Why and Why Not Use My Face?—A Case Study of Face Recognition Solutions in the Workplace

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Abstract. Face recognition (FR) technology is permeating and changing our lives from mobile phone to public space in China. Baidu utilizes advanced FR technology to support tens of thousands of employees in their daily access and payments. However, as a new way of human–machine interaction, a handful of researches of face interaction in the field of HCI were conducted. This study aimed to solve three issues: Users' behavior during face interaction; What are the reasons for using and not using FR? What are the advantages of user experience of FR? With the methodology of field observation and interviews, we studied the face interaction on five typical scenarios, including the gate barriers, corridors, canteen, supermarket, and vending machines. Through the analysis of these issues, we had a comprehensive and in-depth understanding of experience problems and advantages of face interaction in public space. Basing on our findings, design implications were given focusing on reducing or avoiding these problems, and strengthen the advantages of face interaction. We believe it would be beneficial for the FR which is at the early stage of HCI research.

Keywords: Face recognition · Face interaction · Face swiping · Face access · Face payment · User experience

1 Introduction

Face recognition (FR) technology is permeating our daily lives in China. From the applications on personal devices, such as unlocking the phone or logging in the app with face, to public use, for example, the face access at tourist sites, airports and train stations, etc. The word "face-swiping", has gained popularity and become part of our lives.

Baidu has done in-depth work on the technology of FR. It supports tens of thousands of face interactions every day. However, when we wanted to optimize the interaction and design of FR, we found researches of FR in the field of HCI were so few that we didn't know where to start. We didn't know how users use it, if there were any patterns of behavior, why and why not they use it, what experience advantages FR had, and what aspects could be strengthened, what aspects should be avoided, and so on.

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As a new way of interaction, current researches of FR mainly focus on the technological aspects, It is seldom discussed from the user's perspective. Only a handful of researches were conducted on human–computer interaction and user experience. For the early stage of HCI research, it is necessary to learn the real behavior of interaction and understand users' inside thoughts, and Baidu provides us with an excellent scenario for case study. This paper aims to solve the following core issues:

1. *Users' behaviour: Under what circumstances are users prone to use FR? And what behaviors do users have?*
2. *Reason mining: Why do/do not users use FR?*
3. *Advantage of user experience: What are the advantages of "swiping face" from the user's perspective compared to other methods?*

Through a hybrid method we answered these questions and based on these findings, we extended some deeper problems and discussions as the basis of design optimization.

Different from other researches, we conducted the research in real life instead of experimental environment. It mainly covers two categories of application in the company: access and payment. The access category includes the gate barriers and corridors (Fig. 1), and the payment category includes the company's canteens, supermarket, and vending machines (Fig. 2), which amount to 5 typical scenarios.

Usually, the FR devices are made up of an electronic screen with a camera connected to the access control or payment system. The face detecting process is performed by the camera. The authentication status (including the status of face detecting and recognizing) and the user's information (including the employee's name, the greeting words and the amount spent) are shown on the screen. There are also imperceptible FR devices in the company. With no screen, the detection process is performed by an independent camera. Such devices are installed in the corridors, and the light strips on the door shows the result of the recognition.

Fig. 1. Paying at the Gate Barrier (pic. a), and Corridor (pic. b). (Figures in the pic. are examples of researchers, not users)

Fig. 2. Paying at the Canteen (pic. a), Supermarket (pic. b) and Vending Machine (pic. c). (Figures in the pic. are examples of researchers, not users)

The usage process and characteristics of the five scenarios studied in this paper are illustrated as following (Table 1).

Table 1. The summary of the comparison among the 5 scenarios

Scenario	Interaction method	Screen	Feedback method	Traffic characteristics
Gate barrier	Face/card	Yes	Screen + voice	Has obvious peaks, but no lining-up
Corridor	Face/card	No	Light strip	Has no peak
Canteen	Face/card	Yes	Screen	Users line up all the time
Supermarket	Face/card/phone	Yes	Screen + voice	Users sometimes line up
Vending machine	Face/phone	Yes	Screen + voice	Users do not line up due to dispersed user traffic

2 Related Work

2.1 Face Recognition and Usability Researches

The current literature on FR still focus on exploring technology, and there are few studies based on the perspective of user experience or human–computer interaction. In terms of the application of FR technology, relevant researches in China have mainly been news commentary and lacks in-depth research. There are some international studies on biometric authentication that revolve around user experience to compare usability between various methods of authentication (including face, voiceprint, hand gesture, iris, retina etc.).

Comparisons between the various methods of usability primarily take place in lab research of mobile phone screen unlocking. The IBM Watson Center (2012) compared voice, fingerprint, hand gestures and FR as alternatives and found that face and voice recognition were more efficient than passwords or hand gestures. Users also displayed varying response, with some users finding photo-taking troublesome, while others think it is convenient [1]. Rasekhar et al. found that convenience and usability are key factors for users deciding to opt for biometric technology [2]. Alexander De Luca also pointed out that users ranked from most to least important the reasons for using face unlock as safety, curiosity, usability, novelty, emotional factors, prestige and reliability, while ranking the reasons for refusing to use face unlock (in the same order) as usability, reliability, external factors, emotional factors, security, lack of necessity, technology and misunderstanding [3].

There has been a small amount of research on face authentication in the real world. Kvarnbrink et al. performed a case study on the transition from magnetic key cards to FR in the largest gym in Europe and found that users thought FR was favorable and simple. The study revealed that users enjoyed not using swipe cards, and this also benefited the gym given that non-members can no longer borrow membership cards for access [4].

There is a similar study about the application of biometrics in the workplace (2006). It proposed two areas of focus in designing face authentication devices: the physical environment and interaction with the device. However, some of the technological aspects of facial authentication in this relatively old study are no longer applicable. For example, users have to remove their glasses for FR, and this would lead to the trouble of unable to see the screen clearly and voice prompts do little to assist them in positioning themselves accurately. This shows that such technology lacks usability [5]. Wayman et al. also mentioned that different environments can affect device performance, such as whether detection is overt or covert, whether the user is habituated or non-habituated to the device, and whether the device is supervised or unsupervised, standard or non-standard, public or private etc. The device's surrounding environment can be subject to such classifications [6].

2.2 Face Recognition and Technology Acceptance Model

There are few articles based on technology acceptance model (TAM) to study the factors affecting the willingness of using FR. Qingjie et al. [7] have studied the

contribution of various factors. Although there were sources of factors, most of them based on the use of mobile phone, and none of them originated from the research of FR. When summarized the reasons for using and not using faces, we found it difficult to put all the reasons into a traditional usability or user experience framework, such as some environmental and risk factors. Through desk study of TAM, we thought it was applicable to our reason induction.

TAM is a classical model in the field of information technology, which takes willingness to use as a dependent variable and is widely validated and applied. Perceived usefulness and perceived ease of use as independent variables originate from the classical model [8], which are the most basic factors in all related studies.

Perceived Usefulness refers to the individual's perception of performance improvement after the usage of a system. Perceived Ease of Use reflects the individual's experience that a system is easy to operate [8].

Use Context originated from Heijden [9], Gan [10] who supplemented the classical TAM when they studied the mobile payment system. It referred to the specific environment in which users used the information system.

Perceived Enjoyment was derived from Serenko [11], Mun et al. [12], Lee et al. [13], Duamasbi et al. [14] supplements to TAM. It referred to the degree of personal enjoyment in the process of interaction with the system, excluding the results of performance.

Perceived Risk originated from Heijden [8], Lee [15], and Qingjie's [7] supplements to the classical TAM in their research on e-commerce and payment system. It referred to the individuals' subjective feelings resulting from their inability to judge whether adverse consequences have occurred.

In summary, previous studies mainly focused on the interaction of FR on personal mobile phones, and the conclusions may not necessarily applicable to the public space; moreover, the research based on public space lacked representativeness because of either the special scenes (gym) or the earlier time; finally, the research related to technology acceptance model also lacks the source from the real use of FR.

3 Method

We adopted a mixed-methods approach that includes field observation and interviews in this study. Field observation served two objectives: first, to learn and record the real behavior and then code some of them for the description and analysis of users' behavior patterns; second, to select users with typical behavior characteristics as the sample of interview research. Interview was mainly used for in-depth excavation of reasons.

3.1 Field Observation

We conducted four days of field observation in the Baidu Technology Park, focusing on the five scenarios of FR: gate barrier, corridor, canteen, supermarket, and vending machine. There were multiple FR (observation) points for each of the above scenarios given the park's large area. For each scenario, we selected observation points with large traffic flows, meaning more users and higher frequency of usage. We also observed these points during their idle and busy hours in order to learn about their usage in a more

inclusive manner. As observation at different scenarios were conducted during overlapping times, the study was completed through the collective efforts of four researchers. The main researcher delivered standardized training for all participating researchers the day before the observation commenced to ensure the study's consistency. In the standard process, we ensure users are informed of the observations and records.

GoPro cameras in prominent locations were also deployed at each observation point before coding analysis was performed to quantify typical user behavior. These served as a supplementary form of data collection to the researcher's observation. Table 2 shows the duration and traffic recorded by GoPro cameras at each observation point. The cumulative observation time was 21.5 h, of which 13.5 h were coded and 1141 samples were coded. The corridors and vending machines saw lower traffic without no obvious peak periods, which meant a smaller number of users overall.

Table 2. Observation and coded video length, and sample size at the five scenarios

Senario	Observation length	Coded video length	Coded sample size
Gate barrier	4h	2h	339
Corridor	4.5h	4.5h	62
Canteen	6h	2h	402
Supermarket	3h	1h	329
Vending machine	4h	4h	9
Total	21.5h	13.5h	1141

Table 3. Video coding principles and coding methods

Coding indices	Coding method	Implications of each index
Use face or not	• Used • Not used	Classification of users
Hands occupation	• One hand occupied • Both hands occupied • No hands occupied	Confirms whether the user's hands were free or occupied and whether this has a bearing on using FR
Card placement	• Held in hand • Retrieved from pocket • Hung around neck • Unavailable	Reflects the employee card's accessibility to the user and whether this has a bearing on using FR
(For face users) Users' actions	• Looked at the camera in advance • Adjusted posture • No special action	Reflects users' prior planning and willingness to adjust for FR

Within a week of completing the data collection, we selected some recorded video clips based on sample size and traffic flow to encode users' behavior (Table 2). The coding principle and method are shown in Table 3.

3.2 Interview

In addition to field observations, to explore reasons for use/not use and the advantage of experience, four other researchers (who received standard training one day in advance) conducted intercept interviews at the same time. The samples in each scenario are shown in Table 4. The sample covers a variety of functional roles in the company, including product manager (PM), research and development (R&D), sales and sales etc.

Table 4. Sample size of the interviews in 5 scenarios

Scenario	Used	Not used	Total
Gate barrier	21	5	26
Corridor	16	3	19
Canteen	19	11	30
Supermarket	13	10	23
Vending machine	3	0	3
Total	72	29	101

(The number of Use/Not Use doesn't represent the usage rate, which depends on the success rate of intercept interviews)

3.3 Data Integration and Analysis

Both of the analysis of quantitative and qualitative samples provides evidences for the findings and discussion of this paper.

Quantitative Samples and Analysis. Quantitative samples based on GoPro video coding are mainly used to describe users' behavior, and further analyze if there are some patterns of the behavior. We used spss20.0 to analyze the quantitative data to explore the influence of different factors, such as the relationship between the face swiping behavior and whether the hands are occupied or the position of the card.

Qualitative Samples and Analysis. Qualitative samples which gathered from interviews are mainly used to mine the reasons why users use/do not use FR, and to explore the experience advantages of FR. Inductive method was used to summarize.

4 Findings

4.1 Users' Behavior

In this section, we describe uses' behavior from two aspects: ① Under what circumstances are users prone to use FR? We analyzed the influence of two coded factors: "hands occupation" and "card placement" through non-parametric test. ② What behaviors do users have? We analyzed the "users' actions" among the people who use FR though descriptive statistics.

Under What Circumstances Are Users Prone to Swipe Their Faces? To understand under what circumstances users would choose FR, we carried out non-parametric test and post-hoc comparison to examine users' use of FR in different hand-occupied situations. We found that in the scenario of gate barrier, canteen and supermarket, different situations of hand occupation would affect their use of FR (canteen: $\chi^2 = 28.098$, $p = 0.000$; supermarket: $\chi^2 = 20.394$, $p = 0.000$; the gate barrier: $\chi^2 = 25.041$, $p = 0.000$). When both hands were occupied, users were much more likely to use FR than in any other conditions. In the corridor scenario, whether users' hands are occupied has no significant influence on whether users choose FR ($\chi^2 = 0.152$, $p = 0.927$). The scenario of vending machine was not analyzed because of the small sample size (Table 5).

Table 5. Different kinds of hand occupation/whether they use FR in different scenarios

		Access		Payment	
		Gate barrier	Corridor	Canteen	Supermarket
One hand occupied	Used	13.6%	71.7%	22.3%	11.1%
	Not used	86.4%	28.3%	77.7%	88.9%
Both hands occupied	Used	51.9%	72.7%	85.7%	50.0%
	Not used	48.1%	27.3%	14.3%	50.0%
No hands occupied	Used	15.3%	80.0%	26.4%	20.0%
	Not used	84.7%	20.0%	73.6%	80.0%

Another factor that affects users' usage of FR is the position of the employee card. In the canteen, the supermarket, and the gate barrier scenarios, users are more likely to use FR when employee cards are invisible. With cards in sight, we further examined the relationship between the position of the card and whether users choose FR through non-parametric test and pairwise comparison, and found that the position of the card could affect whether users choose FR. (the gate barrier: $\chi^2 = 16.222$, $p = 0.000$; canteen: $\chi^2 = 18.159$, $p = 0.000$; supermarket: $\chi^2 = 8.787$, $p = 0.013$) When the cards were hanging around their neck rather than in their hands, user's willingness to use FR was significantly increased. The vending machine scenario was not included also. In the corridor scenario, the placement of employee cards has no significant influence on whether users choose FR ($\chi^2 = 5.784$, $p = 0.055$). The scenario of vending machine was not analyzed because of the small sample size (Table 6).

Table 6. The position of the card/whether users use FR in different scenarios

		Access		Payment	
		Gate barrier	Corridor	Canteen	Supermarket
Held in hand	Used	3.8%	61.5%	5.4%	6.7%
	Not used	96.2%	38.5%	94.7%	93.3%
Retrieved from pocket	Used	7.1%	28.6%	14.3%	0.0%
	Not used	92.9%	71.4%	85.7%	100.0%
Hung around neck	Used	18.3%	77.8%	21.7%	18.1%
	Not used	81.7%	22.2%	78.3%	81.9%

Except for vending machine, the corridor was completely different from other scenarios, which may be related to its property and interactive method. As an imperceptible way of interaction, it has no screen and locates directly above the user's movement. It can detect and recognise successfully as long as the user does not look down at the mobile phone or wear a hat, which is less affected by the user's subjective choice and other factors.

What behaviors do users have? The descriptive analysis of "Users' Actions" shows that: Of the 254 users who use FR, 235 (92.5%) adapted to different degrees of posture. Among them, 191(75.2%) adjusted their facial orientation in advance and actively looked at the camera. Another 44(17.3%) adjusted their standing position or changed body posture to adapt to the camera after their first standing. We think that these actions on the one hand indicates not only the usage of users, but also with the actively cooperative actions, which to some extent reflects a high level of acceptance. On the other hand, it shows that our FR equipment are not friendly enough and requires additional actions for users which can be optimized.

4.2 Reason Mining: Why Use/Not Use FR?

We interviewed 72 face users and 29 non-face users in 101 qualitative samples respectively (The number of users and non-users does not represent the usage rate, but is affected by the success rate of interception interview). The open-ended answers were summarized as Tables 7 and 8. Since the purpose of this study was to collect the complete set of reasons and the reasons of universality in the workplace as the basis of follow-up research, there was no emphasis on the differences of scenarios in the interviews and the summary.

Reasons and Frequency of Use/Non-use

Table 7. Reasons and frequency of use

Reason	Count
1. Less motion, no need to pick up the employee card or cell phone from pocket	31/72 (43.1%)
2. No longer need to bring the employee card	14/72 (19.4%)
3. Fast	13/72 (18.1%)
4. Hands occupied	11/72 (15.3%)
5. The screen is just facing the face	5/72 (6.9%)
6. Can only use face without employee card	3/72 (4.2%)
7. Feel like looking in a mirror	2/72 (2.8%)
8. Sense of Technology and Freshness	2/72 (2.8%)
9. Simple and smooth interaction	2/72 (2.8%)

(Please note that the denominator is the sample size of users, and each user may have multiple answers so that the total is not necessarily 100%)

Table 8. Reasons and frequency of non-use

Reason	Count
1. Slow	11/29 (37.9%)
2. Previous failure	10/29 (34.5%)
3. Be accustomed to employee card/phone	10/29 (34.5%)
4. Worried about mis-swipe	3/29 (10.3%)
5. Worried about the security of personal information	3/29 (10.3%)
6. The incomplete deployment makes people feel that it is still in the test period and the system is unstable	3/29 (10.3%)
7. It's considered not as reliable as employ card	2/29 (6.9%)
8. Dislike the notification of hi (office communication software within the company, integration of various office functions)	2/29 (6.9%)
9. There is a long queue behind	2/29 (6.9%)
10. The employ card is just in hand	2/29 (6.9%)
11. See others using employee cards	2/29 (6.9%)
12. The balance is insufficient, so turn to mobile payment (face and employee cards are the same payment system, while phone is another)	1/29 (3.4%)
13. The process of registration is troublesome	1/29 (3.4%)
14. Dislike taking pictures (users think face interaction is like taking pictures)	1/29 (3.4%)

(Please note that the denominator is the sample size of non-users, and each user may have multiple answers so that the total is not necessarily 100%)

Reasons Induction Based on TAM. We tried to further summarize these reasons within the same framework, but find that some of them cannot be included in the traditional framework of usability or experience evaluation of web pages or systems (such as Useful, Usable, Desirable). For example some environmental factors: the placement of equipment, the long queue behind etc., and some risk factors: mis-swipe, the security of personal information and so on. Therefore, based on the framework of usability and experience assessment, we used the technology acceptance model (TAM) [8] to summarize the above reasons (Table 9).

Table 9. Reasons and frequency of use based on TAM

Category	Reason	Count
Perceived usefulness	Less motion, no need to pick up the employee card or cell phone from pocket (31/58)	58/83(69.9%)
	No longer need to bring the employee card (14/58)	
	Fast (13/58)	
Perceived ease of use	Simple and smooth interaction (2/2)	2/83 (2.4%)
Perceived enjoyment	Sense of technology and freshness (2/4)	4/83 (4.8%)
	Feel like looking in a mirror (2/4)	
Use context	Hands occupied (11/19)	19/83 (22.9%)
	The screen is just facing the face (5/19)	
	Can only use face without employee card (3/19)	

(Please note that the denominator refers to the frequency mentioned, which is different from Tables 7 and 8.)

Through the frequency, we can see that perceived usefulness is the most important factor that mentioned by both users and non-users. In addition, users have a high degree of agreement on its convenience, which is reflected in 45/58 users mention about "less motion" and "no longer need to bring the employee card" (Table 10).

Use Context is the second important factor for the face users, which indicates that there are still some random factors in the user's choice of using face. We will explain further in the discussion section.

Perceived Risk and Perceived Ease of Use are the second most important factors for non-users, and the perceived risk has been discussed a lot in previous studies. The presentation of face and name would affect the user's risk perception, which can be optimized by design.

Previous failure accounts for the vast majority (10/11) of perceived ease of use, which means that users would abandon FR because of previous failure and change from users into non-users. From interviews, we know that users usually do not know the cause of errors when they occur, so we need to pay attention to effective guidance after errors occur.

Table 10. Reasons and frequency of non-use based on TAM

Category	Reason	Count
Perceived usefulness	Slow (11/24)	24/53 (45.3%)
	Be accustomed to employ card/phone (10/24)	
	Dislike the notification of HI (IM app within the company, integrated various office functions) (2/24)	
	Dislike taking pictures (users think face interaction is like taking pictures) (1/24)	
Perceived ease of use	Previous failure (10/11)	11/53 (20.8%)
	The process of registration is troublesome (1/11)	
Perceived risk	The incomplete deployment makes people feel that it is still in the test period and the system is unstable (3/11)	11/53 (20.8%)
	Worried about the security of personal information (3/11)	
	Worried about mis-swipe (3/11)	
	It's considered not as reliable as employ card (2/11)	
Use context	There is a long queue behind (2/7)	7/53 (13.2%)
	The employ card is just in hand (2/7)	
	See others using employee cards (2/7)	
	The balance is insufficient, so turn to mobile payment (face and employee cards are the same payment system, while phone is another) (1/7)	

(Please note that the denominator refers to the frequency mentioned, which is different from Tables 7 and 8.)

4.3 User Experience: The Advantage of FR Compared to Other Methods

Based on interviews and qualitative observation, we summarize the experience advantages of FR applications into two major aspects:

A More Natural Way of Interacting. For individual users, FR relies on their inherent features to authenticate the identity, which is more convenient and easier. They no longer need to bring an "extra item" with them, instead they are unimpeded by using FR. At the same time, FR needs a smaller range of motion. Users only need to make a short stay within the lens coverage, and occasionally make small angle adjustments, without "taking out employee card or mobile phone", "bending over to swipe card", or "holding the card or mobile phone at a certain height".

For group users, this natural way of recognition will not interrupt ongoing conversations. In a corridor, employees usually walk in groups. If swiping card is needed, one of them needs to temporarily leave the crowd to swipe the card, and the conversation will be temporarily interrupted. However, FR will open the gate for users silently without their notice, and thus it will not interrupt the conversation. This is similar to the observation of smart speaker by Cathy Pearl, the author of Designing Voice User Interfaces [16]. "(During the meal) If one queries a problem through a mobile phone, he will be separated from the group conservation. Of course, they maybe will suspend the conservation and wait for that person to continue. But if he asks a smart speaker to

answer the question, everyone could hear the question and its answer, just as the speaker briefly joins the current conversation."

Emotional Interactive Experience. Compared with the original card swiping, FR is not just an instrument, but a richer feedback mode which allows the emotional communication between human and machine.

"I often have to work overtime. When I leave at night, when I pass the gate barrier using FR, it says 'You've been working very hard'. At this time, I respond to it in my heart, 'Yes indeed'." (Ms. Liu, 31–35, sales)

"Special greetings or decorations can be added to the festival", "warm greetings can be added to the rainy and snowy weather"…

The personalized expectation of employees in feedbacks to the FR gate barrier reflects their needs of emotional communication. If this could be achieved, the company's access control system would no longer be a cold security tool, but a security guard with humanistic care, who would protect and greet you; the payment system would become a smart and considerate salesperson. Such "special employees" allows employees to feel the cares from the company, strengthens the "family ties" between employees and enterprises, enhances the sense of group security, value and the feeling of presence. Also, it increases employees' sense of dependence and acceptance toward the organization. Finally, their sense of belonging will be enhanced [17].

5 Discussion

In the findings, we find some contradictions, such as the perception of security and time, which we dug further and presented in the discussion section. In addition, we add a point based on observations that users seem not to be aware of as a supplement to the reason.

5.1 Different Perceptions of Security

In the part of experience advantage, some users thought swiping their faces were safer because everyone's face is unique in terms of biometric authentication, and no one can substitute or impersonate the other to pass or pay. However, the employee card can be borrowed to others, and some users also mentioned that they "will swipe for a colleague who does not take the employee card."

Some users mentioned that security was one of the reasons why they didn't use FR. On the one hand, they worry about mis-swipes which may cause property loss. People can choose to display or hide their mobile phones and employee cards, but they cannot hide their "faces", and their facial image can be captured directly by camera without noticing them. The feeling of "passive payment" makes users uneasy. In terms of behaviour, some users keep a distance from others when they pay, or do not open the face payment function at all. On the other hand, they worry about the safety of their personal information. The exposure of users' personal information on the screen in the interactive feedback, including users' names, their real-time facial images, and the amount of consumption in the payment, will also make users feel that their privacy is

violated. Researchers have pointed out that users value the way their data is used and stored, and are most reassured when the data is only stored in their devices [3]. During the interview, one user made it clear that "it is acceptable in the company because people around me are my colleagues; but if it is in public, my name and expending details are all displayed on the screen, and will be seen by others. Why would I let strangers see my personal information?" (Mr. Gao, 26–30, RD)

5.2 Different Perceptions of Time

In the process of mining the reason of why and why not using FR, we found an interesting conclusion: among the reasons for use and non-use, time is in the top three (Tables 7 and 8). Why time was the main reason for both using and not using FR? And why there were two completely different attitudes? This is a question worth discussing.

It showed that efficiency was an important consideration for users to make decisions. In addition to, we further explored the reasons:

First, the objective data indicated that it took no more than 2 s on average for access and payment. What were the user's real concerns when both of them took no more than 2 s?

When we asked the users who thought it took too long to swipe their face, "How much do you think swiping your face is slower than swiping the card?" Some users would answer "maybe swiping face wasn't that slow, just because I am used to cards", and some users will answer, "2–3 s slower." For such users, we would further ask, "Why would you care about these 2–3 s?" Then we have obtained some inner thoughts of the users, including: 1 worry about the unpredicted waiting time; 2 bad experiences before (waiting for a long time); 3 fears that more time will be wasted if FR does not work; 4 possible embarrassment caused by the pressure from people lining up behind. As a user said, "Because it is in the canteen, so many people are lining up behind and waiting for me, and on this occasion, I don't feel like wasting a single second." (Mr. Sun, 26–30, RD) Apart from embarrassment, the other three users' thoughts were related to their uncertainty about the new technology. But users who thought swiping face was quicker were less likely to hold such concerns.

Embarrassment has also been mentioned in other FR studies. Many unfamiliar bystanders around will cause embarrassment [18]. Users believe that unlocking the screen of mobile phone by using face in public places is more likely to cause embarrassment than other unlocking methods because "It looks like I'm taking selfies all day." [3]. Although the reasons for embarrassment are different, it may be due to the pressure of the queuers behind, maybe due to the pressure of the queuers behind, and maybe due to holding a cell phone at a specific angle in a public place and so on, embarrassment should be a consideration for extending FR to a wider range of public space applications.

5.3 Supplementary Reasons: Observations on the Route of Movement

Based on the 21.5 h observation, we found that whether users opted to swipe their face was related to the route of his movement approaching to the device, although users seemed not be aware of the subtle impact of this factor since it is not mentioned in the interview.

Accessibility. Take gate barrier access for instance: As the device is positioned at the rightmost gate for both entrance and exit, users who approached from the right would opt for FR whereas those coming from the left would choose to swipe their employee cards. The findings showed that users would not take a few extra steps just to use FR.

Discontinuity of Movement. In addition, a few users mentioned "sense of discontinuity" of FR when they asked to compare the experience between face and card. This made us think that the screen of FR usually had a certain angle with the user's approaching direction. Users need to turn their heads to swipe their faces, which would interrupt the progress to a certain extent.

This has been validated after we have fully measured the height and angle of the device, learned the technical parameters of the camera and the setting of the quality detection strategy of the product: Based on the current configuration of gate barrier, users have to turn their heads in order to achieve recognition (Fig. 3).

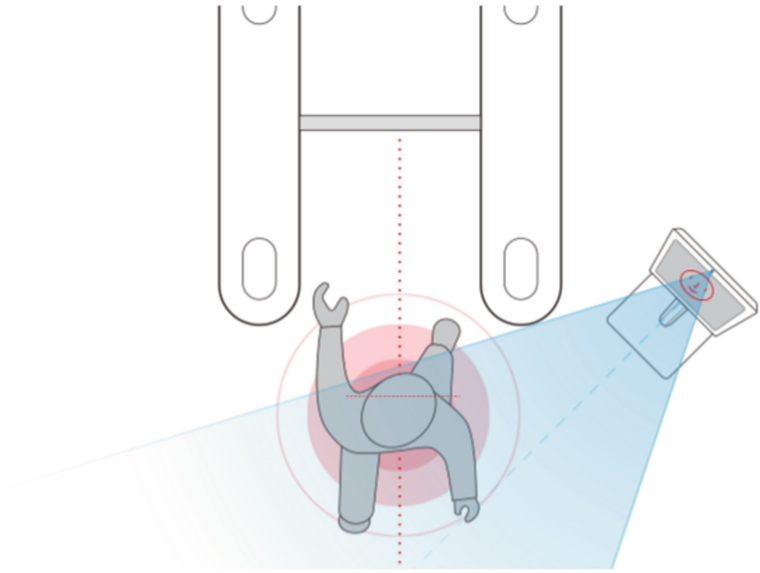

Fig. 3. Based on the current configuration (including device height, angle, technical parameters, etc.), users must turn their heads to interact with FR

There is no such "discontinuity" in the corridor, as the users approach from a distance. Their face can be captured by the camera and successfully recognized as long as they don't look down at their phones or wear hats. Passing through the gate entails a similarly smooth movement of the user walking in a straight path. As for card swiping, however, the user must digress from the original route and swipe on or off against the wall before returning to the gate. Therefore, users in the corridor preferred "FR" as their primary means of access. In comparing the corridor and gate barrier scenarios, users preferred the former. Such oblivious and uninterrupted movement made them relieved of the need to turn, pause and turn again.

6 Design Implication

Based on the findings of this paper, the experience optimization of each scenario can proceed from two major directions: reduce risk perception of non-use reasons and strengthening advantage experience.

6.1 Reducing Risk Perception Through Circulation and Interaction Design

To solve the problem of : “mis-swipe”, the spatial layout can be optimized by circulation design [19], separate the crowd and distinguish the purpose of use. In the canteen, through proper planning of spatial functions, and designers can keep the devices apart from areas for picking chopsticks and napkins which have high traffic. A payment area can be set in the canteen so that users with no intention of paying will not be caught by the camera as readily (Fig. 4).

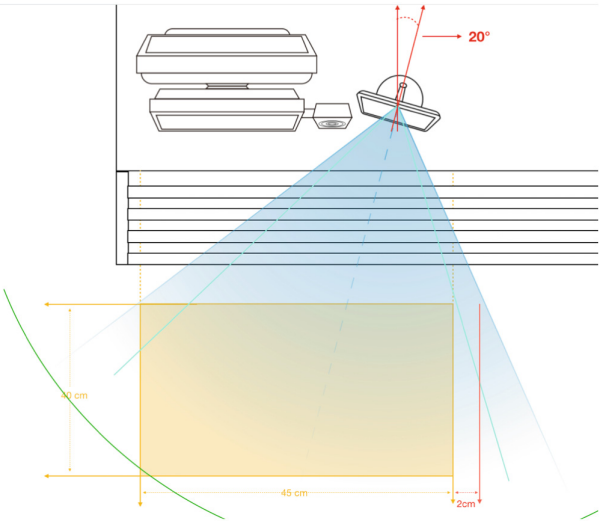

Fig. 4. A payment area can be set in the payment scenario so that users with no intention of paying will not be caught by the camera as readily.

In addition, by adding state feedback and confirmation step in the process of interaction, providing users with clearly causes of error and recovery methods, adding confirmation step with amount before payment, etc., can enhance the user’s sense of control of the system and reduce perception of risk (Fig. 5).

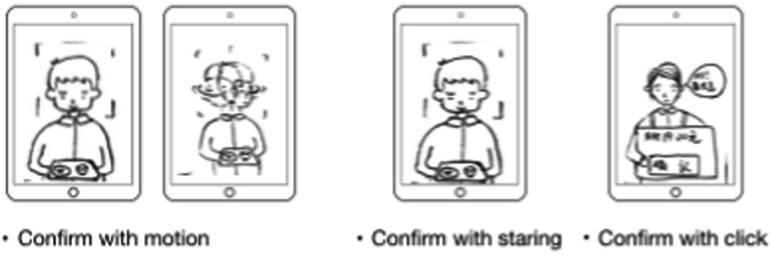

Fig. 5. Add confirmation step to reduce perception of risk.

6.2 Make Interaction More Natural from the Perspective of Ergonomics

As mentioned in the findings, users have perceived some experiential advantages of using face in natural interaction. On this basis, we can add some optimization of ergonomics angle, such as placing equipment and setting technical parameters according to human comfortable interaction distance and turning angle, so as to reduce user's adaptation to equipment and make user's face interaction more labor-saving.

In addition, the angle of the screen and user's approaching direction can be reduced as much as possible, so that the sense of discontinuity caused by turning head or even the turning direction can be reduced (Fig. 6).

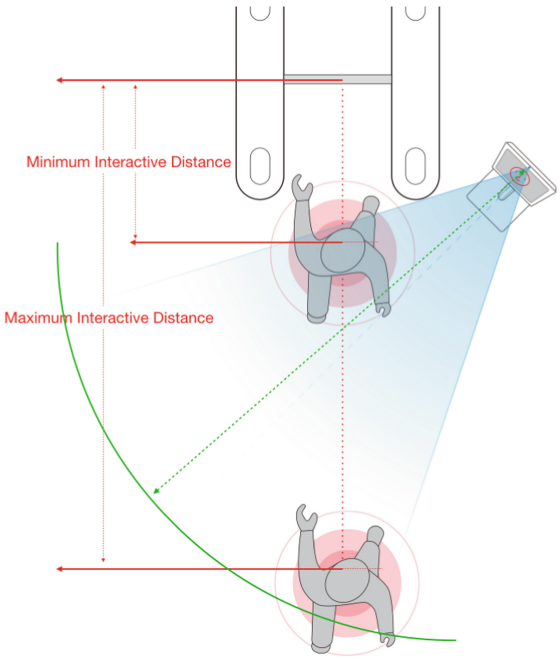

Fig. 6. Place equipment according to users' comfortable distance and angle, set technical parameters, so as to reduce users' action and discontinuity.

6.3 Enhancing Emotional Experience Through Visual and Voice Design

As mentioned in findings, compared with employ card, FR make it possible for affective interactions, and can play a role in many dimensions.

Increase the concern of enterprises. Based on festivals, weather, overtime work and so on, different visual and greetings can be designed to enhance the sense of belonging of employees.

Increase the interestingness of interaction. By changing the different feedback, adding AR expression to the user's face, the interestingness of face interaction can be enhanced, thus enhancing the perceived enjoyment (Fig. 7).

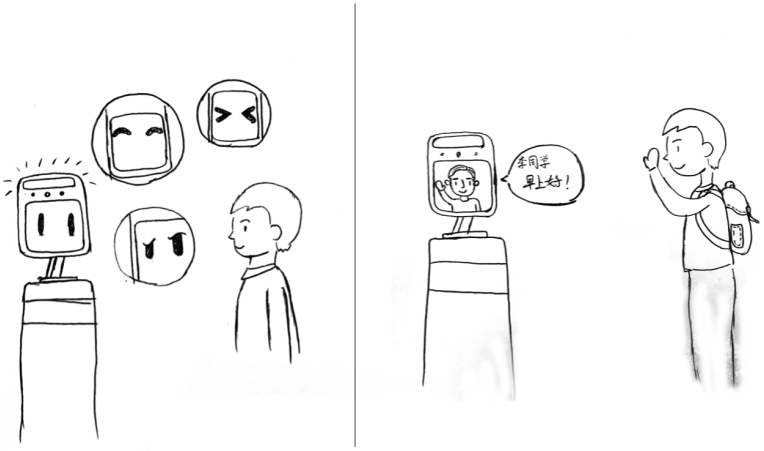

Fig. 7. Examples of visual and voice design to enhance the emotional experience

Reduce insecurity and embarrassment. For example, only showing the contour of the head on the screen instead of the real face, on the one hand, reducing the exposure of personal information to reduce insecurity, on the other hand, it also alleviates the embarrassment of some users who do not like taking photos or looking in the mirror, especially in the presence of onlookers. According to Kvarnbrink et al., users don't mind that other people can see the screen because the author's case only shows the user's sihouette.

7 Limitations and Future Study

This research mainly focuses on real behavior and reason mining, which provides us with a lot of inspiration for subsequent research and design, but still lacks some validation, such as validation of different design schemes, adding factor analysis and structural equation on technology acceptance model, and so on. And this study does not distinguish between two categories and five scenarios. The follow-up research can be the separated studies of specific scenarios.

8 Conclusion

In this study, we have conducted in-depth research on the user's behavior and inner thoughts of using FR, laying the foundation for our follow-up research on face interaction and HCI practice.

Through the research of users' behavior coding, we found that among the people who use FR, they have a high degree of acceptance, not only use, but also actively cooperate. The occupancy of hands and the location of employee cards affect people's choice of faces in some scenarios.

Based on interviews, the reasons mentioned by users are focused on "less motion", "no longer need to bring the employee cards", "fast" and "hands occupied". The reasons not used are focused on "slow", "previous failures" and "be accustomed to employ card/phone". In addition, the immediate environment (use context) can also affect users' choices even though sometimes they are not aware of it. Risk are important factors of non-use besides usefulness and ease of use. At the same time, users affirmed the advantages of face in natural and emotional interaction.

Follow-up research and practice can be conducted focusing on reducing users' perception of risk and enhancing the advantages of experience.

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