Communicative Behaviors and Flow Experience in Tabletop Gaming

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ABSTRACT
The tabletop interface has been touted to merge the best of traditional board gaming and cutting edge computer technology in bringing both intense social interaction and limitless virtual representation to users. This study utilizes flow theory to understand user's enjoyment of playing games. It also explores the interplay between communicative behaviors and game play. Combining observations and questionnaire, data analysis showed certain nonverbal behaviors are correlated with flow. To further explain how social interaction influence game enjoyment, three main themes were identified: through the use of space, reduced nonverbal cues and knowledge transfer. Implications for tabletop game interface design are then discussed.

Author Keywords
Tabletop interface; augmented reality games; flow theory; communicative behaviors; social interaction.

ACM Classification Keywords
H5.3. [Group and Organization Interfaces]: Collaborative computing, Computer-supported cooperative work; J.4 [Computer Applications]: Social and behavioral sciences.

INTRODUCTION
Scholars have asserted that advancements in game research should seek a synthesis of the tabletop and computer technology, drawing upon the strengths of both mediums [21]. Hence, this study seeks to extensively document the dynamics of social interaction and communicative behaviors that takes place in and around gaming on the tabletop interface.

RELATED WORK

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One of the main strengths of the tabletop interface is its ability to foster an intuitive means of collaboration for users. These interfaces are said to lend themselves to natural collaboration due to three main reasons: they build upon users' familiarity with whiteboard/table workspaces, they are large enough to allow for multiple users, and all group members have virtually unrestricted access to items on the tabletop [24]. These factors allow the tabletop interface to be used in a variety of collaborative settings, such as for work, for presentation display, or for gameplay [29].

Communication

In terms of communicative behaviors, this paper focuses on the study bodily movement. [9] developed a classification system identifying five types of body movements that have communicative functions. They are: emblems, illustrators, affect displays, regulators and adaptors. Emblems are gestures with a direct verbal translation, generally a word or phrase, often culture specific. Illustrators are movements that illustrate what is being said verbally, reinforcing verbal communication and emphasize words or ideas. Affect displays are postures and facial expressions, revealing affective or emotional states. Regulators are used to regulate the conversation and interaction. Adaptors are movements that satisfy personal needs and help in adapting to the environment. [15] also highlighted the different degrees of intentionality and awareness for the types of body movements ranging from the use of "emblems" being the most intentional, to facial expressions and postures that occur without any awareness or intention to communicate. Eye contact is also an important component of non-verbal behavior. Performing a monitoring function by checking communication effectiveness and feedback, or an expressive function by offering an insight to emotions and feelings [1].

Flow Theory
The enjoyment of playing games is an intrinsically motivating factor. Studies seeking to better understand the intrinsic enjoyment of playing games have utilized flow theory as their theoretical framework [4,5,25,28,30]. Flow theory [6] explains why people engage in certain activities

even without external rewards. It proposes that the enjoyment of acting in a flow activity justifies the expenditure of time and energy [7].

The experiential state of flow is defined as a pleasurable experience so gratifying that individuals are willing to do it for its own sake, with little concern for what they will obtain as a result of it. The flow experience in games is brought on when the skills of the player matches the difficulty of the game [25]. This exploratory study proposes to examine the interplay between communication and the enjoyment of tabletop game of individuals.

STUDY

In order to examine the dynamics of social interaction and communicative behaviors, as well as how these are related to participants' experience of flow, a user study was designed in which a collaborative multi-user tabletop game called "Comino" was presented as a task to participants.

SYSTEM

Comino is a collaborative tabletop game for up to four players who have to solve a puzzle using both real and digital domino tiles. To link both worlds, special physical interfaces are used.

Figure 1: The main motivation for Comino was to augment a traditional board game with additional digital content. Users have to work together and place domino pieces in each level.

In some cases, users need to switch to the real world using custom-built physical portals that allow a physical impulse to be "transferred" to the physical world and vice versa. Hence digital domino tiles can cause real domino tiles to topple over and vice versa. The setup is based on a rear-projection table with a special surface that allows simultaneously localizing multiple digital pens. Using these pens, the players can position virtual domino tiles on the projected surface. The terrain also designates the area where the virtual and real dominoes can be placed.

Hardware

The table uses a projector (including a mirror) and a special back projection surface to display computer generated images on the tabletop. The height of the table is approximately 90cm, which allows convenient interaction while standing around the table. In our setup, we used an A0-sized rear projection surface (112.0cm×85cm). The surface is also used as tracking surface for the Anoto pens which were used as user input devices. Up to four pens can be used simultaneously.

The interaction between the real and virtual game components was realized using custom built hardware interfaces (the black plastic cube in figure 1), so called "portals" which are connected wirelessly with the computer. Digital styli were used as primary input devices for the study. The used system supports the simultaneous tracking of up to four pens on the tabletop. Each stylus can be uniquely identified and users can move freely around the table while using the wireless stylus. Used data from the stylus includes coordinates in two dimensions, unique identification number and "up" and "down" events. The stylus tracking does not support hover states nor are any additional buttons on the pen. However tangible menus can be used to switch between various modes of interaction with feedback given on the tabletop screen.

Software

For software development Virtools [www.virtools.com] was chosen. Virtools is a real-time 3D authoring environment which allows the creation of interactive 3D content. Comino features custom created game assets which were created using various 2D and 3D programs and then imported into the Virtools application. To create a more realistic and immersive game experience, physics simulation was integrated in the game for a realistic behaviour of the virtual game objects and a more seamless transition between real and virtual game objects.

Gameplay

In each level of the game, players are required to connect two special domino bricks with an unbroken chain of dominoes. Using a wireless pen-interface, players can draw a path on the table's surface for placing the digital (projected) domino tiles.

The players can select between different actions, set up domino pieces, re-position, or delete domino pieces. At the same time, other users can start setting up real domino pieces directly on the same surface of the back-projection table, creating a very strong mixed reality experience. While playing, the users can move freely around the table. Comino has no dedicated mode for setting up the domino pieces. Hence it happens quite often that either the real or the virtual domino pieces start toppling over before the chain-reaction is started by the users, forcing the users to work together even more. The tension of the players is at its peak once everything is set up, the chain-reaction is started and everybody is hoping for his part of the domino line to work until the last block has fallen down and the game advances to the next level.

Test Setup

The study was conducted in a research laboratory with seven groups of three participants each, lasting approximately 45 minutes per group. After reading the consent form and instructions, the participants were introduced to the table and interface. Each participant was given a stylus and a control menu, which allowed him or her to control the function of the stylus. In each group, they shared two portals and 80 real dominoes. The participants were taught how to hold the stylus and how to switch between different input modes using the tangible control menus. An instruction sheet was also given to them, which explained the task required as well as a brief explanation about each item of equipment. Before starting the game, an experimenter indicated the position of the two special dominoes to the participants, but no further verbal instructions were disseminated.

Participants

A total of 21 undergraduate students were recruited from the student body at a local university. They were awarded bonus course credits for participation in the study. Participants were told that the study focused on evaluating the use of game interfaces, but were not given any specific details so as to minimize any potential demand characteristics.

Task

The task itself consisted of two stages. First, the participants were allowed to familiarize themselves with the equipment for ten minutes. Once they were familiar with the devices and figured out the trigger mechanism for the portals, the next stage would begin. The participants were given another ten minutes to complete the second task. Both tasks required them to use a combination of virtual and real dominoes to connect the two special dominoes to form an unbroken chain. During the game, video recording devices were switched on and used to record data for analytical purposes.

Measurements

After completing the tasks, posttest questionnaires were given out to the participants to obtain information on their state of flow during the gaming experience. The questionnaire contained 37 items adapted from flow questionnaire [14], as well as three additional items on participants' appraisal of social interaction. The 37-item flow scale is composed of 9 measures of flow characteristics: challenge-skill balance (α, = .86), action-awareness merging (α = .81), clear goals (α = .86), unambiguous feedback (α = .90), concentration on task (α = .84), sense of control (α = .80), loss of self-consciousness (α = .87), transformation of time (α = .76) and autotelic experience (α = .88). Reliability analyses indicate that subscale items were consistently of acceptable inter-item reliability. As for the items on social interaction, participants were asked if the interaction with the group enhanced their enjoyment of the gaming experience, why/why not, and whether they would have preferred if the task required more interaction with their peers.

In order to examine the differences in communicative behavior and interaction between groups that contrast greatly in terms of their flow state, the individual flow experience scores from the participants were tabulated and summed to give group totals.

RESULTS

The video recordings were analyzed using content analysis, employing an open coding approach. During the initial stages of coding, inductive codes were gathered from early observations of social interaction. These were used as initial coding categories, and adjustments made as further observations were noted. In addition to these content analyses, exploratory statistical tests were used to tie communicative behaviors to flow intensity..

Non-verbal communication

Nonverbal eye contact and facial behaviors

The frequency of the five types of nonverbal communicative behaviors were coded, and pearson's correlations were run to relate the incidence of each to the flow intensity of groups. Bivariate correlations between intensity of flow and nonverbal cues were significant. The intensity of flow was found to be strongly positively correlated with the instances of eye contact, $r(5) = .84$, $p < .01$. On the other hand, flow was inversely related to the instances of illustrators, $r(5) = -.69$, $p < .05$.

Generally speaking, minimal eye contact was observed throughout the various sessions. Due to the shared interface, participants did not look at each other for monitoring or expressive functions. Instead, the peripheral actions of the other participants, together with the illustrators used, replaced the need for eye contact. As such, much valuable information, typically conveyed through eye contact and facial behaviors was potentially lost.

In-depth observations

Qualitative observations were conducted to further explicate the situation. Three key observations of the relation of communication to fostering flow experience are documented: the use of space, reduced nonverbal cues, as well as knowledge sharing.

The use of space

The spatial dimension was an important factor in delineating how social interaction unfolded around the tabletop interface. Although the positioning of the participants around the interface was often arrived at arbitrarily – depending on how each individual chose to position him or herself – it often became an influence in the subsequent interaction dynamics.

Participants in Group 7 were arranged such that two individuals were side-by-side lengthwise, while the third individual was standing along the breadth of the tabletop interface. As the participants navigated the task, it was observed that the first two participants were cooperating in

discussing and sharing information about the task, while the third participant focused on working on another part of the task alone. Consequently, there was little synergy between the three group members and interaction was observed to be sporadic and seemingly inhibited.

Reduced Nonverbal Cues

Non-verbal cues such as the amount of eye contact and emblem-use among participants were considerably reduced among participants in the study. On the average, instances of eye contact among group members were 8.7 times per session, and emblem-use was found to occur in only one out of seven sessions. The tabletop interface is purported to be able to support social interaction of the nature found in traditional board games. However, decreased non-verbal communication documented in this study seems to suggest otherwise.

Knowledge transfer

It was seen that several groups benefited from an uninhibited exchange of knowledge as it pertained to gameplay. As an individual player discovers something about the game dynamics, he or she would share the information with the rest. On occasion, this sharing is prompted by other players inquiring as to how the player managed to perform a certain action with the stylus. These groups progressed more rapidly and were able to figure out portions of the game simultaneously.

As there was a generally low level of interaction taking place, the opportunity for the lone individual to exchange knowledge with the rest was reduced. One participant took about half the total time to figure out the full capabilities of the stylus, while his group members had already acquired it in the early stages. Not surprisingly, the abovementioned group scored the lowest in terms of flow intensity.

DISCUSSION

Concerning the observation of the use of space, it should come as no surprise that, due to the rectangular nature of the tabletop interface, groups were likely to arrange themselves such that two individuals occupied the length of the interface. While the concept of spatial arrangement has been covered by previous studies, for instance [31] that provides a classification of seven positions, this study goes further in asserting that certain arrangements potentially foster an imbalance or asymmetry about the interaction dynamics.

Positioning exacerbates any prior factors that might hinder or facilitate interaction. This is especially obvious if an individual positioned along the breadth of the interface were to be working with a pair of previously acquainted individuals situated lengthwise. The group cohesion is impeded not only by the fact that the solitary individual is unfamiliar with the other two, but their position side-by-side encourages dyadic collaboration and the solitary individual has to work doubly hard to maintain a three-way interactive exchange. On the other hand, if the tabletop interface were to be setup as a square with each individual occupying a side, the distribution of players would be equally weighted on each side, resulting in a much more balanced, cooperation-friendly configuration.

It was also observed that non-verbal cues such as the amount of eye contact and emblem-use among participants were found to be reduced among participants in the study.

Though the tabletop interface seemingly supports face-to-face interaction, upon closer scrutiny the quality of social interaction fostered by the tabletop interface only fulfils three out of the four attributes of a rich media type. The lack of non-verbal cues would mean that communicative signs are lacking in tabletop collaboration. Empirically attesting to the significance of this deficiency, the intensity of flow was found to be strongly positively correlated with the instances of eye contact, as seen in the earlier section.

With regards to knowledge transfer, it is possible that it is another factor – among many – that is fostered by increased social interaction. As individuals interact freely, they tend to lose their inhibitions, whether it is with regards to discussing strategies, cooperating with other group members, or learning from their peers. Hence, this results in a comfortable gaming environment whereby the members of the group are unashamed to address each other's weaknesses in order to advance in the game. This invariably leads to a more immersive and enjoyable gaming experience.

Amendments to tabletop design

The findings from this study suggest several design amendments that could be made to the tabletop gaming interface, in order for it to support rich social interactions that encourage the flow experience during gameplay.

The distinct lack of nonverbal communicative cues would indicate that players are paying much more attention manipulating physical game pieces in relation to the game interface rather than in relation to fellow players. Though much has been done to ensure that the physicality of the traditional board game is transposed to a tabletop context through the use of tangible menus and styli, the fact that this interaction with tangible objects takes place largely in a dialogue between the individual and the interface almost ensures that the bulk of a player's attention is focused on the interface, and not on one's fellow gamers. Hence, it would be extremely helpful if the tangible tools require some form of exchange between players to encourage nonverbal communication. As media richness theory has pointed out, this area of communicative non-verbal cues seems to be notably lacking in tabletop gaming, and significant improvement is due.

The observations from the use of space indicate that tabletop designers should strive to ensure that the spatial positioning of participants do not interfere their gameplay. Previous interfaces have strived to maintain equal access to the interface regardless of vantage points around the table. However, spatial positioning may exert a more insidious

effect, seen in how an asymmetrical distribution of individuals due to a rectangular-shaped tabletop affects the intricacies of interaction during gameplay.

Knowledge transfer is another area in which tabletop gaming interfaces would do well to address. It should be ensured that the information required be fully accessible and understood by all group members before gameplay commences. However, if picking up skills during gameplay is an integral part of the experience, then the game must strive to allow the free transfer of knowledge between members of the same group. For instance, the game setup should include input devices (such as styli) for all members of the group. This would ensure that the opportunities for the development of skills would be evenly distributed among the team. If only one stylus was available, the development would be considerably constrained. Allowing for multiple input devices while fostering social interaction would substantially increase the chances of knowledge transfer between members.

CONCLUSION

This study has documented how the experience of flow in tabletop gaming relates to the communicative behaviors, collaborative styles and general social interaction exhibited by players. Three main communication behaviors were highlighted and discussed, with corresponding amendments proposed to future tabletop design.

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