Design of a social chatbot with gamification for user profiling and smoking trigger detection

Kyana Bosschaerts[1], Jeroen Stragier[2], Bram Steenwinckel[1], Lieven De Marez[2], Sofie Van Hoecke[1], and Femke Ongenae[1]

[1] IDLab, Ghent University-imec, Technologiepark 126, 9052, Gent, Belgium
firstname.lastname@ugent.be
[2] MICT, Ghent University-imec, Miriam Makebaplein 1, 9000 Gent
firstname.lastname@ugent.be

Abstract. User profiling is essential to help smokers quit smoking, but filling out a questionnaire is tedious and therefore, a lot of smokers drop out even though this personalisation can help them greatly in their journey to quit smoking. In this project a chatbot is designed that acquires the necessary data for personalisation through games. Combined with smoking event registrations, the application can detect smoking triggers. 12 participants tested the chatbot for 15 days by talking to it and registering their smoking events. Results show that the chatbot reaches the requirements of a social chatbot, gathers for most games good quality data, and detected smoking triggers are accurate, making the chatbot a great alternative for smokers with an interest in games.

Keywords: Smoking cessation · Social chatbot · Gamification · User profiling · Behavioral change interventions · Digital health

1 Introduction

According to the WHO, modifiable behaviors, such as tobacco use and physical inactivity, cause 80% of non-communicable diseases (NCDs), including cardiovascular disease, type 2 diabetes and cancer [21]. NCDs kill 41 million people each year, equivalent to 71% of all deaths globally. 70-85% of the medical budget of OECD countries is used to treat NCDs. Preventive medicine, focusing on measures to modify a patient's behavior in order to prevent diseases, has the potential to reduce NCD prevalence, improve quality of life and to reduce healthcare costs. Within this research, we specifically focus on encouraging smoking cessation. Despite smoking cessation program development and policy measures in the past decades, still almost 1 in 5 Belgians is a smoker [18]. Tobacco use accounts for over 14.000 premature deaths in Belgium every year. The direct cost to healthcare in Belgium is estimated at 615 million euro and indirect costs, such as absenteeism, are another 746 million. These numbers illustrate the societal and economic importance of designing engaging smoking cessation programs.

Digital Health Behavior Change Interventions (DBCI) are being developed that complement the face-2-face coaching using mobile applications and wearables [22]. They aim to empower individuals by collecting and visualizing vast

amounts of behavioral data in a comprehensive manner and incorporating behavior change techniques to promote a healthier lifestyle, e.g. goal-setting, social support, gamification (rankings and rewards). It has been demonstrated that DBCIs have higher effectiveness when data insights, social, challenges and motivational messages are tailored to the profile of the user [13]. Personalisation is thus an import prerequisite to achieve effective smoking cessation DBCIs [9]. An important part of enabling smoking cessation, is accurately identifying the smoking triggers of a person, i.e. specific contexts, times, locations, social behavior or mindsets that trigger the person to smoke. This allows the DBCI to intervene at the most critical moments for this particular smoker, so that appropriate measures can be taken to prevent a relapse [8].

Today, profile and trigger information is mainly gathered through questionnaires, or by using a smartphone or a wearable, e.g. for collection of location data [20,19]. The problem with gathering personal information through questionnaires is that users oftentimes tend to lose interest after only a few questions [12]. Consequently, a significant proportion of users drop out of the questionnaire. Even though the personalisation would add a lot of value to the user in the end, the process of filling in the information makes the whole endeavour for them not worth it. Sensors that directly detect the information needed for profiling without explicit input from the smoker can partially solve the issue. However, the disadvantages is that these sensors, e.g. wearables, are often expensive, and that they require advanced data analysis to make sense of the data. Moreover, a lot of information is inaccurate because of situational deviations of normal behaviour, a lack of registrations, difficulty to assess how the data should be interpreted within a particular context, or mismeasurements [14].

We therefore propose a social chatbot that gathers the necessary data through games as a solution to the problems regarding the current approaches. Smokers can play a game while in the background the application and the chatbot processes their data, creates their user profile, and detects their smoking triggers. In order to motivate the smoker to play more games, and thus create an opportunity for the chatbot to gather more data, gamification is used [11]. This method of information gathering can replace questionnaires while making it fun for the user to provide their personal information.

This paper is structured as follows. First, the related work is described in Section 2. Section 3 contains the design of the chatbot, while Section 4 deals with the study set-up. Last of all, the results are given in Section 5, while the paper concludes in Section 6.

2 Related Work

A few chatbots used in the healthcare already exist. A mental health chatbot reduces symptoms of stress, depression, and anxiety significantly [3]. The higher the engagement with the chatbot is, the more the symptoms of anxiety and depression lower. Another mental health chatbot Tess is designed to act like a therapist that has different modules that correspond to different types of treat-

ment modalities for depression [5]. These different modules bring different levels of engagement according to the length, complexity and style of the question asked. Furthermore, also other chatbots exist that focus more on promoting healthy lifestyles with as advantages that this can reach a broad audience and that automated personalised messages are possible [6].

In the field of smoking cessation, some studies focus on intervention, and while these do not use chatbots, they indicate that the use of one would be beneficial for behavioral change. None of these apply a chatbot yet either [17]. One study uses short message service (SMS) texting to help smokers quit and prevent relapse. Here participants indicate that this texting should be personalised and interacting, thus preferring a chatbot above the one-way method in the study. Moreover, another study indicates that just-in-time interventions may result in similar outcomes as in-person counseling [7]. In this paper smoking triggers are detected, while in another study known smoking triggers are used to personalize an intervention [8]. This results in significantly greater reductions in urges than just general messages.

In the case of chatbots in smoking cessation, a lot of studies focus on intervention for behavioral change while not giving any attention towards the gathering of the great amount of data needed for personalisation. A chatbot already exists that supports the smoker in their journey to quit smoking [10]. This chatbot is used in combination with a popular smoking cessation app - the Smoke Free app. As far as the limited information allows to discover true features of the Smoke Free app used in this study without paying for it, it seems to be limited to a chatbot without engaging games to discover triggers, complementing thus the questionnaires but not being able to replace them. The work however illustrates the need for more engaging interaction with people wanting to stop smoking. Another chatbot elicits reflection in smokers by allowing open answers to questions and using natural language processing to adequately respond to the given answer [1]. Subsequently, it also identifies smoking reasons of smokers.

Gamification in the healthcare often appear as serious games without any involvement of a chatbot. Serious games educate the players about a particular aspect of their health, or try to help a person by giving the player advice through the game. A study compared some of these serious games targeted at changing the behaviour of smokers and concluded that the games positively affected smoking-related outcomes [4].

In summary, increased engagement and personalization in smoking cessation programs is required to allow for effective DBHI, and multiple studies already point towards a chatbot as a possible solution. Even though some interventions help smokers to prevent relapse, still smoking triggers have to be known first before an intervention can be staged. Gathering this profile information is done through questionnaires and sensors, leading user to disengage and lack of accurate information on the profile, as detailed in Section 1. Finally, it has been shown that games can be an aid for gathering personal data, although this has not been unified within a chatbot yet to steer smoking trigger detection & smoker profiling.

3 Chatbot Design

Before diving into the design of the chatbot itself, first the application as a whole is presented. This contains the interface to converse with the chatbot, and the server which contains the chatbot, the database, and the smoking trigger detection module. Then the designed chatbot and games themselves and the smoking trigger detection module are described.

3.1 General Concept of the Application

The interface of the application is Facebook Messenger because it is the platform with the most users and the interface is familiar so it requires a lower threshold to start interacting with the chatbot[1]. A user can send messages to the chatbot through a Facebook page. The flow after the user sends a message until they receive an answer is given in Figure 1: (1)-(8). The message first goes to the webhook (1) that is connected to the Facebook page who sends it to the server (2). The webhook endpoints at the server side give the message to the chatbot (3) who gets the necessary data to answer from the MongoDB database (4-5). After constructing its answer, the message is sent back with the post method at the server's side (6-7). The message goes back the same way (7-8).

The second flow in Figure 1 (A)-(B) shows the loop that happens every fifteen minutes. The module trigger detection checks repeatedly if there is any new data in the database. If there is, the module either classifies it as a potential or detected smoking trigger. A potential smoking trigger is not confirmed yet, so the module stores the piece of data separately to process it further later.

Since there is a wide variety of smoking triggers, classifying them into categories makes processing a lot easier. These categories are based on previous smoking profiling and trigger studies [2,15] and are the following: negative emotions,

[1] https://datareportal.com/social-media-users

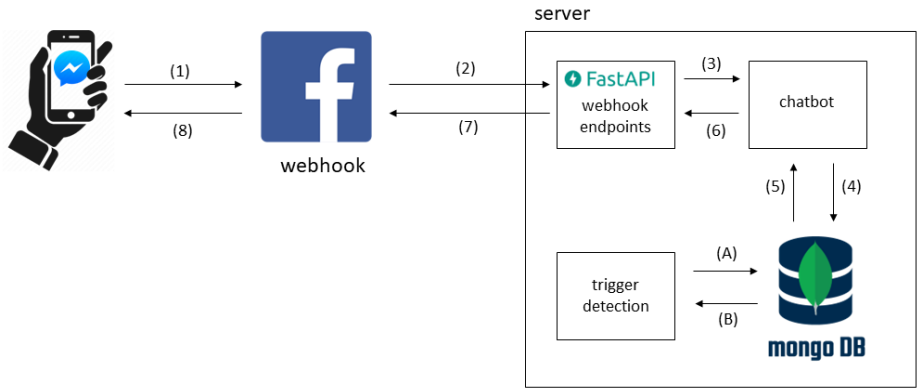

Fig. 1. Schema of the application

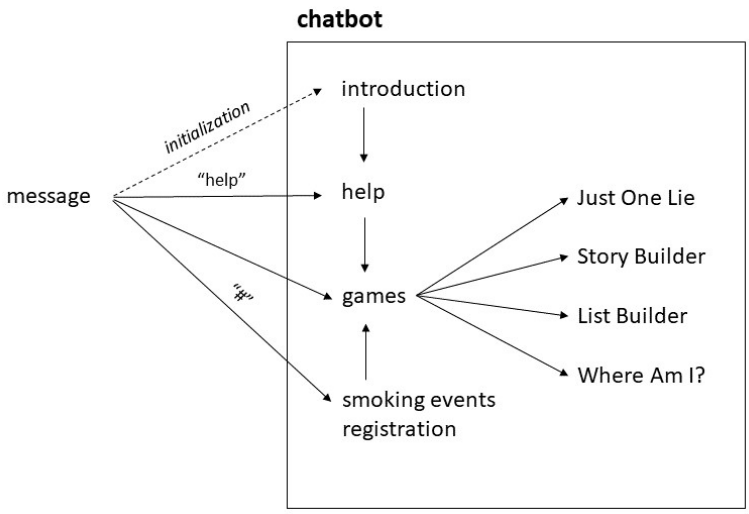

Fig. 2. Schema of chatbot component

stress, activities, smoking cues, substance abuse, location, moment of day/week, and general.

3.2 Chatbot

The chatbot exists out of different main logical components presented in Figure 2 and divided according to the time of sending the message and the content. When starting the chatbot for the first time, it introduces itself and asks after the user's name. Then in the help part the user is informed about all the chatbot's functionalities and how to call upon help again. The main part exists out of the four different games: *Just One Lie*, *Story Builder*, *List Builder*, and *Where Am I*. These games were chosen based on the literature study of existing games that seemed to show most potential towards trigger detection. The last part deals with the smoking registrations and can be called upon by sending "#".

Every game has questions and subjects related to smoking. Only the combination of the output of all the games brings a total view of the user's smoking behaviour. A demo of the chatbot can be found here: http://predict.idlab.ugent.be/projects/imperio/.

Just One Lie In this game one of the players gives two truths and one lie about a certain subject while the other guesses what the lie is. The smoking triggers that could be derived from this game involve hobbies, friends, family, stress factors, negative feelings, daily life, alcohol use, etc. Even smoking triggers themselves are acquired in this game. Moreover, the chatbot informs them about health effects and facts about smoking while dispelling myths around smoking.

Story Builder One player starts with a prompt, and then one by one both the player and the chatbot each add a continuation to the story. This goes on until the players are satisfied with their story. The smoking triggers that could be derived from this game are the ones that happen in specific life events.

List Builder One player starts with a word or group of words around a subject, and the other player answers with a word that begins with the last letter of the first player's word. This goes on until one of the two runs out of options. The smoking triggers that could be derived from this game are about hobbies, stress factors, and family. Even smoking triggers themselves are acquired in this game.

Where Am I? One player is currently at a certain location and gives the other player hints about where they are. The other player guesses with every hint their location. The game ends when the other player guesses or gives up on guessing the place. In combination with smoking events, the smoking triggers that could be derived here are about a location.

The messages that the chatbot sends are static, and the different games have randomisation to keep the interest of the player. *Just One Lie* has 17 lies and 101 truths to educate the user. In the case of *List Builder* each of the four subjects has multiple options as answer for every letter of the alphabet. The hidden feature in *Story Builder* has for two of the smoking trigger categories and for all 6 genres a different story for the user to experience. In the game *Where Am I* the chatbot can guess 23 different places.

3.3 Smoking Trigger Detection

Processing of the data of the different games depends on the category and type of data. The different categories are: negative emotions, stress, activities (such as hobbies and possible breaks during these hobbies), smoking cues (such as seeing a cigarette, lighter, or other smokers), substance abuse (such as alcohol consumption), location, and moment of day/week. A last general category keeps track of all the smoking triggers that do not belong in the former categories. Emotion detection is done through a natural language processing model on data that is not yet classified into a category, such as a life event from *Story Builder*. If a negative emotion is detected in the life event, it is sorted into the category negative emotions. When the context is known and thus the category is known, the potential smoking trigger is integrated into a question to be evaluated later.

Evaluation of the potential smoking triggers is done in the hidden features in the games *Just One Lie* and *Story Builder*. The one in *Just One Lie* looks at former smoking triggers in the same category and determines the likely severity of the new potential smoking trigger. The guess is either confirmed or refuted by the player. An example of this for the potential smoking trigger "game" is given in Figure 3. The hidden feature in *Story Builder* acquires profile data through a scripted story that makes the player the main character. Moreover, a potential

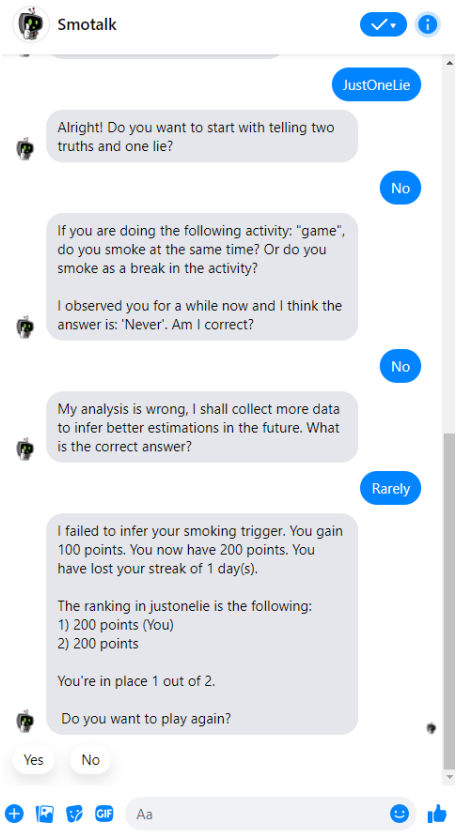

Fig. 3. Hidden Feature: Chatbot guesses severity of trigger [Just One Lie]

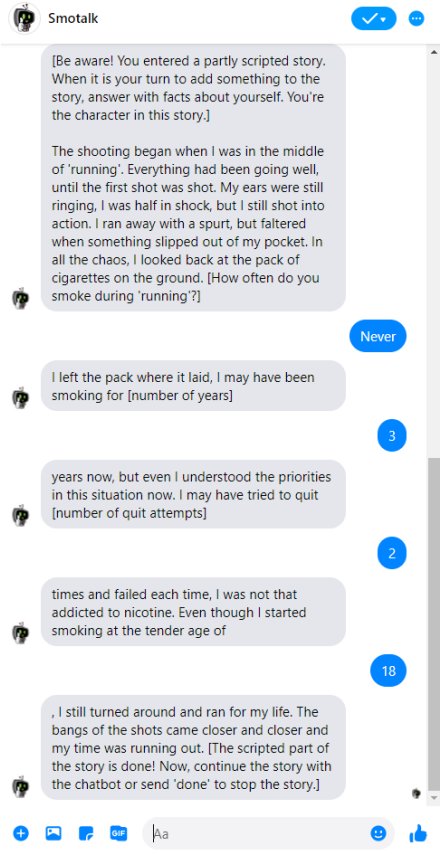

Fig. 4. Hidden Feature: Script requires severity of smoking trigger and personal data [Story Builder]

smoking trigger is integrated into each scripted story, and the player gives the severity when the potential smoking trigger appears in the story. An example of this with the potential smoking trigger "running" is given in Figure 4.

3.4 Gamification

Gamification is integrated into every game through a point system, a streak feature and a leaderboard. Every game gives a minimum number of points, and more points can be gained the longer the game is played or the more effort is done. If a game is played multiple days in a row, a streak is formed. The longer the streak, the more points that can be accumulated every day. This streak feature encourages players to play the same game daily to gain more points. In order to give meaning to the point system, a leaderboard entices the player

to beat other players. It speaks to their competitive side. This combination of gamification elements is implemented to motivate the player to play more games.

4 Study Design

The goal of the study is to evaluate the effectiveness of the chatbot to profile users and to study how engaging the users find the chatbot. The study started with 12 participants who fulfilled the following inclusion criteria:

- Age 18 and above
- A smoker (so someone who is an active smoker and is not currently trying to stop smoking)
- Has a Facebook account
- Is able to hold a conversation in English (since all the conversations with the chatbot are in English)

Even though the study is done in the domain of smoking cessation, the participants were not required to quit smoking since this was not necessarily needed for the detection of smoking triggers. This way the impact of the chatbot on the participants was limited, but still the required personal data could be acquired. The study was approved by the committee on ethics and data management of the faculty of Engineering and Architecture of Ghent University. All participants signed an informed consent form before the start of the study. The requirement for the study was to play at least one game with the chatbot daily and to register every smoking event with the chatbot. During the study there were 2 dropouts due to unforeseen circumstances (IDs 3 and 12) - they only participated for a week, but they did not ask to remove the data already acquired, so the already gathered data could still be used in the analysis.

The study lasted 15 days after which the participants filled in a questionnaire with questions about the gathered data, the chatbot, the smoking triggers, and general opinions.

5 Results

The first author K. Bosschaerts analyzed all the answers. It was a questionnaire specifically tailored to this study, but constructed in collaboration with experienced behavioral change user researcher (and co-author) J. Stragier. The used questionnaire and the code base are made available at: https://github.com/predict-idlab/chatbot-smoking-profiling.

Engagement is an important factor for effective behavioral change, so this is discussed first. Then the participants' answers from playing the games is looked at next. At last, the user experience gained from the questionnaire is given.

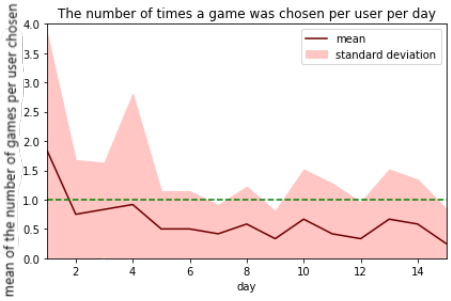

Fig. 5. The average number of times a game was chosen per user per day (number of participants shown (n) = 10)

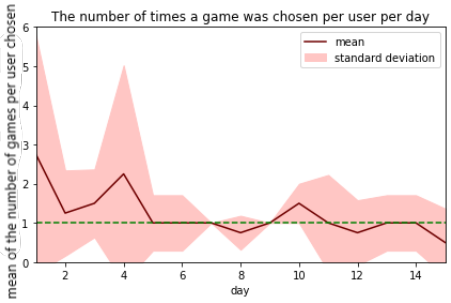

Fig. 6. The average number of times a game was chosen per user per day (selection of 4 participants that engaged every day)

5.1 Engagement

The requirements stated that participants needed to play at least one game per day and that they had to register every smoking trigger, but only a few participants abode by it. The mean reason for this lower engagement is that the participants were not required to stop smoking, so they had less motivation to learn about their smoking behavior. Figure 5 shows that the mean number of times a game was chosen per user per day lays below the minimum of one - the green line. A selection of four participants did fulfill this requirement as shown in Figure 6. Nevertheless, the other participants' data can also be used to measure some aspects of engagement, and their answers can still be used to evaluate the games.

The participants who did not play the game daily, were also the ones that stopped registering their smoking triggers midway. For others, a decline in smoking registrations can be seen in Figure 7. Here the drop-outs - the two participants who quit in the middle of the study - were removed. Manually registering the smoking events is tedious, so naturally, participants register less and less smoking events as the study goes on. The impact of this decline is limited to two categories: moment of day/week and locations. Both of these categories rely on accurate data to infer the smoking triggers, so results here are skewed.

A chatbot has to have a Conversation-turns Per Session (CPS) - the average number of conversation-turns between the user and the chatbot in a conversational session - of at least 10 to qualify as a social chatbot [16]. The CPS of all participants comes down to 10 with a standard deviation of 9.18, while the CPS of the selection of 4 participants is 10.29 with a standard deviation of 6.96. Thus, in both cases the chatbot's engagement qualifies it as a social chatbot. The standard deviation of the CPS of all participants lies higher than the selection because some non-daily players had very long sessions with the chatbot.

The leaderboard in Table 1 gives an other view of game engagement. The user IDs in bold are the four participants that engaged daily. A few participants

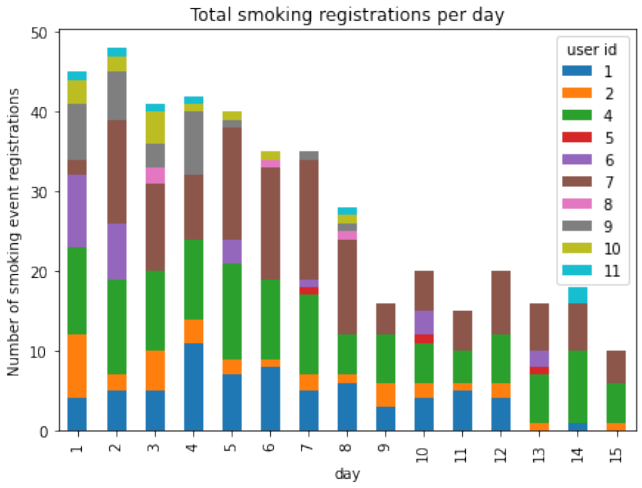

Fig. 7. Total smoking registrations per day (n=10)

mentioned that the leaderboard spoke to their competitive side and made them want to get to the top. The game *Just One Lie* was the most popular one as it is short and it has additional educational value about smoking. The games *Where Am I* and *Story Builder* were preferred by different participants, but *List Builder* was overall the least favourite.

Leaderboard						
rank	id	total points	Just One Lie	Where Am I	List Builder	Story Builder
1	7	4480	0	4480	0	0
2	**1**	3430	930	500	1070	930
3	**4**	2850	1780	570	410	90
4	6	2810	2520	0	120	170
5	**2**	2540	2330	70	70	70
6	3	1090	500	260	210	120
7	**5**	1030	710	320	0	0
8	12	860	630	230	0	0
9	11	700	520	0	180	0
10	8	510	450	0	0	60
11	9	30	0	0	30	0
12	10	0	0	0	0	0

Table 1. Leaderboard; The rank represents all the players from most played to least played, with their ID in the second column. The third column gives the total amount of points per player over all the games, while the last four columns gives the total amount of points per game per player.

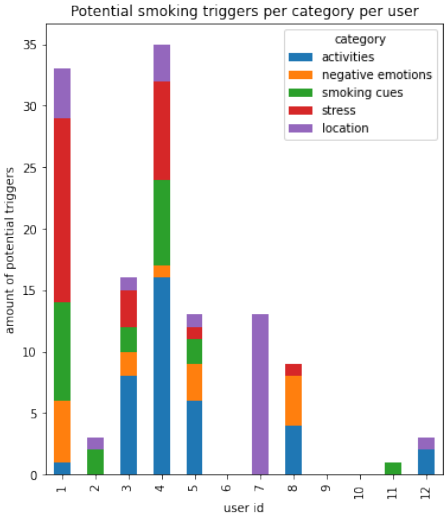

Fig. 8. Potential smoking triggers per category per user (n=12)

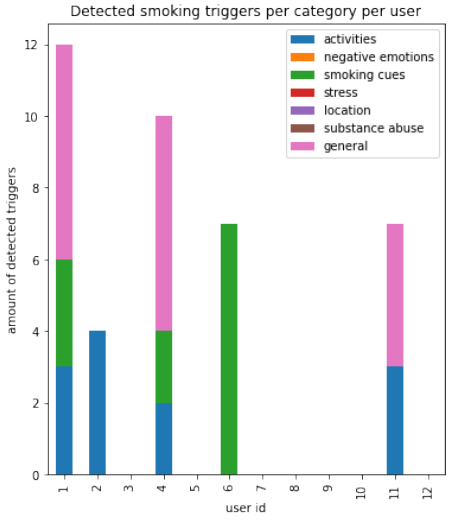

Fig. 9. Detected smoking triggers per category per user (n=12)

5.2 Analysis of Participants' Answers

The quality of the data of both *Just One Lie* and *Story Builder* cannot be sufficiently used for smoking profiling and trigger detection. Due to the nature of the games, the data is riddled with useless information, mistakes, and bad answers. *List Builder* and *Where Am I* are a lot better in comparison. *List Builder* brings high quality, short data. Even though *Where Am I*'s locations were sometimes too specific and in the format of a sentence, most of the data is clean and useful.

A lot of potential smoking triggers, i.e. triggers that could be possible smoking triggers for a certain smoker, but that are not confirmed or refuted yet by the participants during the study, were found as shown in Figure 8. However, very few of the potential triggers could be confirmed or refuted by the chatbot during follow-up games. The few detected smoking triggers through the games are illustrated in Figure 9. This was a consequence of the small number of hidden feature games that were played. Half of the participants indicated in the questionnaire that they were not aware of any smoking trigger they had, while the other half knew about one, two, or three triggers. Smokers are often not aware of their own smoking triggers, and the chatbot is able to detect these for them. None of the substance abuse triggers were found, even though a few users indicated that alcohol was a trigger for them. More games focusing on this category could prevent this problem. The location category required the user to play the game *Where Am I* multiple times at the same location. Hardly anyone played the game more than twice on the same location, however, but combining the game *Where Am I* with Global Positioning System (GPS) data solves the

issue. Since the category moment of day/week was calculated in the end, every user gained a detected smoking trigger in that category. Because of the unreliable manual registrations of the smoking events, as shown in Figure 7, these are not accurate though. The selection of categories was a good choice in the participants' opinion.

5.3 User Experience

The opinion of the participants about the chatbot in Figure 10 is very black-and-white, with persons either liking the games, or not liking them at all. Participants who do not like games in general, as indicated by them in the closing questionnaire, did not like the method used and they also are causing most of the lower ratings in Figure 11. They thought it was taxing to talk with the chatbot every day, as can be seen in Figure 12, and would not like to use the chatbot outside the study. The group who does like games or is neutral towards them, is more divided in their opinions. One common thing that all users experience is that talking with the chatbot takes time and is hard to fit into their daily life. With IMPERIO we will try in the future to determine the optimal intervention point to resolve this issue. The users will get a notification and they will be more inclined to interact with the chatbot.

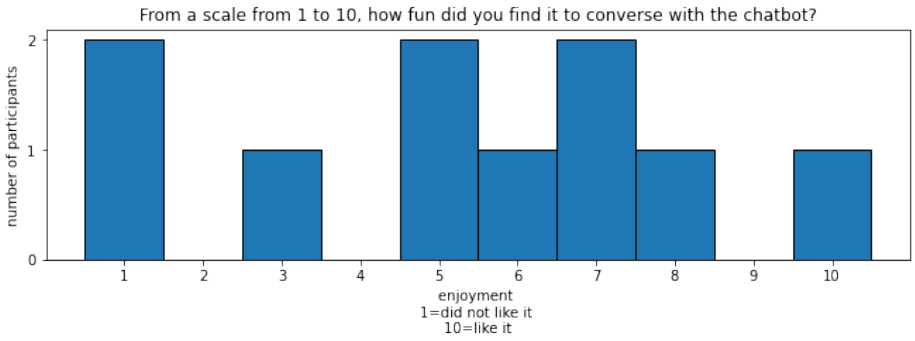

Fig. 10. User enjoyment of the chatbot (n=10)

Even though there are a lot of participants who did not like this gathering of their data through games, when they were asked if they would prefer a questionnaire instead, only three participants were more inclined towards the questionnaire, as shown in Figure 13. This means that there is potential in the method of the study, but that the games need be refined some more. A few adjustments in the implementation have to be made before it can be put to use for a broader public. If some further testing needs to be done, maybe an additional inclusion criteria for the participants has to be that they have to like games or minigames.

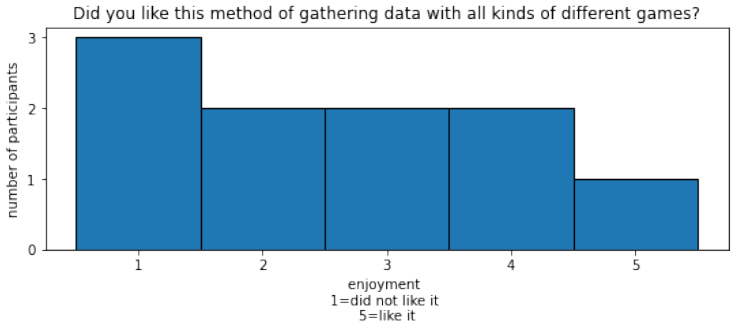

Fig. 11. User enjoyment of the method of gathering data (n=10)

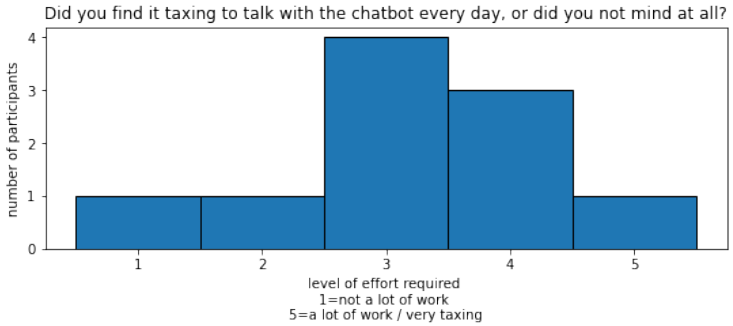

Fig. 12. Level of effort required to chat with the chatbot (n=10)

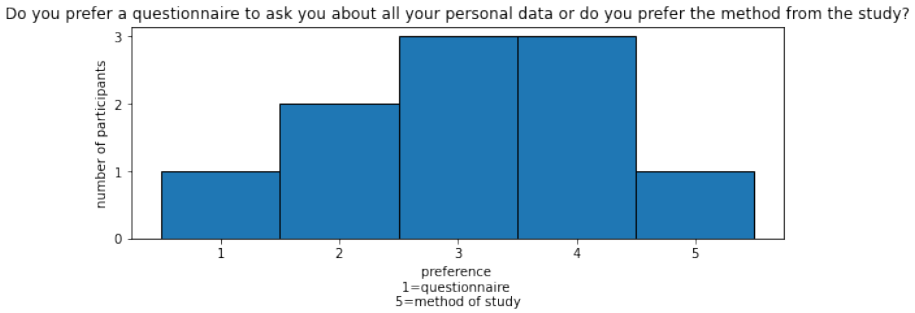

Fig. 13. Preference between questionnaire or study method to ask about personal information (n=10)

6 Conclusion

When personalisation is needed in an application, a questionnaire is mostly used. Such a questionnaire is tedious to fill in, and consequently often is not completed.

In an attempt to look for an alternative, the first few steps were taken in this paper. This approach of combining a chatbot and games to engage users in providing as much personal data as possible while keeping their interest in doing so, can be a possible alternative for a questionnaire after more research around this topic is done.

The chatbot was tested by 12 participants during a period of 15 days. Since the user sample is rather limited, the conclusions written here are only an indication. The engagement with the chatbot was good since it achieved the minimal 10 CPS needed for a social chatbot. Although the chatbot was not able to convince the people who did not like games of its charms, some of these people still recognized that they preferred it above a boring questionnaire. The hurdle of filling out a questionnaire is thus greater than the participants' disinterest into games. For the people who do like games, this project was found to be a great alternative for a questionnaire as soon as the problems with the current chatbot are fixed, i.e. poor data quality in some games, more focus on underrepresented categories of triggers, and changing the manual smoking event registration to an automatic solution.

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References

1. Almusharraf, F., Rose, J., Selby, P.: Engaging unmotivated smokers to move toward quitting: Design of motivational interviewing–based chatbot through iterative interactions. J Med Internet Res **22**(11), e20251 (2020)
2. Brown, A.E., Carpenter, M.J., Sutfin, E.L.: Occasional smoking in college: Who, what, when and why? Addictive Behaviors **36**(12), 1199–1204 (2011)
3. Daley, K., Hungerbühler, I., Cavanagh, K., Claro, H., Swinton, P., Kapps, M.: Preliminary evaluation of the engagement and effectiveness of a mental health chatbot. Frontiers in Digital Health **2** (11 2020)
4. Derksen, M.E., van Strijp, S., Kunst, A.E., Daams, J.G., Jaspers, M.W.M., Fransen, M.P.: Serious games for smoking prevention and cessation: A systematic review of game elements and game effects. Journal of the AMIA **27**(5), 818–833 (2020)
5. Dosovitsky, G., Pineda, B.S., Jacobson, N.C., Chang, C., Escoredo, M., Bunge, E.L.: Artificial intelligence chatbot for depression: Descriptive study of usage. JMIR Form Res **4**(11), e17065 (2020)
6. Fadhil, A., Gabrielli, S.: Addressing challenges in promoting healthy lifestyles: The al-chatbot approach. In: Proceedings of the 11th EAI International Conference on Pervasive Computing Technologies for Healthcare. pp. 261—-265. PervasiveHealth, New York, NY, USA (2017)
7. Hébert, E., Ra, C., Alexander, A., Helt, A., Moisiuc, R., Kendzor, D., Vidrine, D., Funk-Lawler, R., Businelle, M.: A mobile just-in-time adaptive intervention for smoking cessation: Pilot randomized controlled trial. J Med Internet Res **22**, e16907 (2020)

8. Hébert, E.T., Stevens, E.M., Frank, S.G., Kendzor, D.E., Wetter, D.W., Zvolensky, M.J., Buckner, J.D., Businelle, M.S.: An ecological momentary intervention for smoking cessation: The associations of just-in-time, tailored messages with lapse risk factors. Addictive Behaviors **78**, 30–35 (2018)
9. Paay, J., Kjeldskov, J., Skov, M.B., Lichon, L., Rasmussen, S.: Understanding individual differences for tailored smoking cessation apps. In: Proc. of 33rd Annual CHI. pp. 1699—1708 (2015)
10. Perski, O., Crane, D., Beard, E., Brown, J.: Does the addition of a supportive chatbot promote user engagement with a smoking cessation app? an experimental study. DIGITAL HEALTH **5**, 2055207619880676 (2019)
11. Rajani, N.B., Mastellos, N., Filippidis, F.T.: Impact of gamification on the self-efficacy and motivation to quit of smokers: Observational study of two gamified smoking cessation mobile apps. JMIR Serious Games **9**(2), e27290 (2021)
12. Rolstad, S., Adler, J., Rydén, A.: Response burden and questionnaire length: Is shorter better? a review and meta-analysis. Value in Health **14**(8), 1101–1108 (2011)
13. Ryan, K., Dockray, S., Linehan, C.: A systematic review of tailored ehealth interventions for weight loss. Digital Health **5** (2019)
14. Sazonov, E., Lopez-Meyer, P., Tiffany, S.: A wearable sensor system for monitoring cigarette smoking. Journal of studies on alcohol and drugs **74**, 956–64 (11 2013)
15. Shiffman, S., Dunbar, M.S., Li, X., Scholl, S.M., Tindle, H.A., Anderson, S.J., Ferguson, S.G.: Smoking patterns and stimulus control in intermittent and daily smokers. PLOS ONE **9**, 1–14 (2014)
16. Shum, H.Y., He, X., Li, D.: From eliza to xiaoice: Challenges and opportunities with social chatbots (2018)
17. Spears, C.A., Bell, S.A., Scarlett, C.A., Anderson, N.K., Cottrell-Daniels, C., Lotfalian, S., Bandlamudi, M., Grant, A., Sigurdardottir, A., Carter, B.P., Abroms, L.C., Wetter, D.W.: Text messaging to enhance mindfulness-based smoking cessation treatment: Program development through qualitative research. JMIR Mhealth Uhealth **7**(1), e11246 (2019)
18. Stichting tegen Kanker: Rookenquete 2019. https://www.kanker.be/sites/default/files/stichting_tegen_kanker_-_rookenquete_2019_-_def.pdf (2019)
19. Sutfin, E.L., Sparks, A., Pockey, J.R., Suerken, C.K., Reboussin, B.A., Wagoner, K.G., Spangler, J., Wolfson, M.: First tobacco product tried: Associations with smoking status and demographics among college students. Addictive Behaviors **51**, 152–157 (2015)
20. Vogel, E.A., Humfleet, G.L., Meacham, M., Prochaska, J.J., Ramo, D.E.: Sexual and gender minority young adults' smoking characteristics: Assessing differences by sexual orientation and gender identity. Addictive Behaviors **95**, 98–102 (2019)
21. World Health Organisation (WHO): Noncommunicable diseases. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases (2018)
22. Zhao, J., Freeman, B., M, L.: Can mobile phone apps influence people's health behavior change? an evidence review. J Med Internet Res **18**(11) (2016)

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