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Effects of Different Visual Feedback Types on Perception of Online Wait

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ABSTRACT

This study aims to understand the effects of visual feedback designs on time perception and user perception in online wait. We manipulated the salience (implicit/explicit) and framing (hedonic/function) of visual feedback, and the music (exist or not). 23 subjects participated in the two experiments. 8 (2*2*2) visual feedbacks were compared directly in pairs to rank how these augmentations of visual feedbacks compare to one another. We also tested the effects of visual designs on waiting perception such as attention, perceived control, and emotion in the online waiting. In addition, we discussed the potential effects of music and immersion for time perception. MANOVA and subsequent ANOVA tests were conducted. The study findings indicate the salience of visual feedback may significantly affect users' time perception, explicit visual feedback provides users with more perceived control as well as more attention. The hedonic of visual feedback is important to affect users' waiting perception such as. The hedonic designs provide more perceived entertainment. However, inappropriate embellishment design may have a negative effect on user experience. Music plays a significant role in affecting users' time perception and deep involvement. Appropriate music accompaniment will make the whole waiting faster and easier.

1. INTRODUCTION

As everyone knows, wait is acknowledged as the negative experience. The wait in anywhere not only wastes users valuable time resources and opportunity costs, but also makes users suffering psychological pressure including anxiety and boredom [1, 2]. With the passage of waiting time, people are getting more anxiety and irritability. Just like waiting in the traditional environment such as stations, banks, supermarkets, hospitals or restaurants, online waiting is also a common and frustrating experience. For example, when you click on the video, you need to wait for the web page to load the content; when you upload pictures and files, you also need to wait for uploading successfully; when you open the game, you also need to wait for the game to load. Waiting experience will affect the users' impression of system and program availability, result in reducing the quality of user experience.

'Happy time is always short', correspondingly, users tend to overestimate the online waiting time since the waiting experience is always considered as boring and anxious [3]. It is inevitable that hardware quality (CPU, memory), software performance (code) and other objective factors result in the online wait. Reducing the objective waiting time is limited by technology and economy. However, the subjective waiting time of users can be manipulated in a purposeful and effective way. Facing the waiting problem, the original solution was to keep the user informed of the application wait state to alleviate the users' negative experiences. Prior research has emphasized the importance of providing users with feedback about the state of the system [4]. However, modern systems are required to provide more comprehensive and timely instructions, such as more intelligent and interesting solutions. Compared with shorter interactive waiting time, longer waiting time is more likely to have a negative user experience and reduce user satisfaction. A longer response time (longer than 15 seconds) is usually not conducive to productivity, which will result in an increase in error rate and a decrease in satisfaction [5]. Hurt et al. [6] suggested that users prefer to carry out additional activities in a longer waiting time, such as watching a video or playing small games to shorten the perceived time. Nielson [7] research shows that 0.1s is about the limit for users to feel that the system can respond immediately, which means that no extra feedback is needed except for displaying the results. 1.0s is about the limit that users will not interrupt their thought flow of even if they notice the delay. 10s is the limit for users to focus on the conversation. NAH [8] results show that for web users, waiting time longer than 10s is difficult for users to accept. Bouch et al. [9] considered that once time threshold for waiting over than 11 s, the service quality may be judged as "low". Although higher education and private companies have to make an effort to develop online waiting programs, there is currently a dearth of depth studies that focus on understanding the role of visual feedback design on time perception and user experience.

Prior researches show that users' time perception and user experience are generally related to attention, emotion, perceived control and cognitive load [10]. The immersion is also considered to have a potential impact on time perception and user experience. In addition, music is another crucial factor affecting user time perception. Music plays an important role in affecting users' attention and emotion, and their immersion. As far as we know, the current research on online waiting is limited to the visual design, the impact of music effects on user experience and time perception is ignored.

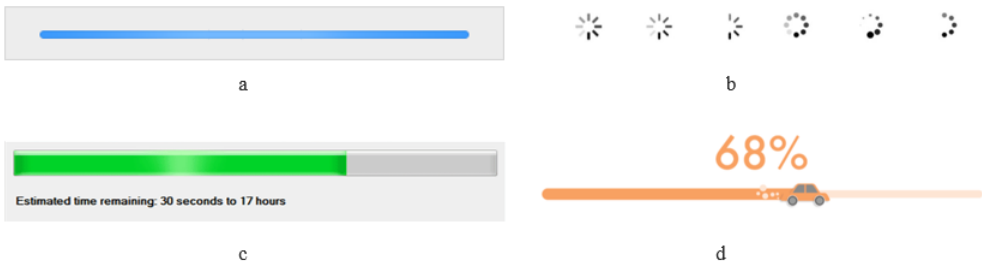
This paper is structured as follows. First, this study explores the effects of visual feedback designs on users' time perception and waiting perception including perceived control, attention and emotion [11] in online wait. Second, given the lack of scientific investigation of music in online wait, this study also investigates how music affects users' time perception and user experience. Finally, by proposing and validating a research model of online wait management based on two models related to time perception: one is cognitive absorption model, the other is attention allocation model. The study aims to present the mechanism of visual feedback designs users' time perception and users' waiting perception (perceived control, attention, emotion). We integrate all these variables into an experiment and provide a solid foundation for better understanding the online wait phenomenon and for future research.

2. RELATED THEORIES AND THEORETICAL BACKGROUND

2.1 Visual feedback in online wait

Web designers and researchers emphasize the importance of providing users with significant system state in online wait, including the requests being processed, the left waiting time, and the progress of the waiting situation. Text or various visual forms are generally used to provide feedback in the waiting screen. The visual feedback [12] can provide more continuity for the human-computer interface [3], reduce the users' perceived waiting time [13, 14], and enhance users' waiting satisfaction and user intention [15, 16]. Moreover, it is found that the visual feedback of online waiting screen is related to users' emotion, that provide more pleasure [17] and acceptance [8, 12] for users, so that it can improve users' tolerance [18] and user experience in online wait. In addition, previous studies suggested the significant effect of visual feedback on users' attention. The visual feedback such as black or white screen, static image [19], dynamic buffer ring [20] or linear progress bar [12, 16] are proved to attract users' attention [10, 21], that may reduce the perceived waiting time of users to varying degrees [18, 22-24].

After investigating about 100 waiting screens, the visual feedbacks can be classified as four categories including explicit, implicit, utilitarian and hedonic design (see Figure 1). For salience of the visual feedbacks, the explicit design represents the visual feedback can convey task progress as well as additional information about the percentage of waiting time that has passed and/or the percentage that remains. For example, the progress bar continuously filled from 0% to 100%, see Figure 1. On contrary, the implicit design conveys the state in simple way without more information. Such as the dot that moves repeatedly which cannot predict the end time. In addition to salience, another distractor that could affect waiting time perception is the frame of visual feedback design. Framing of a progress cue represents the extent to which people perceive this visual object as useful and/or affective as they view it while waiting.



a, b: Implicit design; c, d: Explicit design; c: functional design; d: hedonic design

Figure 1. Visual feedback in online wait

2.2 Influencing factors

2.2.1 Focused attention

Cognitive load has a significant effect on time perception and user experience. Allocating attention plays an important foundational role in cognitive load. The most widely accepted and used theory about it is the attention gate theory. The attention gate theoretical model is an attention resource allocation model [11] that explains how attention and other cognitive components influence the way individuals estimate the passage of time. It is developed on the basis of many prior models, including internal clock model [25], scalar timing model [26], attention allocation model [27], information processing model [28].

The accumulator records the amount of signals generated by the metronome to represent the subjective time. When the user pays more attention, the wider the gate is opened, and more pulse signals can pass through. On the contrary, when the attention gate is closed or opened very small, the signal rarely even cannot pass the gate [26]. Therefore, the time is estimated by the amount of pulses that the switch allows to reach the accumulator through the pacemaker. The allocation attention model suggested that evaluated time is obtained from time processor and visual information processor which share limited attention resources. When the visual processor gets more attention resources, the output of the timing processor becomes less reliable. The more attention resources allocated to the time information, the perceived time is longer.

In the attention gate theory, paying attention to time or non-time information may affect the users' time experience [26, 27, 29-32]. By reducing the physiological arousal or drawing the users' attention off time may reduce the subjective time. Therefore, while the attention resources are transferred to non-time information, divert attention away from waiting time to reduce the perceived time [31]. For example, an interesting stimulus in the waiting screen that attracts more attention may cause the individuals' underestimating the time interval [25, 27]. The users' time perception and waiting experience can be manipulated by the appropriate visual design based on the attention allocation theory and psychological knowledge. Thus, we predict that: during an online wait, the cartoon design decorated on the progress bar can divert users' attention to nontime information.

2.2.2 Emotion

Previous researches in the field of online wait also focused on the effects on time perception. Droit Volet and Meck [22] found that both attention and emotion can affect time perception. For example, a higher emotional arousal state will make the user feel longer, which may be due to the increased arousal of the internal clock pacemaker, resulting in more time pulses (for example, clock acceleration and longer duration) [22, 27]. In particular, for example, the high-intensity negative valence caused by horror movie [21] or electric shock [27] usually leads to an overestimation of time perception easier than neutral stimulation.

The emotional design focuses on the "pleasure" at the top of product characteristics, that can meet the emotional needs of users, enhance the users' stickiness and pleasure, and improve user satisfaction. In addition, emotion plays an important and functional role in interaction design [33], which is generally related to positive emotions including satisfaction, fun, and pleasure. Numerous studies have proved that emotion plays a vital role in role in affecting subjective time. The positive emotion during users' waiting time will indirectly affect people's satisfaction [34]. The objective time is underestimated after users making a hedonic judgment, while the negative emotion leads to the overestimation of time [35]. In turn, the effects of emotion on time will also affect users' cognition, behavior, and emotion itself [36]. Positive emotion is mainly related to entertainment or pleasure in interaction design. Entertainment is defined in terms of "attractive metaphor, content, graphics, attractive animation and satisfactory sound", which is corresponding to functional design.

Most studies in the field of waiting experience have only focused on the function of interface design, this paper seeks to remedy these problems by analyzing the emotion in online wait. In addition, previous studies of have not dealt with cartoon, this paper will examine the effects of more innovative, and interesting feedback on users' positive emotion, thus affecting users' time perception. Consequently, we take the cartoon feedback as the independent variable in this study. We predict that: The entertaining cartoon as the feedback in online wait will enhance the users' pleasure and other positive emotions, and distract the users' attention to the nontime information. The higher the user satisfaction, the shorter the waiting time perceived by the users.

2.2.3 Perceived control

Perceived control (PC) can be defined as a sense of personal responsibility for interaction, commonly referred to as users know that they have controlled the internal state, behaviors of the observed object, and the people, things, or activities around it. Perceived uncertainty (PU) refers to the uncontrollability or unpredictability of the occurrence of events. The weakening of the perceived control may increase the users' anxiety and result in a negative impact on the user experience [37].

When the uncertainty about things is reduced and people are aware of the regaining of perceived control, it may cause a higher evaluation about the work performance and satisfaction, even their cognitive load and tension might be relieved [38]. Thus, the perceived control over the external environment can bring positive emotional experience, and the emotional reaction caused by environmental pressure might also be mediated. Previous studies found that the acquisition of perceived control is equally important in time perception. Users might feel a loss of control while they know nothing about the wait, which leads to an increase of perceived uncertainty and helplessness. A series of negative emotions caused by the lack of perceived control may directly result in giving up the product. By providing any information about wait can make the waiting progress more predictable and controllable, thereby can produce a more positive emotional response to waiting, and tend to conclude that the perceived waiting time is shortened [39].

For online waiting, it is necessary to display different visual feedback including left waiting time, abnormal situation, and completion progress. Many scholars hold the view that compared with waiting in unknown conditions, immediate feedback makes users more likely to have high satisfaction for the system, improving the tolerance of waiting. Based on the above research background, we predict that: During the online wait, the more information about the waiting given by the visual feedback, the stronger the users' perceived control. The salience (explicit & implicit) of visual feedback designs may have a significant effect on the users' perceived control, thus affecting the users' time perception and the waiting evaluation.

2.3 Music

Different authors have measured the effects of music on user experience in a variety of ways. Music has a subjective and strong impact on emotions [40, 41], and it can influence the users' behavior by reducing anxiety and distracting attention [42, 43]. As a multi-modal medium, music must be considered owing to it is used in complex human-computer interfaces. For example, visual effects may have an effect on the perception way of audio, and audio will also affect visual perception.

Music is widely used in daily life owing to a significant impact on emotion [44, 45], such as using the music in waiting rooms to alter subjective waiting time, or using music in supermarkets to encourage people to stay longer and shopping more goods [46, 47]. The previous studies have proved that music can indeed change the perceived time of users, and the perceived waiting time with music is shorter than that without music [48, 49], while the subjective waiting time will be shorter when the accompanying music is consistent with the preferences of the subjects [49, 50]. Moreover, [22] suggested that the effects of rhythm related to subjective arousal on music is the main factor of time distortion. Emotional valence does regulate the effect of rhythm on time perception. The perceived waiting time of pleasant music is estimated shorter than that of unpleasant music.

Previous studies indicated that music has a significant effect on immersion besides emotion [44, 45], environmental noise, and sound effects can increase or decrease the subjects' immersion in the game [46-48], thus affecting the time perception. For example, the high-intensity load caused by terrible sound effects can make users overestimate the time. When someone is so immersed in an experience that his or her attention cannot be distracted by other things, he or she may ignore the passage of time. Therefore, concentration may reduce the perception time. That is to say, if a person's attention is focused on the clue (or task) or immersed in waiting, then the user has fewer cognitive resources for processing temporal information [49]. As a result, the perceived waiting time is shorter. Another purpose of this study is to explore the effects of music on users' emotions, pleasure, and immersion in online wait. We predict that: The pleasant music in online wait will distract users' attention from

waiting time, make users have more pleasure, shorten the perceived waiting, and encourage users to wait.

3. HYPOTHESIS AND RESEARCH MODEL

The major objective of this study was to investigate the effects of different visual feedback designs on users' time perception and user waiting experience perception. Based on the attentional gate model and the waiting time literature, we hypothesize the effects of temporal information and distractors (Salience, Framing, Music) on perceptions of the waiting experience, PWT, and use intention as depicted in our research model (see Figure 2).

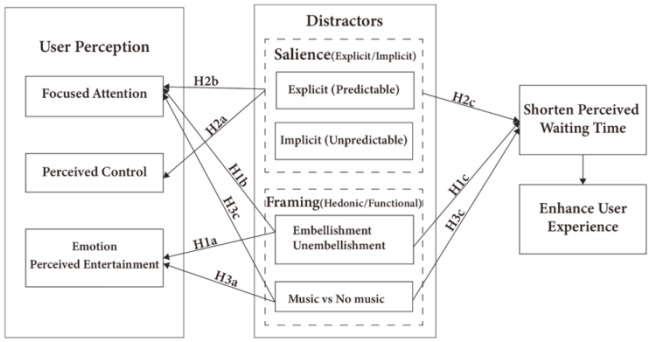


Figure 2. Research model

H1 The interesting cartoon (Hedonic design) provided in online wait will enhance the users' pleasure and other positive emotions(H1a), and distract the users' attention(H1b) to the nontime information. The higher the user satisfaction, the shorter the waiting time perceived by the users(H1c).

H2 During the online wait, the more information about the waiting given by the visual feedback, the stronger the users' perceived control. The salience (explicit & implicit) of visual feedback designs may have a significant effect on the users' perceived control(H2a) and attention(H2b), thus affecting the users' time perception and the waiting evaluation.

H3 The pleasant music in online wait will distract users' attention from waiting time, make users have more entertainment(H3a), and distract the users' attention(H1b) to the nontime information. shorten the perceived waiting time, and encourage users to wait(H3c).

4. METHODS

To determine whether the visual feedbacks would have an effect on users' time perception, and explore how the designs affect users' attention, perceived control and emotion. The research was composed by two experiments. In the Experiment 1, 8 (2*2*2) visual feedbacks were compared directly in pairs to rank how these augmentations of visual feedbacks compare to one another. In Experiment 2, we tested the effects of visual designs on the waiting perception including attention, perceived control, and emotion in the online waiting. In addition, we discussed the potential effects of music and immersion for time perception.

4.1 Participants

According to the China Internet Network Information Center's 'Statistical Report on the Development of China's Internet in 2018', it was reported that young people born between 1991 and 2001, aged between 19 and 29, had the largest proportion of Internet users, which are likely to watch animated icons in HMI most. Therefore, a total of 30 participants (16 males) with a mean age of 26 years (ranging from 19 to 29) with normal or normal-to-corrected vision took part in all experiments. All had the experience of using smartphones, desktop computers and usually spend around 2 and 5 h a day using personal smartphones for various purposes. Participants were first required to complete a questionnaire covering name, gender, age, grade, major, and eyesight, and make them familiar with the experimental materials.

4.2 Materials

The experimental materials are made by Adobe Illustrator and Adobe After Effects with the size of 600px*45px. The experimental materials are shown in Table 1. The length/width of the progress bar and size of the figure/font were kept consistent for all forty-eight loading symbols to minimize potential confounds. To avoid the effects of color on visual cognition, the experimental stimuli are made of black and white except the cartoon embellishment. About 5, 10 and 20 seconds of startup delay would lead to around 20%, 50%, and 70% of abandonment rate, respectively [50]. In order to maximize the effects caused by different visual feedbacks, the online waiting time is set 8s. Moreover, to avoid the effects of emotion and familiarity on the study, the modes of visual feedbacks were designed based on daily use.

8 (2*2*2) visual feedbacks were compared directly in pairs to rank how these augmentations of visual feedbacks compare to one another. 1 shape(rectangular) * 2 (embellishment or un embellishment) * 1duration (8s) * 2 frame (explicit or implicit) as experimental stimuli to investigate how does the design affect the attention, the perceived control and emotion in the online wait, and the presence/absence of music is used as an independent variable (4*2=8) to study the effect of music on the users' time perception and immersion.

Table 1. Experimental materials

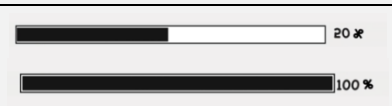
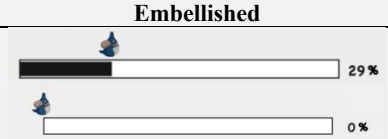
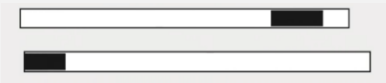
Form	Unembellished	Embellished
Explicit		
Implicit		

Table 2. Measurement items used in the studies

Factors	Item	Description
Perceived Control	PC1	I felt relaxed while I am waiting (not at all relax - relax)
	PC2	I felt in control while I am waiting
	PC3	while I am waiting, I am able to know or control the current waiting status
Focused Attention	FA1	while I am waiting, my eyes are always watching in the waiting interface
	FA2	while I am waiting, my attention is always. on the wait interface
	FA3	while I am waiting, I am immersed in the waiting process
Perceived Entertainment	PE1	This waiting design is fun
	PE2	I felt that this visual feedback makes me happy
	PE3	I feel that this waiting experience makes me happy

4.3 Experiment setting and procedure

4.3.1 Experiment 1

Two experiments were carried out in an Ergonomics Laboratory of China University, loading visual feedbacks were presented on a 24-inch monitor (resolution of 1,920 × 1,080) with the size of 1,280 × 720 pixels at a rate of 12 frames per second. The experimental background is gray (see Figure 2). Comparing all distinct ordered pairs of the 8 visual feedbacks would have required 64 trials. To maintain the attention of the subjects and ensure the integrity of the experiment, 28 pairs of different and unique visual feedback pairs along with the functions paired with themselves (8 trials) for a total of 36 trials per user. The experimental stimuli were presented in random order. This kept the total task time under 22 minutes. The measurement items used in the study are shown in Table 2.

Before the experiment, participants were informed to familiarize the operation requirements in advance. The experimental interface (see Figure 3) provided three response buttons that allowed users to select if the first(A) or second(B) visual feedbacks appeared to be faster or if they were equal in duration. Another button enabled the user to replay each trial before proceeding to the subsequent pair of progress bars. Once an answer was provided, the next trial was initiated. To make the experiment have higher ecological validity than research in controlled environments, the response and replay buttons could be pressed at any time, they could watch loading symbols as many times as they want.

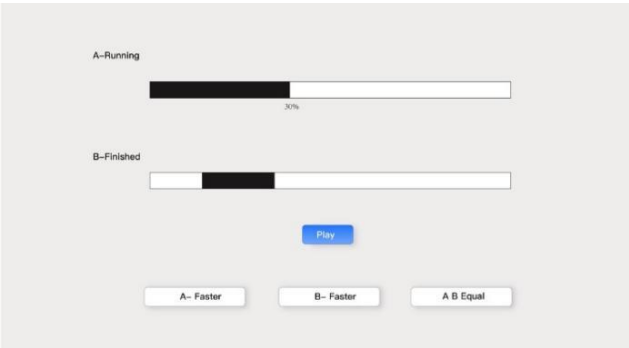


Figure 3. Experimental interface in Experiment 1

4.3.2 Experiment 2

One day after Experiment 1, 23 subjects were re-summoned to experiment 2. All the experimental settings and materials were the same as experiment 1. Participants were asked to give a subjective rating for each of eight different visual feedbacks for how they feel about the waiting experience in a 7- point Likert scale. The scale was based on extensive literature: Bradley and Lang's [51] self-assessment model (SAM) was used to measure emotional state; The deep participation of users was measured by using the cognitive absorption model of Rey chav, iris Reychav and Wu [52]; All items in the questionnaire were measured by the 7-point Richter scale (1 = totally disagree; 7 = totally agree).

5. RESULTS

5.1 Experiment 1

28 trials for each subject, a total of 644 trials were obtained. The experimental data were sorted out by Excel and processed by SPSS 22. Participants had strong preferences among the 8 visual feedbacks. Preference index is used to measure the effect of visual feedback on users' time perception: -1 if the first visual feedback(A) was preferred, +1 if the visual feedback(B) was preferred, and 0 if the participant had no preference. For example, when 23 subjects compared the 4th visual feedback with the eighth visual feedback, 1 subject felt A was faster, 16 subjects felt B was faster, and 6 subjects felt there is no difference between A and B. Therefore, the average preference score was: (- 1 + 16 + 0) / 23 = 0.65, and a positive value meant that more subjects felt visual feedback 8 was faster. As shown in Table 3, there are significant preferences in different visual feedback.

In order to assess the effects of different visual feedback designs on user time perception, repeated-measures ANOVAs were used (Table 4). As shown in Table 3 and Table 4, the rating on waiting time perception significantly differed among different visual feedbacks ($p < 0.001$). However, there is no significant difference in time perception between the embellished and un-embellished visual feedback design ($F=1.108$, $p=0.034>0.05$). which was contrary to our initial expectation that the participant would focus on the cartoon decoration and perceived shorter waiting time(H1c). Therefore, the utilitarian or hedonic design of visual feedback does not have a major difference in time perception. In addition, there is a significant main effect for the visual feedback between explicit and implicit design ($F = 14.829$, $P < 0.01$).

The results indicated that the explicit or implicit design of online waiting could be manipulated by design means. However, contrary to previous research results, the data of Experiment 1 showed that most of the participants felt that implicit was faster than explicit progress cues in online wait. The hypothesis H2c is supported by results. The salience (explicit & implicit) of visual feedback designs do have a significant effect on the users' time perception and the waiting evaluation. Moreover, the presence / absence of background music ($F = 7.481$, $P = 0.012 * < 0.05$) has a significant impact on time perception, which indicates that music is an important

factor influencing users' time perception. As can be seen from Table 3, presents that the pleasant music in online wait makes users perceive shorter waiting time. In terms of interaction effect, the interaction effect of visual feedback design is significant (F = 6.505, P = 0.019 * < 0.01).

5.2 Experiment 2

The purpose of Experiment 2 is to investigate how different visual designs affect users' perception and user satisfaction in online wait. Figure 4 shows a detailed comparison of the mean of 8 visual feedback measured by 23 subjects (with standard error of the mean as the error bar). To test the effects of the independent variables including explicit/implicit, embellishment /un-embellishment, with/without music on the users' perception including perceived control, attention, and emotion. The MANOVA results (Table 5) obtained in Experiment 2 showed that rating on waiting perception significantly differed among different visual feedbacks ($p < 0.01$). In addition, we discussed the potential effects of music and immersion for time perception.

As shown in Table 5 and Figure 4, the visual feedback design shows a significant effect on user perception (P<0.001). More exactly, Subsequent ANOVA test showed that online users reported more focused attention (M_{EMB}=4.15, M_{UNEMB}=3.37, F=104.87, P=0.000<0.01) and more perceived entertainment (M_{EMB}=4.05, M_{UNEMB}=3.42, F=102.014, P=0.000<0.01) when the wait screen included embellished visual feedback it did not. The experimental results imply that the embellishment or un-embellishment of visual feedback on the wait screen significantly affects users' attention and emotion. Interestingly, the results of Experiment 1 present that embellishment have no major effect on users' time perception. Therefore, two experimental results support the hypothesis H1a and H1B, and fail to support H1c.

Significant mean difference was found between explicit and implicit visual feedback with respect to the perceived control (M_{EXP}= 4.30, M_{IMP}=2.62, F=638.807, p=0.000<0.01) and attention M_{EXP}=4.11, M_{IMP}=3.41, F=21.753, P=0.000<0.01). Moreover, the experimental results show the salience (Explicit/Implicit) has a significant effect on the perceived entertainment (M_{EXP}=3.43, M_{IMP}=4.04, F=2.18, p=0.00<0.01). Consequently, H2a and H2b are supported. It implies that providing more information about the waiting state for users can enhance the users' perceived control and attention during the online wait. However, H2c was contrary to our initial expectation that explicit would not shorten perceived waiting time even it provides more perceived control and focused attention.

Table 3. Preference score means for all pairs

	1(ex/no/no)	2(ex/no/yes)	3(Ex/yes/no)	4(Ex/yes/yes)	5(Im/yes/no)	6(Im/no/no)	7(Im/no/yes)
2(E/no/yes)	0.74						
3(E/yes/no)	-0.57	-0.70					
4(E/yes/yes)	0.30	-0.69	0.61				
5(I/yes/no)	0.65	0.83	0.65	0.74			
6(I/no/no)	0.57	0.30	0.52	0.61	0.09		
7(I/no/yes)	0.83	0.70	0.65	0.57	0.35	0.65	
8(I/yes/yes)	0.78	0.83	0.78	0.65	0.52	0.57	0.17

Table 4. ANOVA results of effects of loading symbol factors on the rating for waiting time perception.

Source	Type III sum of squares	DF	MS	F	Sig
Revised model	3.633a	6	0.606	7.645	0
intercept	1.466	1	1.466	18.504	0
Salience	1.175	1	1.175	14.829	0.001**
Embellishment	0.088	1	0.088	1.108	0.304
Music	0.593	1	0.593	7.481	0.012**
S*E	0.251	1	0.251	3.173	0.089
S*M	0.515	1	0.515	6.505	0.019*
E*M	0.152	1	0.152	1.924	0.18
Error	1.663	21	0.079		
Total	11.176	28			
Adjusted	5.297	27			

* p<0.05, **p<0.01

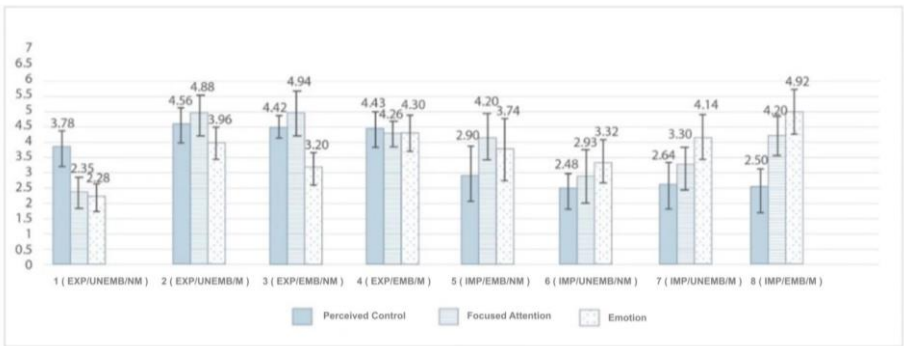


Figure 4. Main effects of salience, framing and music on rating of waiting perception

Table 5. MANOVA results of effects of visual feedback factors on the rating for waiting perception

Source	ID	Type III sum of squares	DF	MS	F	P
Revised model	PC	134.206a	7	19.172	100.778	0.000
	FA	130.696b	7	18.671	79.464	0.000
	PE	104.307c	7	14.901	85.09	0.000
intercept	PC	2208.984	1	2208.984	11611.409	0.000
	FA	2859.285	1	2859.285	12169.331	0.000
	PE	2567.539	1	2567.539	14661.531	0.000
Salience	PC	121.528	1	121.528	638.807	0.000
	FA	5.111	1	5.111	21.753	0.000
	PE	16.242	1	16.242	92.745	0.000
Embellishment	PC	1.853	1	1.853	2.739	0.132
	FA	24.64	1	24.64	104.87	0.000
	PE	17.865	1	17.865	102.014	0.000
Music	PC	0.895	1	0.895	4.702	0.031
	FA	20.891	1	20.891	88.915	0.000
	PE	65.761	1	65.761	375.517	0.000
S*E	PC	0.453	1	0.453	2.381	0.125
	FA	2.959	1	2.959	12.593	0.000
	PE	0.022	1	0.022	0.124	0.725
S*M	PC	4.109	1	4.109	21.599	0.000
	FA	2.959	1	2.959	12.593	0.000
	PE	1.633	1	1.633	9.324	0.003
E*M	PC	4.945	1	4.945	25.992	0.000
	FA	66.56	1	66.56	283.286	0.000
	PE	0.155	1	0.155	0.883	0.349
S*E*M	PC	0.424	1	0.424	2.227	0.137
	FA	7.575	1	7.575	32.239	0.000
	PE	2.63	1	2.63	15.021	0.000
Error	PC	33.483	176	0.19		
	FA	41.353	176	0.235		
	PE	30.821	176	0.175		
Total	PC	2376.673	184			
	FA	3031.333	184			
	PE	2702.667	184			
Revised	PC	167.689	183			
	FA	172.048	183			
	PE	135.128	183			

a. R^2 =.800(Adjusted R^2 =.792), b. R^2 =.760(Adjusted R^2=.750), c. R^2 =.772(Adjusted R^2=.763)

Significant mean difference was found between visual feedback with music and without music with respect to the focused attention (M_M = 3.91, M_{NM} = 3.61, F = 88.915, P = 0.00 < 0.01), and music can significantly affect users' emotion (M_M = 4.34, M_{NM} =3.13, F = 375.517, P = 0.00 < 0.01). As a result, the presence of pleasant music in online wait can make users have more perceived entertainment and distract users from waiting time, thus H3b and H3c are supported experimental results. Moreover, the experimental results show that the presence of music can also enhance the users' perceived control over the current state (M_M = 3.53, M_{NM} = 3.39, F = 4.702, P = 0.031 < 0.05). Combined with the results in Experiment 1, the visual feedback with music in online wait has a significant impact on the users' time perception, which can make users perceive shorter waiting time, thereby supporting H3c.

Moreover, significant interaction effect was found between embellished visual feedback and no embellished visual feedback on attention (F=12.593, P = 0.000 < 0.01). The salience and music have a significant interaction impact on users' perceived control (F=21.599, P=0.000<0.01), focused attention (F=12.593, P=0.000<0.01), and emotion (F=9.324, P=0.003<0.01). Moreover, the embellishment and music show a significant effect on perceived control (F=25.992, P=0.00<0.01) and focused attention (F=283.286, P=0.000<0.01).

6. DISCUSSION

6.1 Salience

Together these results indicate that the salience of visual feedback have a significant interaction impact on users' time perception and waiting perception. More specifically, the explicit design makes users felt shorter waiting time than the implicit design, which was inconsistent with previous researches [10, 24, 53, 54], and failed to support H1c.

The major differences between explicit and implicit visual feedback mainly owing to attention and perceived control. It implies that providing more information about the waiting state for users can enhance the users' perceived control and attention during the online wait, which was consistent with prior research results [13]. However, the explicit design enhanced users perceived control and divert from time information, but failed to shorten the perceived waiting time. Although the perceived control can promote the user experience and entertainment during the online wait, make users expect the current waiting state with hope, and the continuous update of waiting time information provides people with the opportunity to adjust their expectations of waiting time, and at the same time makes them feel more control. Surprisingly, it did not make users feel the shorter waiting time.

These results suggest that the explicit design makes users felt a shorter waiting time than the implicit design. This inconsistency may result from different reasons. A possible explanation for this might be the different experimental settings (the duration of loading video is too short to show the difference between explicit and implicit visual feedback); the unique evaluation method (the direct comparison tests); the participants (the culture, gender, and age all affect users' perception of waiting time and willingness to wait). Another possible explanation for this is the loading speed of visual feedback. Previous studies suggest that different functions in visual feedback, such as power, inverse power, and other functions included speed change, which can improve the users' waiting experience and enhance satisfaction.

The implicit progress bar loads twice as fast as the explicit progress bar, which makes users perceive the system is hardworking and believe the waiting is about to end. Conversely, the explicit design with time information constantly updates makes users own high expectations at the initial stage of waiting. However, the unchanging waiting state makes the users' expectations fall over time, and fail to get continuous satisfaction. Consequently, users may get anxious and bored, and even feel that the loading speed gradually slows down.

6.2 Cartoon visual feedback

The research results show that the presence of cartoon decoration on visual feedback can significantly enhance the users' satisfaction and the hedonic progress cue can divert the users' attention from time information. Previous studies and our experimental results indicate that interesting cartoon (Hedonic design) provided in online wait will enhance the users' pleasure and other positive emotions, and distract the users' attention to the nontime information. However, there is no statistical difference in the perception of waiting time between embellished and un-embellished visual feedback design.

The data of Experiment 1 showed that 54% of the subjects preferred to choose the progress bar without embellishments faster, 24% of the subjects felt that the progress bar with embellishments was faster, and 22% of the subjects believed that there is no significant difference between the embellished and unembellished visual feedback on time perception. The number of subjects felt that the visual feedback without embellishment was 2.27 times faster than that with embellishment.

Therefore, even if the results of this study show that the embellishment has no obvious effect on time perception, the cartoon embellishment should be taken into account when designing a wait screen owing to the hedonic design can reduce anxiety and enhance the entertainment for users. It is noteworthy that inappropriate embellishment may have a negative effect, considering more coordinated visual feedback design can enhance the overall satisfaction of the waiting experience.

6.3 The effects of music

The research results show that the pleasant music in online wait can enhance perceived entertainment and distract users from waiting time. Consequently, the users may perceive a shorter waiting time and be encouraged to wait. This finding proves that the effects of using music in online wait are consistent with that in the physical environment (e.g., playing music while waiting for payment in the supermarket). The effect of music on users' waiting experience and time perception is obvious. However, the users' perception and evaluation of music are subjective, thus more research should be conducted to confirm that the results are applicable to a wider range of people. In addition, the attributes (volume, rhythm, etc.) and effects of music should be carefully selected. In a word, the preferred and relaxing music can be selected to encourage users to wait longer in the online waiting environment.

6.4 Limitation and future research

Like all studies, this study has its limitations. The effectiveness of this study is limited due to the limitations of the subject, experimental settings, experimental materials and other conditions.

For the participants, the recruited subjects are mainly concentrated in universities. Although it was reported that the main Internet users are young adults, the research results may be not universal in reality.

In addition, this study didn't consider the individual differences of the subjects (age, gender, culture, etc.). For the experimental materials, this research is limited to the common rectangular progress bar, which did not take into account other shapes and cartoon decorations. Therefore, more interesting embellishment can be used in the actual design. Moreover, the experimental setting can't be restored one by one when simulating the real situation. For example, the waiting time is fixed at 8s, there are no other tests for shorter and longer waiting time. To sum up, the time perception and user experience in the different environments or tasks should be explored in the future, and the differences between a wider range of people and individuals should be investigated to test the universality of the research.

7. CONCLUSION

This essay has discussed the effects of different visual feedbacks designs (Explicit/Implicit, Hedonic/Function, Music/No music) on user time perception, and also tested how visual designs affect the waiting perception including attention, perceived control, and emotion in the online waiting. The results of this investigation show that: in the online wait, the salience (explicit/implicit) of visual feedback can significantly affect users' time perception, explicit visual feedback provides users with greater perceptions of control and diverts attention from nontime information. The cartoon embellishment of the visual feedback is not vital for the users' time perception, but it is helpful to enhance the users' pleasure. It is worth noting that inappropriate decoration can even play a negative role. Music has a significant effect on the users' time perception and user experience. Appropriate music accompaniment in online wait will make the whole waiting experience faster and easier. Our research results can provide some design reference for design practitioners in the future, and enrich the theory of time perception.

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