

Applying Natural User Interface to Leverage Playing Engagement in Culture Practice Content

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ABSTRACT

From gesture pattern recognition to human voice control, the technologies of Nature User Interface (NUI) have widely been used in situations from interactive media to virtual museums. However, the application of NUI in games has not been well explored. On a mission to enhance physical embodiment of control gestures in game, we developed a physical NUI-based interaction that mimics the activity of blowing on the fire during cooking, in the cultural context of celebration of a specific holiday.

By testing and recording participants remotely, we examined the effect of application of an NUI blowing interface on the level of play engagement. Participants in the NUI input group scored significantly higher on play engagement compared to the non-NUI group using mouse-clicks to control the fire, and this effect is not due to ethnic background effects. Moreover example video recordings showed qualitatively greater engagement in the NUI-condition as participants actively looked around the game environment.

This suggests that the use of physically oriented interactions can enrich games that inform us about cultural practice. The strategy allows players to engage in culturally relevant interactions with physical embodiment.

CCS CONCEPTS

K8.0 Personal Computing: General: Games; H5.1, Information interfaces and presentation: Multimedia, Information Systems: evaluation.

KEYWORDS

Natural User Interface; Play engagement; Physical embodiment; Interactive narrative; Immersion; Cultural practice.

1 Introduction

1.1 Natural User Interface in Games

Natural User Interface (NUI) refers to interaction methods that apply principles of natural human behavior in its design. The behavioral repertoire involves a range of interactions that human beings are capable of, including touch, speech, body movements, and gestures. The core guidelines of NUI design include [1]:

1. The interactive experience should feel like an extension of their body for experienced users.
2. The interactive experience should feel natural and accessible for beginner users.
3. The design of the interface should take context into consideration, including behavioral metaphors, visual cues, feedback control, input/output methods, and environmental design.

Natural User Interfaces can convert human action to data, leveraging design patterns that involve gesture and touch pattern data [2]. These functions offers users with the ability to intuitively interact with or operate computerized systems using natural gestures, and realizes smooth and adaptive user experience.[16] The implementation of NUI technologies often involves the augmentation of the user with natural movement input device, such as Microsoft Kinect™, which is developed and applied for interacting with virtual immersive environment and for making user feels to be part of occurrences in the system [17]. Sound or voice interaction, considered as a type of NUI [3], allows the system to use human acoustic data processed for a specific task to reduce cognitive load, increase learnability, and facilitate direct interaction.

Recent studies raised the question of NUI design specifically for games [4]. Some of the major concerns include: 1. usability issues in functional reliability, including noise reduction ability, spelling identification, and recognition sensibility; 2. detachment caused by incompatibility between the player and virtual avatar. 3. A disparity between actions appropriate in the game world and actions natural in the real world in NUI interfaces. The latter can cause a disconnection between the player and the character she controls and thus undermine the overall game experience. The current study suggests an additional NUI guideline: that efficient utilization of sound input that synchronizes connection between the player and game context may lead to enhancement of immersion, flow, and identification to the character [18]. The present study and corresponding game design were inspired by existing games such as *Dandelion*, in which a player is asked to puff at a dandelion to make it move [14], as well as *The Voice in the Garden*, which utilized human sound input to unfold a story [15].

1.2 Structure of Play Engagement

Engagement is defined as the psychological state at different sequential levels of player experience (Figure 1). Hence immersion suggests the lowest level of engagement while absorption suggests highest level of engagement [5].

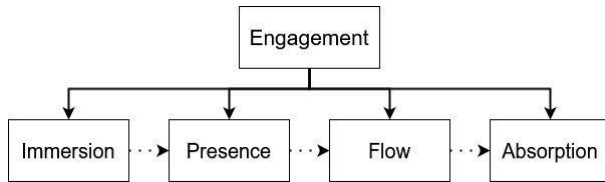


Figure 1: Engagement and its components. Continuous lines mean composed-of, dotted lines mean prerequisite.

The first level, immersion, refers to the experience of being a part of an environment under the game context. Specifically, immersion describes the player's experience in the game scene while retaining awareness of the peripheral environment [6]. Existing studies illustrate that immersion is associated not only with a virtual environment, but also the player's identification with characters from that environment. (7)

Presence is defined as one's experience of being inside a particular place. In a gamified environment, presence refers to the player's subjective feeling due only to being in the virtual world [8]. Presence can be critical for designing educational environment for effective learning in cases like teaching of history and acquisition of hands-on skills [9, 10]. As such, our work concerns a game that delivers both historical knowledge as well as hand-on culture practice.

Flow is a psychological state characterized by intense enjoyment and efficiency when challenge is achieved, particularly when the player's skill and the difficulty of the task are in balance. Many players report feeling of being in control but unaware of the passage of time during this level of engagement [11].

Absorption is often described as experiencing total engagement during game play. In contrast to immersion and presence, and in common with flow, being in a state of psychological absorption involves an altered state of emotion, feeling, and cognition, and experiences and affect is less accessible to consciousness. [12].

2 NUI Application and Game Design

With the colors of traditional Chinese New Year in mind, we used warm colors and aesthetics of the fire bar to show players the presence of the warm festival cultural atmosphere. The story of the game involves a young man who has left his native home of China. The real meaning of New Year in the traditional sense is revealed to him after a ghost of the New Year guides him in his travels around the world. Every time he comes to a new country, he helps with cooking the New Year dinner and spends the New Year night with a local family. By experiencing New Year's night in different cultures, the young man finds out that the real meaning of New Year is to accompany your family. Finally he goes back to his hometown to spend New Year's night with his own family.

Storyboard

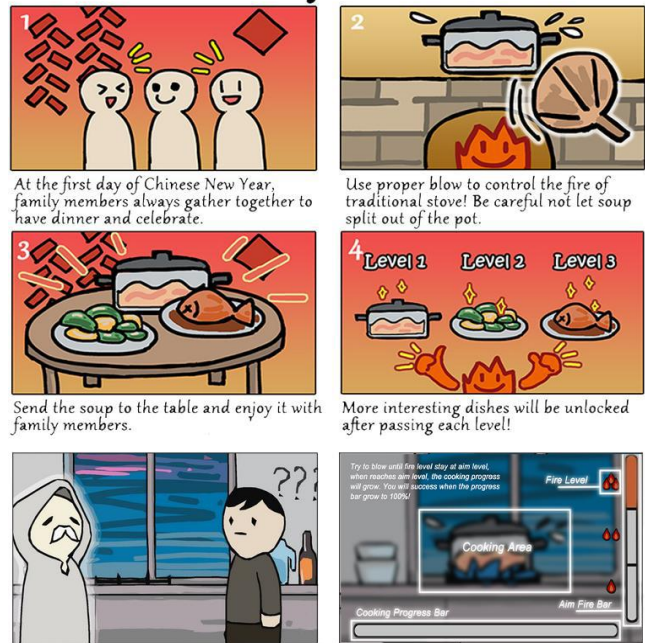


Figure 2: Visual elements, background story (game context) and game mechanics (rule for blowing and mouse-clicking in cooking interaction).

As the previous researchers had demonstrated, game interaction that lacks consideration of context in its design can have a detractive influence on game immersion and experience [19]. Following the perspective of NUI design, our game used volume detection as input rather than conventional voice interface technology like speech recognition, to enhance the physical embodiment of control gestures in the game.

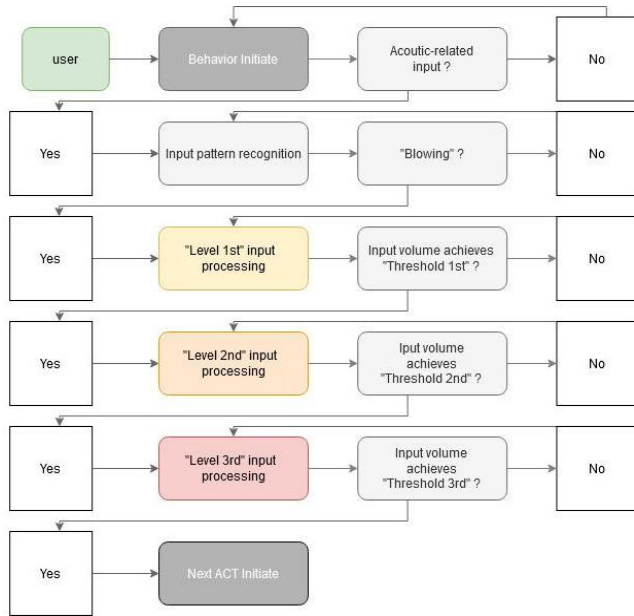


Figure 3: Design of interaction and the process of game playing and interface during the blowing mechanism. Higher level means larger fire proportion.

Players are asked to blow at the microphone to control the fire level during cooking, thus connecting the cultural activity of “cooking” with physical interaction. The size of the fire changes in proportion as the blowing sound volume received (or mouse click in the control), just like the player is blowing a real fire and her breath makes the fire shake. To see how the mechanism affects playing engagement in the narrative environment, we used remote play and qualitative analysis to assess play engagement.

3 Method

3.1 Hypothesis

We investigated whether or not applying NUI principles in the form of a blowing mechanism enhances players’ level of engagement. Since utilization of NUI mechanics may benefit immersion, flow, and identification to the character, we hypothesized that participants’ level play engagement will be enhanced if assigned the NUI based condition. Additionally, since the game used in this study carries out a traditional culture practice, we also tested whether or not participants’ ethnic background has an influence on play engagement.

3.2 Participants

We sampled 20 participants ranging from 19 to 31 years of age, with an average age of 25.5. 12 were males (60%), and 8 are females (40%); 4 are Caucasian (20%), 15 are Asian (75%) and 1 African American (5%). To help avoid recruitment bias and avoid face-to-face contact during COVID-19, we use an online recruitment system to find participants. Of the 20 participants, 2 agreed to participate in this study on camera and provided consent.

3.3 Questionnaire

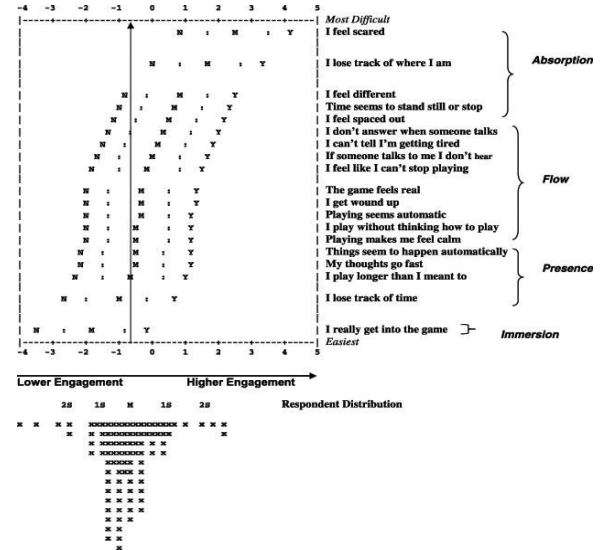


Figure 4: 19 test items of GEQ in difficulty order corresponding to Absorption, Flow, Presence, and Immersion.

We adopted the Game Engagement Questionnaire (GEQ) to measure the level of engagement in this game. The GEQ is a 19-items 5-points scales questionnaire (1 = strongly agree and 5 = strongly disagree) developed as a self-report measure of the player’s potential for engagement in a virtual environment from the initial level of immersion to the deeper level of psychological absorption [13].

3.4 Procedure

Experimenters first met the participants on Zoom. To standardize the context, we asked all participants to sit at a desk with enough space for operating the game. All participants were randomly assigned into either the NUI condition (using blowing to control the fire) or the conventional interface condition (using the rate of mouse clicks to control the fire). Experimenters next presented the background questionnaire digitally, and showed the participant a tutorial level in order to become accustomed to the fundamental rule of the game to the same degree. During the experiment, participants with consent to be videotaped were screen-recorded via the webcam for further qualitative analysis. After finishing the game task section, the GEQ questionnaires were given.

4 Results

4.1 Experimental Data Analysis

We performed a Student’s t-test to investigate the influence of NUI application on level of playing engagement. Of those 20 participants, there were 10 participants randomly assigned into NUI condition ($M = 8$, $SD = 3.4$) and 10 randomly assigned into non-NUI condition, the situation that participants use conventional mouse and keyboard as input ($M = 4.2$, $SD = 4.05$). The results demonstrated significantly better play engagement

scores (Figure 5) in the NUI blowing condition, $t(18) = 2.273$, $p = .036$.

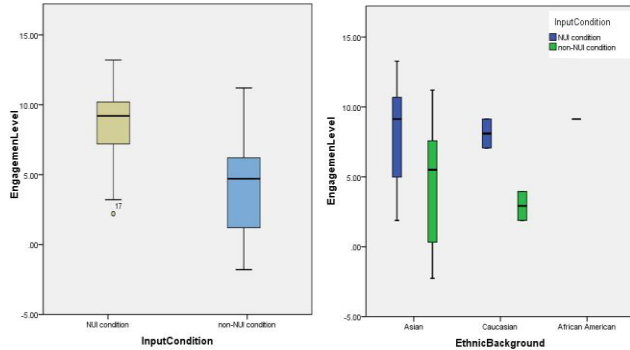


Figure 5: Difference in level of engagement in the game (left), and Ethnic background factors (right) in NUI condition vs. non-NUI condition on engagement.

To make sure the effect of NUI blowing on play engagement is not due to the ethnic background of the participants, a one-way between subjects ANOVA was conducted, showing no significant effect of ethnic factors on engagement, $F(2,17) = 0.267$, $p = .769$, despite Asian participants ($M = 6.06$, $SD = 4.51$) attaining slightly higher scores than Caucasian participants ($M = 5.5$, $SD = 3.11$).

There was also no significant effect by gender, $t(18) = .411$, $p = .686$. Interestingly, age and engagement level (Figure 6) were found to be marginally correlated, $r(18) = -.432$, $p = .057$.

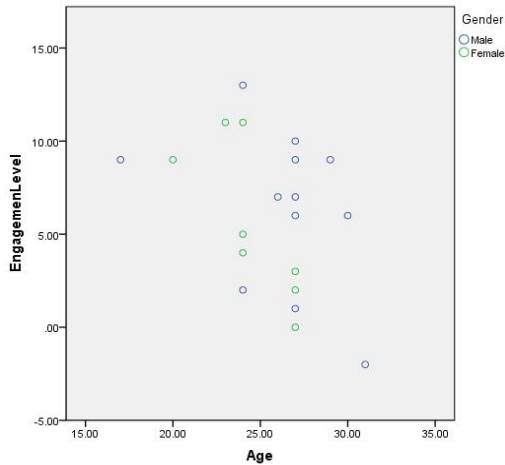


Figure 6: Correlation between age and playing engagement

4.2 Qualitative Analysis

Only two participants consented to be recorded. Hence we can only perform a rudimentary qualitative comparative analysis on facial expression based on these case studies. The participant in NUI condition appeared to more actively engaged when “blowing” behavior is initiated compared to participant under same stage that used “mouse-clicking” in non-NUI condition (Figure 7). As seen in

the video, the participant in NUI condition (3 shifts in eye contact with game scene) less distraction than the participant in non-NUI condition (7 shifts in eye contact with game scene). Additionally, the participant in NUI condition (5 times in smile, 1 times in laugh) appeared to be more emotional engaged than the participant in non-NUI condition (3 times in smile, 0 times in laugh). However, a more precise qualitative analysis is required for drawing the conclusion.



Figure 7: different facial expression under NUI condition (above) and non-NUI condition (bellow) was observed.

5 Discussion and Next Steps

We have demonstrated that utilizing NUI design-based interaction in the form of physical blowing can be beneficial to play engagement in a game involving cultural practice. Our effort to revisit NUI technology and the theory of engagement may help other researchers and designers to gain a better understanding of the use of these technologies.

In our case, blowing fire is essential to the experience of cooking in our particular cultural experience, making the embodied experience key to the way players can engage with the game. We did not observe significant difference between ethnic factors, suggesting that it is the NUI design that promulgated the effect on engagement in cultural context. However, we did obtain a comparatively less diverse data distribution due to the availability of participants under current COVID-19 limitations on user testing.

Future directions include using biometric technologies such as eye tracking and facial expression analysis to determine the attention and physiological engagement level of participants. We speculate that the use of NUI blowing mechanism as a controller is limited to identifying with cultural stories and practices, and not with the environment the character is embedded in. It may be that the blowing interaction is intimately tied to the activity of cultural practice played in the game and not with the context in which it takes place. To test this, we would test whether the ability to modify environmental variables like lighting and space using the same interaction would lead to changes in the level of immersion.

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APPENDIX

For additional demos, videos, and code related to this project, see
<https://youtu.be/ts4ROUzls14> and
<https://github.com/Tomaslei/SpiritOfNewYear>