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Swipe up to smoke less cigarettes! Introducing a mobile Approach-Avoidance Task Application to fight Smoking

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Abstract: Automatic tendencies to approach addiction-related stimuli have been linked to the development and maintenance of harmful drug use behavior. Recent studies have shown that these automatic approaches can be directly addressed and modified by cognitive bias modification (CBM). However, the training and treatment effects are rather small and compliance could be impaired by time-consuming, multiple laboratory training sessions. Here we present a mobile variant of the Approach-Avoidance Task (app-AAT), which is evaluated by a feasibility study. The app-AAT is designed to improve the efficiency of CBM training by allowing smokers to access the training at any time, and by offering the option to track consumed cigarettes. Our first run with eight participants showed that the app was rated very positively with 4.2 out of 5 points (engagement: 3.7, functionality: 4.5, aesthetics: 4.4) by using the german Mobile App Rating Scale (MARS-G).

Keywords: addiction, approach-avoidance task, AAT, approach bias, cognitive bias, cognitive bias modification, CBM, dual process model, mobile applications, smoking, therapy, usability

1 Introduction

Nicotine and tobacco are still among the most deadly addictive substances today. On average, smokers lose about ten years of their lifetime. In Germany alone, it is estimated that 121.000 people die every year as a result of smoking. The current coronavirus pandemic in particular has made it all the more important to reduce smoking, as a study from China of patients diagnosed with COVID-19 reported that the odds of disease progression, including eventual death, were 14 times higher among people with a history of smoking compared to those who did not smoke [6]. Despite the proven harmful effects, about 25-30% of the adult population in Germany smokes, most of them daily [1]. Although there are gold standard procedures for the treatment of addiction diseases, these are often not used, or are discontinued prior to the end of treatment. Reasons for this are long waiting times to get a therapy place, fear of stigmatization and sometimes long journeys to the therapist. But even after successful treatment the relapse rate is alarmingly high. Only about 25% of those treated manage to remain abstinent for more than six months [2, 7, 11]. For this reason, we are developing an effective extension for already existing therapies, in the form of a mobile application.

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2 Theoretical Background

Dual process models [4, 13] assume that our behavior is controlled by two different cognitive processes. These are on the one hand reflective processes (e.g. knowledge, motivation), which are accessible to the consciousness, and on the other hand automatic, hard-to-control impulsive processes (e.g. approach/avoidance, attention). In the case of an addiction, it is assumed that the impulsive processes become more dominant, thus leading to an imbalance between the processes. In the case of a smoker, the sight of a smoke-related stimulus would increase the craving and thus the motivation to consume a cigarette. The processing of addiction-relevant stimuli is therefore biased in favor of these.

The cognitive bias modification (CBM), which attempts to retrain the impulsive processes in favor of the reflective processes, intervenes at this point. One CBM procedure that has already achieved success in several studies aiming at measuring and modifying a drug-related approach bias [5] is the approach-avoidance task (AAT) [10, 12]. During the AAT training the participants are shown images with either neutral or addiction-related content on a monitor. Furthermore, the im-

age categories have a certain distinguishing feature. For example, all neutral images are tilted to the left and all addiction-related images are tilted to the right. Using a joystick, the participants are instructed to interact with the images. For this purpose they receive explicit instructions (e.g. "Pull all pictures tilted to the left towards you and push all pictures tilted to the right away from you"). Since this interaction, in which addiction-related images are pushed away, is trained in each session with several hundred images, it is hoped that after a few sessions the addiction-related approach bias will become weaker. This in turn would have the positive effects of permanently reducing consumption, and supporting traditional therapies that address reflective processes.

We try to improve the AAT training by offering it as a mobile application (app). This would allow different training contexts and provide a training that is always available, especially in environments where smoking is a common practice. Since it is estimated that 3.1 billion people will own a smartphone by 2021 [9], mass access to the training is guaranteed.

With our study we want to find out whether the app-based AAT (app-AAT) can help smokers to reduce the number of cigarettes they smoke and to change their smoking behavior. In this paper the results of the first eight participants are presented and analyzed.

3 The app-AAT

3.1 Requirement Analysis

The app must be able to implement the general requirements of the AAT in order to be used for CBM training. This includes indirect instructions, for example that the image content should be ignored and instead a certain, not too dominant, distinguishing feature should be observed. In order to retrain the automatic approach to addictive stimuli, the movements must be simple and intuitive, so chains of action are not allowed. Furthermore, no distracting elements should be present so that users can concentrate fully on the smoke cessation training.

Another important factor is the enlargement or reduction of the displayed images. This is intended to visually reproduce an approximation or avoidance of the stimuli. While gold standard methods of smoking cessation in most cases address the reflective processes, our application can address and retrain the automatic impulsive processes in this way. With the implemented cigarette counter, however, the reflective processes can also be addressed with our application, which we expect to improve the user experience and the training outcome.

In order to have access to the training results of the participants without having direct access to the device, a server to which the data is sent needs to be used. In this way, a user administration can also be implemented, via which the participants can be assigned to their respective training condition. The app's settings are thus automatically adjusted, making user intervention impossible.

Fig. 1: Images tilted to the left have to be "approached" by swiping down, while images tilted to the right have to be "avoided" by swiping up.

3.2 Design and Implementation

For easy access, the Android app-AAT is downloadable via the Google Play Store. Study leaders can assign the participants into their appropriate groups via a web application, which uses the same database as the app. Each user receives a user name and a password with which he or she can log in to the app. Due to the server connection, the settings of the app-AAT are automatically adjusted via the internet, meaning that 50% of the stimuli in the training group (TG) are addiction-related, while in the control group (CG) only 8% are related to smoking.

Once a session is started, participants are instructed to pull all images tilted to the left towards them by swiping down on the touchscreen, and to push all images tilted to the right away from them by swiping up. Figure 1 shows one image of each category. An approaching movement enlarges the images, while an avoiding movement reduces them in size. In the TG condition (images in total: n=100; smoke-related: n=50) all smoke-related stimuli are tilted to the right, the tilting of the images in the CG condition (images in total: n=100; smoke-related: n=8) is random.

To determine the approach bias, each session is preceded by a bias measurement. In this process, each image, both neutral and addiction-related, is approached and avoided once. Prior to the very first training session, a long bias measurement is performed with 25 neutral and 25 smoke-related images (100 images in total). At each subsequent session a short

Fig. 2: In the left view, users are visualized the individual timestamps of their smoked cigarettes. The right view shows a list summarizing the cigarettes consumed during each day.

bias measurement with 3 randomly selected images from each category (12 images in total) is performed. During these measurements, reaction times are recorded for each image at three points in time: When the screen is touched for the first time after the image appears, when the finger is lifted of the screen and when the image disappears. These times can be used to calculate the approach bias of each test person by subtracting the median time of pulling movements from the median time of pushing movements. After the last image of the bias measurement disappeared, the training scenario described above begins seamlessly.

The app also features a cigarette counter, either directly within the app, or with a separate home screen widget. Thus, the participants are asked to track their smoked cigarettes with the app, whereby a timestamp for each cigarette is stored in the database. Users can either view and delete the individual timestamps (see Figure 2), or view a list of how many cigarettes have been smoked per day.

4 Study Design

To evaluate the app-AAT by a feasibility study, participants were divided into two groups: The training group (TG) and the placebo control group (CG). All test persons used the app-AAT for two weeks to verify the reliability, aesthetics and functionality of the application. In addition, they were asked to use the included cigarette counter to track the number of consumed cigarettes.

Participants and Methods

Eight smokers (two females and six males; mean age: 56.8 years, range: 41-67) took part in our study, which main goal was to evaluate the usability of the app. Four of them were divided into the TG and CG condition each.

At a first face-to-face meeting, all participants received a psycho-education and an introduction to the app-AAT. Afterwards, the participants could use the app for two weeks to conduct the mobile AAT training and to track their consumed cigarettes. After the training period, the test persons are invited again to fill out the German version of the Mobile App Rating Scale (MARS-G) [3, 8], which is used to rate the app in terms of commitment, functionality, aesthetics and subjective quality.

5 Results

Two participants from the CG discontinued the study before completion, one of them for health reasons. This leaves results of four participants from the TG and two participants from the CG. Due to the coronavirus pandemic the MARS-G questionnaire was queried by telephone.

Evaluation of the MARS-G questionnaires

The rating scale evaluates the quality of apps on four dimensions. All items are rated on a 5-point scale from “1 - insufficient” to “5 - excellent” [3].

Section A addresses engagement (entertainment, interest, customization, interactivity, target group). In this category, the app received an average rating of 3.7 points. Section B deals with the functionality of the app (performance, ease of use, navigation, gestural design) and was evaluated with 4.5 points. In section C the aesthetics (layout, graphics, visual appeal) are rated with 4.4 points. Section D (information) was omitted due to the early status of the app. In the section about subjective quality it was asked whether the app would be recommended, how often one would use the app, whether one would pay for the app and with how many stars the app would be rated. 3.8 points were achieved here. The last section asks whether the use of the app has changed the knowledge, attitude and intention to change in relation to nicotine consumption. This was graded with 3.9 points. As a result, the app-AAT achieves an overall rating of 4.2 points.

6 Conclusion

In summary, it can be said that the AAT procedure was successfully implemented with all requirements and that the feasibility study was successful. 75% of the participants completed the entire study and conducted at least one complete training per day. The overall rating of the app with 4.2 out of

5 points is also very satisfactory, only minor changes have to be made for the main study.

7 Future Work

To evaluate the efficacy of the app-AAT, at least 150 additional subjects will be recruited for a randomized controlled trial (RCT). For this purpose, at least 50 persons each will be divided into three groups: A TG, a CG and a waiting group (WG). In addition, the number of cigarettes smoked daily will be evaluated in order to determine changes in smoking behavior. While the TG and CG conditions are able to conduct the AAT training over the course of 14 consecutive days, the WG condition is only able to track their smoked cigarettes within the app.

On the first meeting, all participants will receive a psychoeducation and an introduction to the app-AAT. Subsequently, an assessment of subjective and objective smoking behavior will be performed using, among others, the Fagerström Test for Nicotine Dependence (FTND) and measurements of the approach bias, the two most important outcome measures for this work out of a larger test battery. Afterwards, the participants could use the app for 2 weeks to conduct the mobile AAT training and to track their consumed cigarettes. In order to achieve comparability in post-measurements, the training will be deactivated after the 14 days, while the cigarette counter can still be used. After the training period, the test persons are invited again to perform the evaluations of smoking behavior and bias values. In order to determine whether the results are retained, the participants are re-invited after four weeks.

In addition, we are currently developing an iOS version of the app-AAT in order to include owners of Apple devices in the study as well.

Author Statement

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