (26.56%) prefer swipe input, and 132 prefer voice input (15.24%), as shown in Fig. 2(b).

When typing in different language contexts, users tend to have different preferences towards keyboard layouts. For Chinese input, as shown in Fig. 2(c), 42.49% prefer the T9 layout, and 56.81% prefer the standard Qwerty layout. While for English input, 81.41% of users prefer the standard Qwerty layout, as shown in Fig. 2(d).

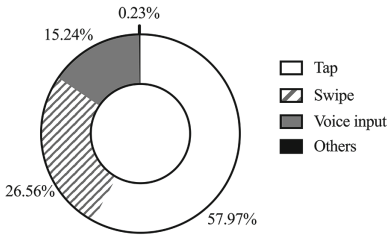
The satisfaction score of users for keyboard input ($M = 72.95$, $SD = 19.23$; full score is 100) remains to be improved. As for the optimization suggestions, 434 participants (50.12%) want the keyboard layout to be further optimized; 364 participants (42.03%) hope that the input method should be improved; 658 participants (75.98%) hope that the algorithms including automatic correction, fuzzy recognition, etc. can be optimized.

709 participants (81.87%) report that they once have been performing a certain main task while using the smartphone for keyboard input, i.e. type under the dual-task context, as shown in Fig. 2(e). The average frequency (i.e., dual-task input frequency) is 0.52 (the range is from 0.00 to 1.00, $SD = 0.21$).

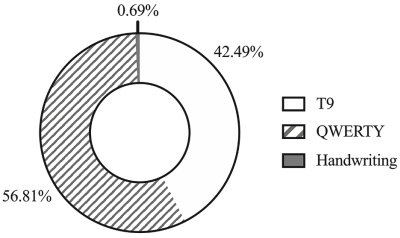
Among all the participants, 223 participants (25.75%) use keyboard input while in a meeting; 326 participants (37.64%) use it while in class; 78 participants (9.01%) use it while driving; 95 participants (10.97%) use it while riding a bike; 501 participants (57.85%) use it while walking; 508 participants (58.66%) use it while chatting offline.



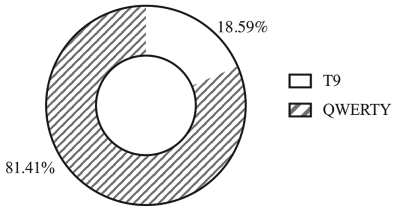
(a) Users' preferred typing gestures.



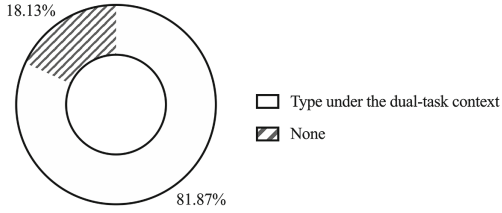
(b) Users preferred input method.



(c) Users' preferred keyboard layout for Chinese input.



(d) Users' preferred keyboard layout for English input.



(e) Users typing under dual-task context (driving, walking, having a meeting or class, etc.).

Fig. 2. The comprehensive view of the user experience of the keyboard on smartphones.

3.4 Regression Analysis

Hierarchical multiple regression was applied to find potential factors that influenced user satisfaction on smartphone keyboard use.

The results in Table 1 show that both input frequency and dual-task input frequency have a significant positive correlation with user satisfaction on keyboard use.

Table 1. Hierarchical multiple regression results for user satisfaction on smartphone keyboard use (N = 866).

Variable	B	95% CI		SE	β	R^2	ΔR^2
		LL	UL				
First step						.01	.01*
Constant	64.20***	58.09	70.31	3.11			
Gender	1.93	–0.71	4.58	1.35	.05		
Age	0.30**	0.08	0.53	0.11	.09**		
Second step						.14	.13***
Constant	52.60***	37.07	68.13	7.91			
Gender	1.95	–0.54	4.43	1.27	.05		
Age	0.43***	0.22	0.64	0.11	.13***		
Smartphone size	–1.84	–4.01	0.33	1.11	–.05		
Input frequency	22.21***	16.20	28.23	3.07	.25***		
Dual-task input frequency	14.76***	8.72	20.79	3.07	.17***		

*p < .05, **p < .01, ***p < .001

4 Discussion

To sum up, modern smartphones had a screen size of around 6.5 in. on average, with one-handed usage becoming an important input gesture. The traditional QWERTY keyboard was the most common keyboard layout, with type and swipe being the most used input methods. Discomfort on the hand when using the smartphone was mainly concentrated around the thumb and the thenar. In addition, the dual-task operation has become common, with increasing numbers using type or swipe keyboards while driving and walking in particular.

4.1 Unsatisfactory User Experience of Current Smartphone Keyboard

The current user experience of smartphones has shown that users are suffering from hand discomfort and diseases such as thumb tenosynovitis and carpal tunnel syndrome for smartphone keyboard use. According to users' self-report, these reasons are mainly over time smartphone use and larger, heavier smartphones. Keyboard layout, algorithm, and input method are expected to be optimized to improve the user satisfaction.

The findings on typing gestures correspond with previous research. One-handed input is a commonly adopted input gesture for smartphones. The thumb is limited in typing flexion and extension when securing the device with only one palm and four fingers [21]. Compared with those using smartphones by both hands, one-handed smartphone users suffer from more serious input discomfort, large smartphone users in particular [22–24]. Moreover, our results have shown that 22.86% of users prefer one-handed operation because it frees the other hand to perform other tasks, thereby improving overall work efficiency [25, 26]. Therefore, the optimized interaction design for one-handed usage is in urgent need.

Therefore, these results had achieved a basic exploration of user experience of the keyboard on smartphones, indicating a vast improving space for keyboard input design.

4.2 Status of Input Under the Dual-Task Context

The findings on the single and dual-task input scenarios indicated that the impact of input behavior on the dual-task context is one of the main focuses of human-smartphone interaction research. The use of input methods under multitasking operations has become a common behavior in human life. Our results have shown that more than 80% of people had been using smartphones for text input when performing a certain task, including driving, indicating a high safety risk.

Also, according to the regression model, there is a significant positive correlation between the input frequency, the dual-task input frequency, and the score of smartphone input method satisfaction. This accorded with the previous research that user stickiness and satisfaction were tightly correlated, and satisfaction was a dominant factor of continuous use intention [27, 28].

4.3 Inspirations for Future Study

This study also has some limitations which could be optimized in future studies. Firstly, we could enlarge the sample size and recruit more participants from other regions with more details on user profiles, e.g., the education level and the occupation. Secondly, we could investigate more on the applications of input under the single or the dual-task context, e.g., input behaviors while walking and driving.

Based on the findings, in the future, researchers could conduct more in-depth research in the following directions.

First, the design of the smartphone keyboard needs further optimization from aspects of layouts, algorithms, and other input methods. Numerous keyboard designs and concepts have been proposed, including scaling up or down the keyboard button size and curved design keyboards, e.g., Microsoft WordFlow Keyboard [29], and changing the keyboard button positions, e.g., IJQwerty [30], Quasi-Qwerty [31], etc. In addition to changing the keyboard layout, designers could try to optimize the input algorithm, which may contribute to a better user experience. Functions like fuzzy recognition or correcting erroneous input automatically based on natural language processing (NLP) could be beneficial [32–34]. Also, various input methods, including type, swipe, hand-gesture, eye-tracking, and brain-computer interface, may be conducive to optimizing the human-smartphone interaction process [35–37].

Second, more emphasis should be put on the safety issue in the dual- or multitask context. Our results have shown the dual- or multitask input scenarios have become increasingly common, which may bring a high safety risk, driving [19], walking, and riding a bike in particular. The government and researchers should consider these and take appropriate measures, e.g., ban the text input function when Map apps usage is detected in real-time.

Third, further optimization for input under diverse dual- or multitask scenarios should be investigated. Scenarios such as input in a meeting or class often require as little distraction as possible for the main task and are often accompanied by one-handed use. The applications for such specific input scenarios are in crucial need of an optimized input method.

To summarize, the overall results could provide research objects and basis for organizations and corporations to enlighten future studies on the optimization of the smartphone keyboard under various scenarios.

Appendix

The whole list of the questionnaire items.

Part	Item
Demographic statistics	1. What's your gender? ○ Male ○ Female 2. What's your age? _____ 3. Which one is your dominant hand? ○ Right hand ○ Left hand ○ Both
Users' experience and habits when interacting with their smartphones	4. What's the operating system of your smartphone? ○ iOS ○ Android ○ Others 5. What's the size of your smartphone? _____ 6. What's the average daily usage time on your smartphone? _____ 7. How often do you feel uncomfortable with your hands when (after) using your smartphone? (0%–100%) _____

8. Where are your hand discomforts mainly concentrated in your hand?

- ☐ The thumb and thenar eminence
- ☐ Between the thumb and the index finger
- ☐ Wrist
- ☐ Others
- ☐ None

9. What hand diseases have you ever suffered from smartphone use?

- ☐ Thumb tenosynovitis
- ☐ Carpal tunnel syndrome
- ☐ Others
- ☐ None

10. What do you think are the reasons for "hand discomfort caused by smartphone usage"?

- ☐ The large size of smartphone screen
- ☐ The heavyweight of smartphones
- ☐ Using the smartphone for too long
- ☐ Playing games on smartphones requires more sophisticated hand and finger movements
- ☐ Mobile App interface design is not ergonomic enough (such as keyboard, game interface, etc.)
- ☐ Others

11. how often do you use the smartphone keyboard for text input? (0.00–1.00)

0.00 1.00

Users' experience and habits when using smartphone keyboard	12. What typing gestures have you used (i.e., in a certain environment, you may use this method)? ☐ Type with both hands ☐ Hold the smartphone with one hand, type with the other ☐ Type with one hand
	13. What's your first choice of typing gesture? ○ Type with both hand ○ Hold the smartphone with one hand, type with the other ○ Type with one hand
	14. What's your most frequently used text input method software? ○ Huawei input method ○ Baidu input method ○ Sogou input method ○ QQ input method ○ Apple input method ○ iFLYTEK input method ○ Google input method ○ Others

15. Which input methods have you used when using your smartphone (i.e., in a certain environment, you may use this method)?

- ☐ Tap
- ☐ Swipe
- ☐ Voice input
- ☐ Handwriting
- ☐ Others

16. What's your first choice of input method?

- ○ Tap
- ○ Swipe
- ○ Voice input
- ○ Handwriting
- ○ Others

17. What's your preferred keyboard layout for Chinese input?

- ○ T9
- ○ Qwerty
- ○ Others

18. What's your preferred keyboard layout for English input?

- ○ T9
- ○ Qwerty
- ○ Others

19. What's the satisfaction score of your current input method? (0–100)

0 100

Users' experience of the dual-task operation on smartphones	20. Have you ever used your smartphone for keyboard input while performing a main task (such as messaging while having a meeting), and what following scenarios are included? ☐ Using the smartphone while driving ☐ Using the smartphone while in a meeting ☐ Using the smartphone while in class ☐ Using the smartphone while riding a bike ☐ Using the smartphone while walking ☐ Using the smartphone while chatting face to face ☐ Others ☐ Never
	21. When use a smartphone for keyboard input, how often do you perform another or multiple main tasks at the same time? (0.00–1.00) 0.00 1.00
	22. What aspects of the smartphone keyboard input method you use now need to be improved? ☐ The keyboard layout ☐ The input method ☐ The algorithms including automatic correction, fuzzy recognition, etc. ☐ Others

○: single-choice questions. □: multiple-choice questions.

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