Preparing a Psychological Experiment on a Tactile Display

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ABSTRACT
Seamless IT interfaces can provide sophisticated environments for experiments. We describe a setting from motivational psychology, targeting to identify the attitudes and strategies of Poker players by observing their individual cards and activities in a non-invasive way. A digitally supported game on a tactile table can help to simulate a typical casino atmosphere even in a lab environment, while necessary data can be directly gathered and stored for later processing. Starting from the requirements defined from psychologists, we describe selected design issues when deploying the Poker game to the tactile display. The paper concludes with findings collected in experiments and recommendations for further work.

Categories and Subject Descriptors
J.4 [Computer Applications]: social and behavioral sciences – *psychology*.

General Terms
Measurement, Design, Experimentation, Human Factors.

Keywords
Decision making; Poker; Tactile interface.

1. INTRODUCTION
Research on judgment and decision making has a long-standing tradition in Psychology [3]. Basic cognitive processes of these phenomena have been widely studied in laboratory settings, using simplified and straightforward experimental paradigms. However, to study decision making in naturalistic settings, such as individuals' everyday life or in work settings, other research designs are needed. In particular, we need tools that allow for capturing the complexity of the decision making process as well as the surrounding context. At the same time, the natural progress of the internal decision making process under study should not be affected by the process of measurement. Employing IT interfaces can be a means to this end of non-invasive data collection.

The setting to be analyzed by the work presented in this article is a Poker game. Poker players constantly need to make decisions under uncertainty. Apart from that, their decision context is comparatively stable, that is their decisions are always affected by the same variables (e.g., quality of own cards, betting behavior of other players). Other aspects of the environment, like the many influences that are present in typical scenarios of daily life or work, can be rather neglected. In such a gaming context, it is possible to study further determinants of decision making, such as motivational processes or individuals' attitudes. The current study will investigate the interplay of achieving gains versus losses and individuals' self-regulation processes, that is how individuals adapt their behavior and betting decisions to the course of their play. This makes Poker games a valuable object of study, given that the conditions are close enough to a common casino setting. A table with a touch-sensitive display is a proper tool for such experiments, since it combines the natural appearance and handling of the game with the possibility to seamlessly measure all required parameters.

The article describes the design aspects of such experiments, which were prepared in combined efforts from psychology and computer science. This work is based on general design guidelines for haptic interfaces [2] and games [5], as well as on the concept of immersion [1]. Starting from the specific requirements defined by the investigators from psychology, along with the framing conditions of available tools and technologies, we analyzed the current state of the art and derived our own approach for designing the experimental setting. This is described in section 2. The results of our work, with a focus on technical design issues, are presented in section 3. First results of psychological experiments are stated in section 4. The article concludes with some findings from this projects as well as ideas for further work in section 5.

2. DESIGNING A TACTILE POKER GAME
The central approach is to support a minimum invasive data collection by the utilization of a table-sized computer with interaction patterns that are mentally close to a traditional Poker game. While the output of the Poker application is audio-visual, the input of the players is tactile in order to achieve a naturalistic handling.

2.1 Identified Requirements
Besides the main requirement to implement a highly realistic Poker game, the following sub requirements have been formulated to ensure valuable experiments:

- Support of 4-6 players
- Designated cards and chips area for each player
- Natural and undisturbed game flow
- Poker mode: Texas Hold'em (including common rules like rotating dealer, random cards, …)

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- Minimum efforts to setup and monitor the game
- No dealer required (reduces side effects by investigators)
- Logging of experimental data, relevant for decision making:
    - Who has which cards at a specific moment?
    - Which cards are on the table at a specific moment?
    - When do players bet?
    - How much do players bet?
    - How long do players need to make a decision?
    - What is the chance to win for specific players at a specific moment?

These requirements served as minimum functional specification for the following tool review and design process.

2.2 Related Work

The number of digital and even touch-based Poker games is high. But, most of them do clearly falsify the flow of a traditional Poker game. They create a considerable distance between players by using separate devices or put a specific, non-natural technical system into the foreground of the gaming environment. Thus, we focused on Poker games that can be carried out on a table-sized, touch-based computer to simulate the traditional Poker setting. Thus, only the following two candidates have been identified to be relevant for this project.

The *Poker surface* system [6] has been developed as a combination of a touch-based table component and a mobile phone component. The table serves as central gaming area, while the mobile device shows players their private cards and supports several interaction gestures. The players may even play tricks (manipulations) with their chips. In general, this software could have been a very useful groundwork for our project. Unfortunately, the code was not accessible for further work. Moreover, the non-natural way to integrate mobile phones into the game flow was another drawback of this system.

Another solution for a touch-based table is the *Surface 2.0 Multitouch Poker* system that was developed in a student project and published as Open Source[1]. The software is well-split into two components: A table-site, open part and a mobile, private part. Large parts of this solution could be re-used for our project. However, user tests have revealed several discrepancies between expected and occurring system behavior, i.e. Poker rules were not adequately implemented, and some functions were buggy. Therefore, several modifications have been made. Furthermore, the software lacks ofs appropriate logging mechanisms for the collection of the required experimental data. These have been added.

Both systems have been developed for the Microsoft *PixelSense* platform (formerly: *Surface*), one of the most popular and affordable multi-touch table computers. The same hardware will be used in this project.

2.3 Approach for Development

As we decided to use the Micosoft PixelSense table computer, our tactile Poker game benefits from the Surface 2.0 Multitouch Poker software.

[1] https://github.com/B3J4y/Poker

Figure 1: Samsung SUR40 with Microsoft PixelSense

The chosen hardware is a Samsung SUR40, running the Microsoft PixelSense platform [3]. The table computer has a 1080p LCD HD display with a screen diagonal of 40”. Per 8 pixels one optical sensor recognizes objects on the display surface. Pre-defined shapes are used to identify objects like fingers and optical PixelSense tags. A powerful AMD Athlon II CPU as well as a Radeon HD 6700M graphics board ensure smooth handling even with this high resolution and touch recognition. The system is able to simultaneously handle up to 52 fingers and other objects. The PixelSense uses a modified Windows 7 operating system. Figure 1 depicts an empty gaming environment.

The Surface 2.0 Multitouch Poker software for this hardware already covers central game mechanics and comes with a pleasant graphical design. However, some fundamental changes had to be implemented to fulfill the defined requirements:

- No use of mobiles, to reduce the technical distraction as well as the setup time to a minimum (just to the table computer)
- Implementation of an alternative mechanism for private areas/cards as we do not use mobiles
- Implementation of appropriate logging mechanisms to collect data about decision making
- Correction and optimization of tactile interaction mechanisms regarding to initial Poker tests with the unmodified software
- Implementation of helpful gaming instructions for Poker beginners

The following section explains and illustrates the resulting Poker software in more detail.

3. THE TACTILE POKER ENVIRONMENT

One of the central requirements was the creation of a mostly realistic Poker setting. IT tools like the PixelSense table are used to log the player actions. Though, players should feel and act as in a traditional casino atmosphere. The following design issues of the resulting Poker@PixelSense have been considered due to this philosophy, based on the previously defined requirements.

3.1 Special Design Issues on a Tactile Display

The implementation of our Poker@PixelSense system was designed for up to six players. This number of players is typical for Poker games. Moreover, this is the maximum of players to be conveniently placed around the table (size: 108 cm × 70 cm).

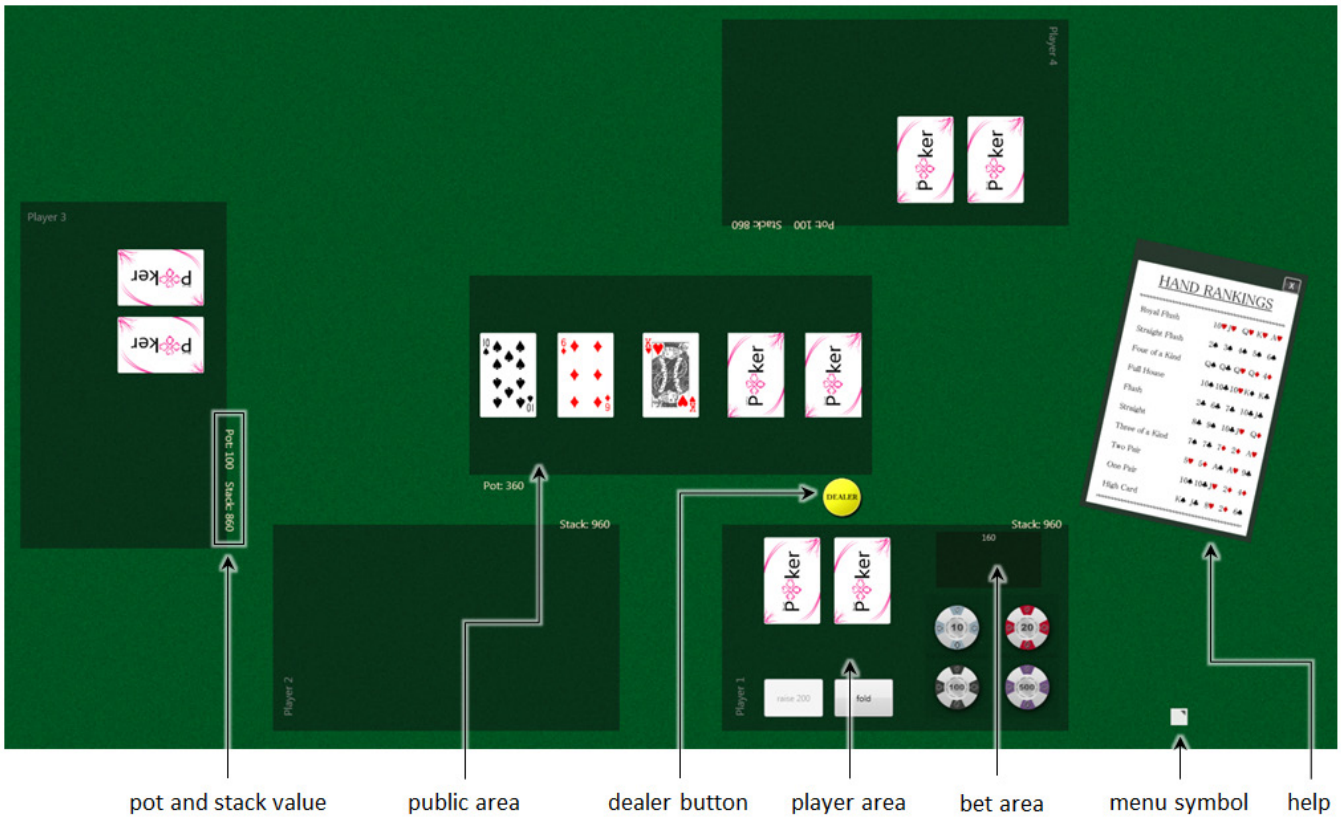

Figure 3: User interface on the PixelSense table computer

To ensure consistent experimental settings over multiple game runs, the software performs all tasks of a dealer. This includes:

- Dealing and uncovering of cards
- Automated collection of blinds
- Monitoring of correct bet and call amounts
- Interpretation of cards
- Proclamation of the winner(s)
- Distribution of the pot

Thus, the experiment investigator's tasks are limited to the setup of a game:

- Placing of players at the table
- Registration of players' names in the software
- Initial sizing of players' stacks
- Initial sizing of the blind
- Start of the game

After the start of a game round, the table presents the Poker environment as depicted in Figure 3. The number of player areas depends on the number of registered players. Four to six players are a valuable number. The player area is labeled by the player's name or – as for anonymous data collection – just by a number. Furthermore, the current player amounts are given for a simple orientation.

Each player area includes multiple elements. One of the most important elements is the personal set of two virtual gaming cards. In general, the use of physical Poker cards instead of digital cards would increase the immersion of the Poker setting. Unfortunately, this is not feasible because of the low recognition resolution of the hardware and other recognition restrictions (e.g. red color is not recognized due to the light spectrum used by the optical sensors). Thus, a pure digital game without physical artefacts has been developed.

The players can look "under" their cards by using their fingers to slightly move the deck image to one side. As Figure 4 illustrates, the players in our experiments mostly used their other hand to hide the exposed cards – as known from a traditional Poker game.

All other elements in the gaming area are hidden for non-active players. This design issue became important after the first user tests and because of two reasons: First, the active player is clearly identified by his active elements on the table. Second, non-active users may put their arms on the table to feel comfortable without evocation of a software reaction.

The chips on a player area are typically used to visualize the player's available amount, as well as to place bet and call amounts. The players place their chips by simply moving them into the bet area with their fingers.

In addition, two buttons are provided in the player area to easily raise the pot with an "all in" (if possible) and to fold.

The second important area on the board is the public area with all common board cards. As typical for a Texas Hold'Em, the dealer uncovers the five cards round by round.

Figure 4: As in a usual casino setting, players use their hand to hide their slightly exposed cards

Each round, another player becomes the formal dealer for this round. As the software covers nearly all dealer responsibilities, the dealer button on the board only serves as a marker to indicate who starts a betting phase.

For Poker beginners in particular, the values of their different hands (along with consequences for their further play) may be unclear. That's why we introduced a help sheet to make the introduction of Poker rules more effective.

At the end of each game, the software announces the winner(s) and uncovers the winning cards. The other players may voluntarily uncover their cards as well, or may decide to still hide them to prevent other players from deriving their strategy.

During the game, a menu symbol allows to setup, start or cancel a Poker game. In addition, it provides the possibility to raise the blinds during a game.

Beyond a standard game course including logging mechanisms, the Poker@PixelSense system may run in a training mode without logging to introduce new players to Poker in general as well as to this special software.

3.2 Gathering and Logging Data

The main goal of our Poker game is data collection for the psychological experiments on decision making. Thus, logging of the game status and all player activities is one of the central functionalities of Poker@PixelSense.

All player activities are stored in a simple text-based log file. Figure 5 shows an excerpt of a typical log. Each line in the text file stores details of one activity. The nine attributes of the activity are separated by semicolons.

Each activity is identified by a timestamp. This is followed by the name of the acting player or "dealer" if the software performs this task. The next attributes are the action that was carried out, the current amount of the player, the hand cards of the player as well as the common board cards and the current pot value. For an easy interpretation of the player's decision the software calculates the win probability of the current player based on his hand cards and the common board cards.

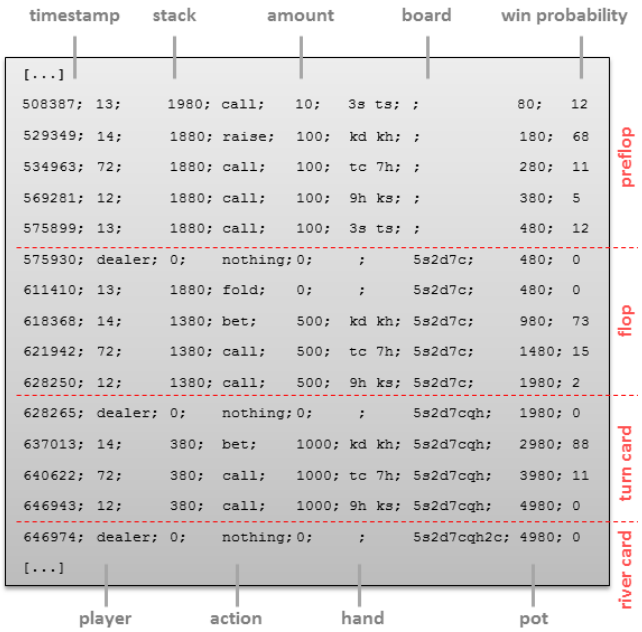

Figure 5: The log file contains information on all activities and intermediate results of a game, including player names, actions, hand and board cards, as well as win probabilities.

Figure 5 highlights the four bet rounds of a typical Texas Hold'Em game that can be tracked in the log file. During the preflop round each player only knows his two hand cards. At timestamp 575930, the dealer discovers the first 3 board cards (flop). This round is followed by discovering the turn card (timestamp 628265) and the final bet round (river card) with all cards discovered (timestamp 646974).

During the rounds, the win probabilities of players change and they adapt their activities. For instance, player 14 has a win probability of 68% in the preflop round (timestamp 529349). He decides to raise by only 100 credits. In the turn card round, player 14 wins by a probability of 88% and bets the high amount of 1000 credits.

We decided to use a simple plain text format to log the actions. CSV files can be easily read and edited with any text editor or data analysis tool. Moreover, this helps to minimize the integration effort when using the file as input format for another software tool.

3.3 Preparing the Lab Setting

As already mentioned the investigator has the responsibility to setup and monitor the experiment.

After defining date and time of the game as well as the involved players, he or she prepares the given lab environment in order to achieve a comfortable, casino-like atmosphere. This can be addressed by a quiet room with closed sun-blinds (better are curtains), comfortable seats, some snacks and drinks, as well as dimmed light.

Moreover, the investigator has to care for requirements of the technical environment. Technology does also benefit from dimmed light, since the touch recognition hardware is based on optical pattern recognition. A direct and bright light incidence massively disturbs the recognition and must be prevented.

Furthermore, configuration of the game has to be carried out. Rules are explained to the players, and a pre-phase for training on the software takes place. Afterwards, the experiment itself starts, consisting of 10 rounds of Poker. Beyond automated recording of the game, additional information on attitudes, motivation and emotions of the players is gathered in between rounds via an online survey on a tablet computer.

Finally, the investigator is responsible to save the log file for further analysis at the end of an experiment.

4. FINDINGS FROM EXPERIMENTS

When the Poker@PixelSense prototype was completed, we carried out some beta tests with interested colleagues and students from our team in order to identify weaknesses and possible improvements of the system. This was also used to verify if logics and handling of the game are appropriate, especially if the implemented mechanisms to reveal one's personal cards are suitable. This could be confirmed, and the system is now available in a stable version.

Starting from summer 2014, we conducted the experiments. The sample consists of about 60 players, formed to groups of 4 to 6 players according to their level of Poker experience and their availability on-site. This results in more than 30.000 activities logged during the experiments (around 10 MB of logging data). Players are University students from different disciplines.

The usefulness of the gathered data for psychological research is very high, since the players' behavior is directly recorded by the gaming environment itself. This is real behavioral data, which is extremely useful because it is very valid and exact. This is in strong contrast to other approaches based on self-reports, since it is not biased by memory effects or individuals' motivation. Moreover, the data is immediately recorded during the decision making process, without distracting players from their game, which is a great benefit for accuracy and expressiveness of the gathered data. Finally, automated recording saves a lot of time and money, as the alternative would be to have students record the information while watching the players. This data can then be combined with the data assessed through the online survey, allowing for complex statistical models of participants' cognition, motivation, emotion, and actual behavior.

At the time this article is finalized, most of the experiments are successfully completed. A first analysis of the gathered data promises interesting insights on decision-making strategies and motivational processes of Poker players. Results of the upcoming in-depth analysis will be prepared for further discussion in the scientific community. The aim is to learn from this well-defined game setting how surrounding conditions influence personal motivation and decision making, in order to transfer these findings to other fields which are harder to study.

From a technical point of view, the suitability of the tactile Poker game could be proven. Only minimal problems were reported by the players, which could be quickly solved on-site and did not influence the experiments.

5. CONCLUSION AND FURTHER WORK

In this article we present the development of a digital Poker game on a touch-based, table-sized computer. The main objective was to automatically gather most accurate and immediate information on the status of the game and the activities of the players, in order to study their motivation and decision making. Thus, a second objective (with even higher impact on the design process) was to create a tactile gaming application which is as close as possible to a common casino-like game. We identified the requirements that come along with these objectives, analyzed existing software and described our design approach to fulfill these requirements.

As a result from this objective, and in contrast to previous work, we decided to integrate the private areas of the players directly into the game table. We could show that this is a suitable approach, since like in traditional settings players simply cover their cards with their hands when slightly uncovering them. Thus, complex mechanisms for coupling the table with mobile phones of the players could be avoided. Again, this makes it easier to gather synchronized data on the game.

Analysis of recorded data is subject of current work. Additionally, we think about possible improvements. A higher degree of immersion could be reached by using physical gaming cards, as far as they can be recognized by the table. A solution to circumvent the infra-red sensors' problem in detecting red color could be to use old German gaming cards (with black and green instead of black and red symbols). However, this will be hard for Poker games, but rather suitable for Skat or the like. Finally, the recognition resolution of the table still has to improve in order to detect card symbols of regular size. Extended usability studies with players could then reveal whether these changes produce a more realistic and sound game flow than exclusively playing with digital cards.

The flexibility of the system would further allow for programming specific experimental manipulations, such as non-random game flow or "planned" gains or losses for certain players. This would enable us to study specific situational influence factors or events. Experimentally manipulating these factors would further strengthen the causality of the observed effects.

Beyond studying players' behavior in different types of games, the approach of in-situ monitoring could be of certain value also to other fields. This includes complex business simulations, group-based problem solving etc. Moreover, the experimental setup could be extended to further sources of data. With regard to individual decision making, information on physiological data would add to the explanatory value of the gathered data. Indicators such as participants' heart rate or blood pressure could be used to investigate the psycho-physiological processes behind decision-making, such as situation-induced strain. In addition to logging information on individuals' touching of certain features on the display, eye-tracking devices could provide more information on information-seeking behavior prior to actually touching the display. Video recording could be used to document the social interaction and communication between actors, which would be particularly interesting in group task simulations. Increasing the complexity of the obtainable data will improve the precision with which we can map and predict individuals' decision-making and behavior. However, the variety of sensors involved in such an experiment would require a complex infrastructure to ensure synchronicity and interoperability of related data and tools. This is an important subject of upcoming research in our group.

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