Exploring Persuasive Techniques for Medication Compliance

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Abstract
Mobile applications that incorporate persuasive techniques have recently been shown to have a positive impact in helping their users achieve pre-defined wellness goals (*e.g.,* keeping active, eating healthier, *etc.*). In this paper, we present MoviPill, a mobile phone based application that combines a set of persuasive techniques (*i.e.,* social competition through a game, social support, virtual rewards and entertaining self-monitoring) to help patients improve their levels of medication compliance. In a 6-week field study, 18 elders used a simplified version of MoviPill that included only the game component. Still, both their compliance levels and the precision of the drug intake time improved by 60% and 43% respectively, when compared to the baseline (*i.e.* their usual medication reminding tools). We plan on evaluating the additional persuasive techniques with further studies.

Keywords
Mobile interface, elderly, medication compliance, healthcare, game, user study

ACM Classification Keywords
H5.2. Information interfaces and presentation (e.g., HCI): User-centered design.

Introduction
Medication adherence is an essential component of a successful health outcome. However, a recent review of 139 studies reporting compliance data showed that only 63% of patients continue with their medication after a year and patients take their medication only 72% of the time [1]. The World Health Organization envisions a

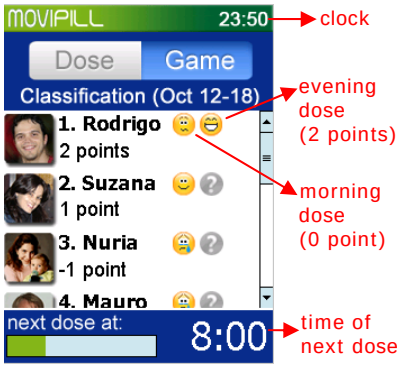

figure 1 MoviPill game screen with the ranking of players. Emoticons represent how compliant they were with that dose (*i.e.*, a laughing face is 2 points, smiling is 1 point, worried is 0 point, and crying is -1 point).

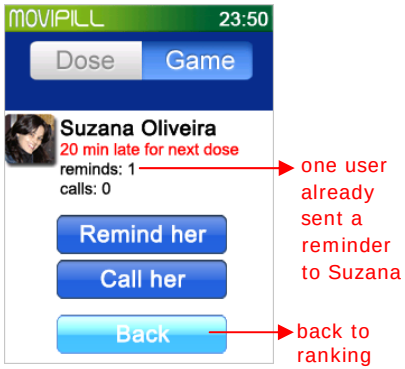

figure 2. Mockup of the social support persuasive technique applied as part of the MoviPill game. In the example, information on how late the user "Suzana" is to take her medication (screen visualized after choosing this user from the ranking list in figure 1).

more pessimistic scenario estimating that only 50% of patients follow their doctors' prescriptions. In order to tackle this challenge, medical experts have tried a variety of approaches, such as creating special calendars, "smart containers"[1] , mobile phone-based reminders, systems for pharmacist telephone follow-up intervention [3], among others (Kripalani et al. [5] compiled a review with several of these approaches). Still, previous work reports cases in which medication compliance was not improved by reminders *alone* [4], or even where automated reminders were perceived negatively by the users [6]. The problem lies on the fact that passive reminders do not typically engage users in doing the tasks by themselves. Hence, the main hypothesis that motivates the work presented here is that *patients can become more compliant in taking their medications when the task is not seen as an obligation, but rather as an engaging experience.* We propose a mobile phone-based system called MoviPill that combines four different persuasive strategies in order to address engagement: social competition, social support, virtual reward and entertaining self-monitoring. Next, we present the MoviPill system and outline major findings derived from the field study.

MoviPill system

Our approach towards increasing levels of compliance (remembering to take a dose) and adherence to medication regimens (taking doses at the prescribed time) aims to change how the drug intake task is perceived. In order to provide an engaging experience, our solution is based on a mobile phone application that applies four different principles of persuasion [2]:

- Social competition: Users of the MoviPill system are connected through a social network that relates their illness with the reality of other people. Implemented as a game, this technique persuades patients to be more compliant to their medication by trying to win their peers in weekly competitions. The game dynamics are simple: more points are given to players that take their medication very close to or at the prescribed time, and fewer points otherwise (see figure 1). Most compliant patients are highlighted in a virtual "hall of fame" and a record of their drug intake routine is stored as an additional resource for their caregivers;
- Social support: Game players can also get more points by reminding peers to take their medication on time (see figure 2). We expect patients to be more engaged in the drug intake task by receiving *social reminders* instead of system reminders.
- Virtual rewards: Whenever MoviPill users take their medication on time throughout the day, they are offered a virtual reward, such as a family photo, a favorite song, or a joke (see figure 3).
- Entertaining self-monitoring: MoviPill minimizes the boredom and complexity of tracking medication compliance by combining appropriate statistics with an engaging virtual character that is shown on the idle screen of the mobile phone (*e.g.*, if the character is a dog, it looks and acts happy when the patient is being compliant and sick otherwise – see figure 4);

The current version of the MoviPill prototype implements the social competition principle. We describe next the methodology of the user study to evaluate the impact of this persuasive technique on medication compliance.

Field Study

Participants

Eighteen participants (male: 9; mean age: 68 years, S=4.19) were recruited by phone for a 6-week user study. A randomized sampling methodology was used and participants were assessed by FASS[2], a social service foundation in the autonomous community of Andalusia (Spain). All subjects were retired, did not know each other, received 40 euro (about 59 USD) as a gift for participating in the experiment, and they *did not* receive any monetary incentive for winning the weekly

[1] MEMS (aardexgroup.com), Glowcaps (rxvitality.com)

[2] www.juntadeandalucia.es/fundaciondeserviciossociales

figure 3. Mockup of the virtual reward reward persuasive technique. In the example, the user took his/her daily medications on time and can opt for hearing a favorite song, seeing a family photo or reading a joke.

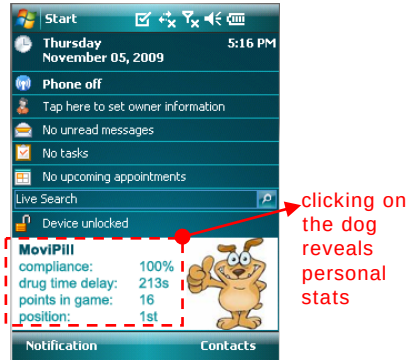

figure 4. Mockup of the self-monitoring persuasive technique. In the example, the startup screen on the user's mobile phone with a happy dog on the bottom indicating that, so far, the patient has been compliant to his/her medication prescription.

competitions of the MoviPill game. Thirty-nine percent lived with a husband or spouse, while the rest lived alone. Ten (55%) did not have any experience with computers, while 4 (22%) had an intermediary knowledge, and the remaining 4 (22%) were advanced users. In terms of medication compliance, the majority of the participants (12 or 67%) reported that they did not typically forget to take their medications; four participants (22%) forgot rarely, and 2 (11%) forgot sometimes. As for the strategy that participants used to remember to take their medications, 3 participants (17%) reported using some form of spatial arrangements of the pillboxes, while the majority (14 or 78%) remembered to take their medications because of their daily routines. Only one participant (5%) declared taking advantage of family members that reminded her to take her medications.

Apparatus

Each participant was assigned a HTC smartphone (model P3300, with its charger) with the MoviPill application and a pillbox equipped with a sensor (maker AARDEX model MEMS 6 – see figure 5). The pillbox was used to collect ground truth on the users' medication intake in order to compare with data manually entered by them via the Dose interface in the MoviPill application (see figure 6). Drug intake information entered via the Dose interface was transmitted in real time to the remote server and MoviPill refreshed the game status after every 5 minutes to ensure the data presented in the game was always updated.

Procedure

During the first meeting with each participant, we explained the mechanics of the game, supervised the initial interactions with the application, and helped them to transfer their medication into the MEMS pillbox. For this study, we focused on one –not life threatening, *e.g.,* prescribed for pain, attention, *etc.*– medication that needed to be taken twice per day so that each participant had the same chances of winning points. Participants were asked to continue taking their other medications using their usual routines.

Two intervention methods were evaluated in the study: *Button* and *Game*. On the *Button* treatment, subjects used the smartphone to register each drug intake by pressing a single button on the screen (equivalent to the button shown in figure 6, but on a blank screen). In this treatment, participants had to trust their own methods to remember when to take their medication. In the *Game* treatment, subjects also used the smartphone to register each drug intake (see figure 6), but they also had a "Game" button on the screen to view the weekly ranking –by compliance– of all the participants in the game and their daily drug intake status (see figure 1). The *Button* treatment was used instead of a standard control group (*i.e.,* electronic pillbox *without* the phone) because in the case of proving that subjects were more compliant in the Game treatment, we wanted to guarantee that the reason was the game, and not simply because of introducing new technology to the participants' day-to-day life.

Given the size and nature of our sample, we decided to conduct a crossover experimental design to eliminate individual differences from the overall treatment effect. Therefore, our sample was randomly divided in two groups of nine subjects, and each group was submitted to one of the treatments in the first three weeks (*i.e.,* users 1-9: *Game*; users 10-18: *Button*) and to the other treatment in the remaining three weeks (*i.e.,* users 1-9: *Button*; users 10-18: *Game*).

Results and Discussion

From a total of 1512 doses over the 6-week period, only 15 doses were not taken in the Button treatment (1%). However, when participants were playing the game, this small level of noncompliance was reduced by 60% (six missing doses). Moreover, only one out of 18 subjects was more compliant when submitted to the Button treatment than to the Game treatment, which is a good indicator of why a significant difference could be found between the medians of prescription adherence in both treatments ($N = 18, Z = -2.263, p = .024$). These results reveal that even with a very compliant sample, a significant improvement could be observed, thus

figure 5. MEMS electronic pillbox used by the participants of the study.

figure 6. MoviPill dose screen where patients inform medication intake. Drug intake data gathered by the phone was matched with ground truth data gathered by the MEMS pillbox to check if elders were pressing the button at the right time but taking the dose later on (game cheating).

confirming that *a mobile social persuasive game can help elders adhere to their medication prescription.*

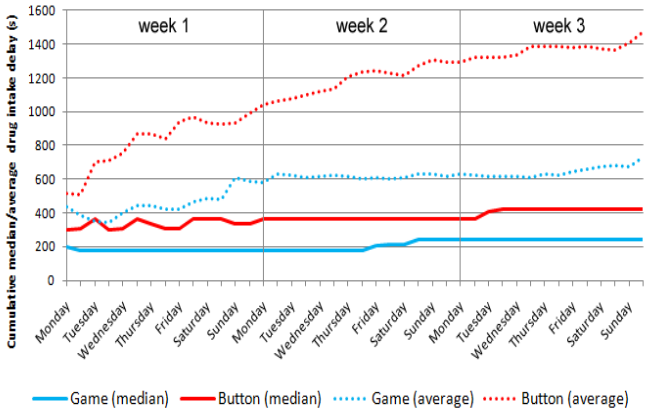

figure 7. Comparison of median and average drug intake delays over time in the Game and Button treatments

With respect to adherence to medication regimen, participants took their medication with a shift of ±25 minutes on average of the prescribed drug intake time ($\bar{x} = 1471s$ in Button; $\bar{x} = 731s$ in Game). Due to the presence of outliers, the median drug intake delay better characterizes the data, revealing a 43% improvement when participants played the game ($\tilde{x} = 240s$ *vs.* $\tilde{x} = 420s$; $N = 720, Z = -8.944, p < .001$). Another way to analyze this data is to consider each participant's median drug intake time as a single output and compare the median of the medians between treatments. Again, a significant difference could be found between regimen adherence in the Game and Button treatments ($N = 18, Z = -2.250, p = .024$). Therefore, we corroborate that *a mobile social persuasive game can help elders adhere to their medication regimen (i.e., take doses at the prescribed time)*. Figure 7 compares median and average drug intake delays over time for each treatment.

These results led us to reflect on the impact of social competition for the elderly. Note that none of the users knew each other and no incentives were offered to those winning the weekly competitions. It is very interesting to see that such a simple persuasive technique is able to motivate compliant patients to be even more compliant. We expect the impact of the MoviPill prototype to be even more significant on samples of non-compliant subjects.

Conclusions and future work

We have explored the use of social competition as an effective persuasive technique to improve adherence to both medication prescription and medication regimen. In ongoing work, we plan to validate the impact of the other persuasive techniques that are part of the MoviPill system: virtual rewards, entertaining self-monitoring and social support during the game.

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