Cognitive Bias Modification using a Mobile Training App - Effects on Implicit Positive Orientation and Explicit Optimism in Students

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Module 12: BSc Thesis PSY 2022/2023

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June 29th, 2023

APA 7th

Abstract

Background. Students are at a higher risk of developing a mental health disorder during their academic career. Increased levels of positive orientation (PO) have found to have beneficial effects on student's mental and physical well-being. PO is psychological constructed by self-esteem, life satisfaction, and optimism and relate to specific beliefs an individual has about themselves. Along these concepts, automatic positive associations towards oneself can be described as implicit PO bias or self-concept. Aim of this study was to investigate changes in implicit PO and explicit optimism by using a cognitive bias modification (CBM) training through a mobile app. Additionally, mediating effects of implicit PO on training effects on explicit optimism were investigated.

Method. 50 students participated in a non-randomized controlled experiment and were divided into one intervention group (n = 28) and one control group (n = 22). To measure implicit PO, a modified implicit association test was used based on Costantini et al. (2016). The Life Orientation Test-Revised was used to measure explicit optimism. Measurements were recorded pre and post intervention. The intervention consisted of CBM training sessions twice a day for three days. During the training sessions participants were asked to do simple repetitive association tasks.

Results. A multivariate repeated measures ANOVA revealed no significant training effects on implicit PO or explicit optimism. However, tests of simple contrasts suggest that CBM training had a positive interaction effect on implicit PO. Similarly, simple tests indicated positive effects of LOT-R scores in the intervention group. No significant effects were found for implicit PO as a mediator for training effects on explicit optimism.

Discussion. This study offers an initial insight into the potential of CBM training enhancing levels of implicit PO, thereby, positively altering participant's positivity self-concept bias. To further investigate the concept of implicit PO and to identify effective intervention methods, future research is needed. By gaining more insight into implicit PO, the development of effective CBM interventions can lead to a cost-efficient and accessible option for students to benefit from.

Keywords: positive orientation, optimism, positive psychology interventions, cognitive bias modification, implicit association test

1. Introduction

Mental health disorders affect millions of people globally every year of which only a fraction of individuals receives appropriate treatment (Auerbach et al., 2016; Grasdalsmoen et al., 2020; Kessler et al., 2005). Facing multiple challenges within academic, social, and individual contexts, especially university students' mental health and well-being are becoming an increasing health concern among the public (Brown, 2016). Although, transitioning to university life holds great potential for positive effects on students' personal development, it is also considered a critical and sensitive transitional period in which they are exposed to various stressors, potential drug and alcohol abuse, and disrupted sleeping habits (Duffy et al., 2019; Harrer et al., 2019). Further, for many university students, it is the first time moving from home, being separated from family and peers, and starting a new life in an unknown environment, hoping to make new social connections while adapting to new academic challenges as well which can be perceived as stressful by many (Auerbach et al., 2016; Kesseler et al., 2017).

Due to these circumstances, students are more likely to score higher in levels of depression compared to the general population (Sheldon et al., 2021). In a cross-national study from 2016, the 12-month prevalence of mental disorders in students between the ages of 18 and 22 years was estimated about 20.3% of which the most common disorders reported were depression and anxiety (Auerbach et al., 2016). Depressed individuals a more likely to engage in negative rumination, dampening positive feelings and social withdrawal which contributes to the maintenance of their symptoms (Andrews & Wilding, 2004; Collins et al., 2023). Individuals suffering from anxiety experience various psychological symptoms, such as fear and distress, as well as physical symptoms including sweating, increasing heart rate or muscle tension (Harris et al., 2002). Anxiety often leads to avoidance of public speaking situations, especially, for students, public speaking anxiety can have a significant negative impact on their academic performance, as well as their personal and professional lives (Harris et al., 2002). Poor academic performances as well as increasing drop-out rates are associated with struggling mental health such as depression and anxiety (Andrews & Wilding, 2004; Hubble & Bolton, 2020; Sheldon et al., 2021).

Researchers have found that especially students with psychological vulnerabilities are at an increased risk to develop mental health issues (Carr et al., 2013; Sheldon et al., 2021; Zheng et al., 2014). In a systematic review about risk factors for mental health problems in university undergraduate students, low levels of self-esteem, emotion regulation, self-

perceived health, stress, and cognitive functioning were identified as leading and consistent predictors for anxiety and depression in students (Sheldon et al., 2021).

Interventions that have been effective in alleviating student's mental health risks are self-guided stress management and promoting positive mental wellbeing programs (Amanvermez et al., 2022; Tennant et al., 2007). Cognitive-behavioural therapy (CBT) and mindfulness-based intervention had positive effects on students with depression and anxiety (Huang et al., 2018).

Research shows that even though effective treatments are available for mental illnesses in university students, there is a significant lack in treatment, with only one in five receiving the minimum necessary treatment (Auerbach et al., 2016; Wang et al., 2005). Therefore, it is important that researchers not only focus on intervention methods but prevention of mental health issues to minimize the need for treatment at a later stage.

1.1. Positive Orientation

Having a positive orientation (PO) might play a potential role in overcoming students' challenges and positively contribute to their academic success and overall well-being. According to Caprara (2009), PO is a psychological construct that refers to an individual's tendency to focus on positive aspects of their experiences and surroundings, while minimizing negative aspects. Characterizations of PO include general optimism and sense of hopefulness, and it is associated with greater psychological well-being, resilience, and coping abilities (Costantini et al., 2016). Costantini et al. (2016) refer to PO as "(…) a high-order latent dimension that is responsible for the covariance of self-esteem, life satisfaction, and optimism (…)" (p.1) which is related to certain self-beliefs of an individual.

A high level of self-esteem is considered as essential factor of emotional health and strongly indicates an individual's subjective well-being (Duy & Yıldız, 2019; Padhy et al., 2011). Research relates self-esteem to better health outcomes, decreased criminal activities, lower levels of anxiety and depression, and generally, greater success in life (Padhy et al., 2011; Orth et al., 2009; Solomon, 1991) Self-esteem is positively related to academic achievement of students (Yang et al., 2019).

Life satisfaction constitutes subjective well-being by evaluating one's own life and current circumstances (Usán et al., 2020). As Diener (2000) stated, life satisfaction leads to experiencing positive feelings more frequently while negative feelings are experienced less. As important psychological component of subjective well-being, life satisfaction is also related to academic success of students, the ability to maintain positive relationships with

their social environment, and a general optimistic hopeful perspective towards their life (Usán et al., 2020).

Regarding optimism, research indicates that having an optimistic outlook on life can lead to better health, work performance, and educational attainment, which are all crucial factors for social mobility (Scheier & Carver, 1993). Optimistic individuals are known to have better physical health, experience less depression and are more likely to achieve academic success compared to pessimistic individuals (Rasmussen et al., 2009; Solberg Nes et al., 2009). Additionally, studies suggest that people can learn to cultivate a positive mindset which means that optimism can be a promising area for relearning interventions (Peters et al., 2010).

According to the research in positive psychology, PO can be cultivated through intentional practices such as gratitude, positive self-talk, and mindfulness (Seligman & Csikszentmihalyi, 2000). Individuals with a higher score in PO are more likely to interpret events in a positive light, to approach challenges with a growth mindset, and to maintain positive relationships with others (Caprara et al., 2019). Therefore, PO has potential in coping with various stressors caused by university demands. For instance, university students who score higher in PO might be more likely to perceive failures as opportunities for growth and learning processes instead of indicators of personal incompetence. Consequently, this type of positive mindset holds multiple benefits that can assist students to maintain or increase their level of motivation despite academic adversities.

Furthermore, PO can enhance the general state of well-being of university students. Numerous studies suggest that people with a higher score in PO tend to have increased mental and physical health outcomes in comparison to those with negative orientation (Alessandri, et al., 2012; Caprara et al., 2013; Alessandri et al., 2012). Therefore, university students with higher PO could not only benefit from better academic performances but from an overall positive university experience due to their increased well-being.

1.2. Cognitive Biases and Self-concept

In order to find effective ways to increase levels of PO, it is essential to comprehend the underlying cognitive mechanisms and factors contributing to a positive oriented individual. According to Kahneman (2003), the dual process theory suggests that human cognition and decision-making relies on two different systems: an intuitive, automatic, and experiential system (often referred to as System 1), and a more deliberative, reflective, and rule-based system (often referred to as System 2). Similarly, implicit cognitive biases work

with automatic, unconscious associations in which an object or stimuli is associated with positive or negative feelings, for example (Bursell & Olsson, 2021).

Studies have shown that implicit cognitive biases (automatic, unconscious mental processes) play an important role in healthy behaviours as well as in somatic disease symptoms and mental health disorders (Mobini et al., 2013; Grafton et al., 2017; Kakosche et al., 2017). Different types of cognitive biases influencing an individual's perception and evaluation are attentional bias, memory bias and interpretation bias, for example (Chen et al., 2020; Vuilleumier, 2005; Watkins, 2002). A study by de Hullu et al. (2017) found effects of trained positive interpretation bias led to decreased social anxiety. Over the past decade, research in attentional bias for positive emotional stimuli increased, suggesting that trained modified attentional bias to positive information is associated with higher levels of optimism as beneficial outcome for well-being and mental health (Pool et al., 2016; Segerstrom, 2001).

Especially research in the field of information processing studies memory biases as cognitive mechanism (Romero et., 2016). Typically, memory bias is assessed by recall-tasks. For instance, when people suffering from depression were examined, the extent to which they remembered negative stimuli that have been shown to them recently was compared to positive or neutral stimuli. Recalling more negative stimuli indicated a negative memory bias (Wisco, 2009).

A study by Bulteau et al. (2023) identified autobiographical memory in combination with excessive negative self-references as important factors contributing to how an individual filters information. As individuals identify themselves with negative features, they become more resistant to positive information which is incongruent with their negative beliefs and expectations about themselves. On the contrary, negative information confirming a negative self-identity is processed more easily which is commonly known in patients suffering from depression disorder (Tarlow & Haaga, 1996; Bulteau et al., 2023; Collins et al., 2023). Increased attention towards and memorization of environmental cues relating to the self, are explained by Cunningham & Turk (2017) with the self-processing bias. Therefore, it is important to take into account not only memory biases and information processing biases, but the self as negatively conceptualized individual.

Regarding PO, implicit memory bias and a negative or positive self-concept may explain the automatic activation of positively or negatively related associations in response to certain stimuli (Wiers et al., 2011). Based on these insights, a positive implicit self-concept

could be derived from positive automatic associations with oneself, as individuals with higher PO would be expected to associate themselves more with positive stimuli than negative ones.

Further, these findings indicate that people with high PO can develop a positive-related self-concept ("I am confident", "I am happy") instead of associating themselves negatively ("I am insecure", "I am unsatisfied"). These positive beliefs about one's self-concept bias can be considered as unconscious positivity bias or PO bias by which the individual has positive attitudes towards itself on an implicit level. Similarly, studies have defined implicit self-esteem as automatic, unconscious self-evaluation and self-association that cannot be controlled (Koole et al. (2001); Zhang et al., 2020).

As implicit self-esteem overlaps with the concept of implicit PO, it can be suggested that positive self-concept biases can be measured with response latency paradigms such as the Implicit Association Test (IAT) which is commonly used to assess implicit self-esteem (Greenwald et al., 1998).

Research by Costantini et al. (2016) developed a PO-IAT to assess PO on an implicit level reliably. In this study, a set of 12 items was selected to measure PO which were balanced by six positive words and six negative words. Additionally, items mirrored facets of PO namely self-esteem, life satisfaction, and optimism (Costantini et al., 2016). Items were also selected considering "[…] the structure of PO that emerged originally from self-reports." (p.2; Alessandri, Caprara, et al., 2012). Regarding the psychometrics, PO-IAT showed high internal consistency and clear convergent validity with other PO-related constructs and measures. In this study, the PO-IAT was replicated in a modified manner; since the original IAT used items in Italian, appropriate English translations were used. Additionally, one recommended translation "self-assured" was changed into "confident". Further, the pronoun "my" was replaced with "myself". Additionally, in this study, the same items and design were used to conduct the cognitive bias modification training as intervention.

1.3. Explicit Optimism

Research has shown that explicit measures are related to the self-concept and show small but significant correlations with implicit measures (Hofmann et al., 2005). An explicit self-concept can be defined as conscious representations of the self which are derived from personal experience and reflection (e.g. memory, introspection) (Lindgren et al., 2017). By using self-report questionnaires, explicit measures of a conscious self-concept can be measured. In line with the dual process theory, a study by Asendorpf et al. (2002) found that implicit measures on subject's self-concepts predicted spontaneous behaviour whereas

explicit measures anticipated controlled behaviour (Kahneman, 2003; Schnabel & Asendorpf, 2010). To investigate cognitive bias and self-concept, it is therefore important to examine not only implicit but explicit measures as well.

In this study, explicit optimism is measured as additional outcome variable since it is one of the key components of PO as psychological construct (Costantini et al., 2016). Measuring implicit PO alongside explicit optimism might help to unravel underlying mechanisms of forming and maintaining positive expectations. As these concepts are closely connected, potential influences of implicit PO on explicit optimism will be investigated to answer the question to what extent explicit optimism might be explained by implicit PO.

1.4. Cognitive Bias Modification

A method to change implicit biases and self-concepts is called Cognitive Bias Modification (CBM). CBM through technical devices has the potential to change maladaptive cognitive biases by exposing participants to simple repetitive association tasks (Wolbers et al., 2021). Research has shown that CBM that beneficial effects in multiple areas leading to decreased levels of anxiety, depression, addition, and fatigue, for example (Mobini et al., 2013; Kakoschke et al., 2017; Wolbers et al., 2021). In this study, such association tasks are designed with the help of a training app in the TIIM platform targeting implicit PO as positive self-concept bias. Selected items were chosen and partially modified based on the PO-IAT developed by Costantini et al. (2016). The PO-IAT by Costantini et al. (2016) showed high correlations (.55 to .70) between the three facets of implicit PO (self-esteem, life satisfaction and optimism) on an explicit level and was replicated and modified for this study. Considering the general lack of research regarding the influence of CBM on an explicit level and to gain further insights into the relationship between implicit PO and explicit measures, explicit optimism is investigated as additional outcome measure.

1.5. Aim of the Study

This study aims at testing the influence and potential effectiveness of the CBM training app on implicit PO and explicit optimism in students. A training app was designed targeting the participant's positive or negative self-concept bias by providing them with repetitive association tasks. During the CBM training, individuals were presented with self-related or other-related stimuli as well as positive and negative stimuli which represented the three dimensions of PO and were instructed to categorize these stimuli into two pairs (positivity/me + negativity/others). This repetitive practice aimed at strengthening automatic associations of positive self-related information, thereby cultivating a positive orientation

bias.

The app was tested among university students who were divided into one experimental group and one control group. To measure implicit PO, an Implicit Association Test was developed. Besides implicit PO, potential effects on explicit Optimism were be measured using the Life Orientation Test-Revised. Therefore, participants answered questionnaires and tests before and after the intervention to look for any effects on these outcome measures.

1.6. Research Questions & Hypotheses

1) **Research Question 1**: What is the effect of the CBM training app on implicit Positive Orientation?

   Hypothesis 1: Post intervention, students of the intervention group will have a higher implicit PO-score than at baseline and compared to the control group.

2) **Research Question 2**: What is the effect of the CBM training app on explicit Optimism?

   Hypothesis 2: Post intervention, students of the intervention group will have a higher score on explicit Optimism than at baseline compared to the control group.

3) **Research Question 3**: Is the effect of the CBM training app on explicit Optimism explained by a change in implicit Positive Orientation?

   Hypothesis 3: Implicit Positive Orientation explains the intervention's effectiveness on explicit Optimism.

2. Methods

2.1. Design

The study was approved by the University of Twente's Ethics Committee BMS/Domain Humanities and Social Science (Requestnr. 230191). Data was collected in April 2023. The study involved a non-randomised controlled experiment with a pre-and post-test design. Afterwards, participants' scores were compared on a between-subject and within-subject level. The influence of the CBM training in the TIIM App was measured on the dependent variables implicit PO and explicit optimism.

2.2. Participants

The sample consisted of 54 participants. Four participants were excluded as they did not finish the first IAT and thus provided no useful data for the analysis. Three participants were excluded from the intervention group, while one was excluded from the control group.

Thus, the intervention group consisted out of 28 participants and the control group out of 22 participants. Besides that, no further participants were excluded. Thus, data was analysed from 50 participants of which eleven were male (22%), 37 were female (74%) and two identified as non-binary (4%). The age range goes from 19 to 31 (M = 22.4, SD = 5.37) and 17 participants were Dutch (34%), 29 were German (58%) and four came from another country (8%). Furthermore, one participant indicated that secondary school (2%), two that vocational education (4%), six that University of Applied Sciences (12%), 31 that a University bachelor's degree (62%), and ten that a University Master degree (20%) is either their current or highest achieved education level.

Participants were recruited via the SONA System, which is the test subject pool system of the University of Twente, as well as via convenience sampling of the researchers' networks. The eligibility criteria for this study were that participants needed to be at least 18 years old and have sufficient reading skills and an understanding of the English language. Besides that, they must have had access to a computer or laptop with a functioning keyboard to complete the tests. Before starting the pre-tests, participants had to give clear consent and it was made sure that they understood that taking part was voluntary (see Appendix A).

2.3. Materials

2.3.1 Measuring Explicit Optimism with LOT-R

The Life Orientation Test-Revised (LOT-R) is a psychological assessment tool designed to measure individual differences in optimism and pessimism independent of a specific time frame. It was developed by Scheier, Carver, and Bridges in 1994 as a revised version of the original Life Orientation Test (LOT). The LOT-R consists of 10 items stating positive and negative expectations of which three items measure optimism, three measure pessimism, and four items serve as fillers to reduce the likelihood of response bias or distortions in the data. These filler items are unrelated to the construct of optimism and are not used in the scoring process. The remaining six items ask respondents to rate their level of agreement with statements related to optimism, such as "In uncertain times, I usually expect the best" and "I tend to look on the bright side of things." (Scheier, Carver, & Bridges, 1994).

Each item is rated on a 5-point scale ranging from "strongly disagree" (1) to "strongly agree." (5). Three negatively worded items are reverse coded so that higher scores indicate higher optimism. The scores on the LOT-R range from 6 to 30, with higher scores indicating greater levels of dispositional optimism. In addition, separate scores can be calculated for optimism and pessimism subscales. For example, LOT-R scores from 19-24 suggest a high

level of optimism (and low level of pessimism). As the scoring system is kept continuous, there is no set standard for categorising individuals as either optimistic or pessimistic. The LOT-R has been used in a variety of research studies to assess the relationship between dispositional optimism and various outcomes, such as psychological well-being, coping with stress, and physical health (Carver et al., 2010; Chang et al., 1997; Jovanović & Gavrilov-Jerković, 2013).

Overall, the LOT-R has been shown to have good psychometric properties, including adequate measures of internal consistency and test-retest reliability (Chiesi et al., 2013). It is considered a useful tool for both research and clinical purposes, providing insight into an individual's overall level of optimism, which can have important implications for their mental and physical health outcomes. In this study, Cronbach's Alpha showed good internal consistency (Cronbach's α = .84 at baseline; Cronbach's α = .9 after the intervention).

2.3.2 Measuring Implicit PO with the PO-IAT

Implicit PO was measured using an Implicit Association Test (IAT), which is a computer-based reaction time test that assesses the strength of automatic associations between concepts (Costantini et al. 2016). Together with the questionnaires, the IAT was generated using SoSci Survey (Leiner, 2016) and was made available to users via www.soscisurvey.de. To measure implicit PO, the PO-IAT required participants to categorise stimuli that are presented on a computer screen into different categories as quickly and accurately as possible. By pressing the appropriate keys "E" or "I" on their keyboard, participants were asked to categorise words as positive or negative as either "Me" or "Other" and pronouns such as "Them" or "l" as either "negativity" or "positivity" (see Appendix B). For example, when the positive stimulus "confident" appeared, it needed to be categorised as "positivity/me" as fast as possible. In case the stimulus was falsely categorised by the participant, a red "X" appeared signalling that a mistake was made. The participants needed to correct their mistake first by pressing the right key to continue with the test.

The PO-IAT measured the time it took participants to respond to each stimulus, in which the differences in response time indicated the strength of implicit associations quantified by the D-score. When computing the D-score, the average response times of block six and seven (Me/Negativity + Others/Positivity) was subtracted from block three and four (Me/Positivity + Others/ Negativity). Afterwards, values were individually standardised by dividing them by the standard deviations of response times of blocks three and four collectively (3/4), and blocks six and seven (6/7) collectively. The resulting mean value of the

two quotients was considered the index value or D-score (indicating the strength of the implicit association).

Therefore, a positive D-score indicated that the participant had a stronger association between themselves and positive concepts (shorter reaction times in block 3/4), while a negative D-score indicated a stronger association between themselves and negative concepts (shorter reaction times in block 6/7). The range of values for the D-score is not limited, which means that it can be less than -1 or greater than +1, depending on how much the response times differ. A D-score of zero indicated no stronger implicit association with either of the two concepts being tested (Nosek et al., 2005).

2.3.3 CBM Training in the TIIM Application

In order to conduct the CBM training, the TIIM application was used. The TIIM (Twente Intervention Interaction Machine) application is a tool created by the Behavioural, Management and Social Sciences (BMS) Lab at the University of Twente (The BMS Lab, 2023). It is a free mobile app available on both the IOS App Store and the Android Play Store, although with restricted access. TIIM allows students, researchers and teachers at the University of Twente to design surveys, long-term studies, or interventions. In this study, the app was used to conduct the CBM training via the response latency platform of the TIIM application. As the response latency platform is a relatively new development, there is not much research on its effectiveness yet. However, previous studies by Wächtler (2019) and Pieterse and Bode (2018) found significant results when using the TIIM application for interventions aimed at reducing a fatigue bias. Furthermore, Wolbers et al. (2021) mentioned that it is a very convenient and inexpensive training tool, as participants can use the TIIM app at any time and place and because very little mental effort and literacy are required for the use of this mobile CBM training app. This suggests that the platform might be an effective tool for conducting CBM.

Twice a day for three days, the participants were asked to complete the CBM training to potentially strengthen the self-concept implicit PO. In the app, participants were asked to swipe certain words that appeared in the middle of the screen either down on the screen, to the category “Me/Positivity”, or upwards on the screen, towards “Others/Negativity”. Furthermore, a zooming function was incorporated. When words were swiped down towards “Me/Positivity”, the word on the screen became larger, stimulating a sensation of approach. Similarly, when the words were swiped away towards “Others/Negativity”, the words became smaller, generating a feeling of avoidance (Wiers et al., 2010). The words that appeared in the middle of the screen were the same stimuli that were used in the IAT (see

Appendix B), and each word was presented five times, in a randomised order. When a participant swiped the word to the wrong category, the category label turned red, and the participant was asked to swipe again until they categorised it correctly. When they did swipe the words into the correct category, the category label turned green, and a positive chime confirmed their choice. Besides the training sessions, the app included a welcome message and brief daily instructions. The participants received notifications from the app as a reminder to complete their training sessions.

2.4. Procedure

The questionnaires included in the research but not relevant to this thesis were: Patient Health Questionnaire – 9 (PHQ-9), the State-Trait Anxiety Inventory (STAI), and the Perceived Stress Scale (PSS).

After signing up via the SONA System, participants received a link to the SoSci website with information about the study and the informed consent form. This included a brief introduction to the purpose of the study and the procedure. Participants were informed that the effect of the CBM training and PO levels were measured, along with other aspects of mental well-being. Besides that, it was stated in the form that participation was entirely voluntary, withdrawal was possible at any time during the study, and the researchers could be contacted for further information or when experiencing problems. After giving consent, participants filled in demographic information which included age, gender, nationality and current (for students) or highest achieved education level. Lastly, they filled in their email address to receive information about the next steps of the study. This email address was solely used for research purposes and not stored in the dataset or given to third parties.

The first 30 participants that signed up for the study were assigned to the intervention group and received an email with the link to start the pre-tests. The next 30 participants were assigned to the control group and received another link to the pre-tests. Both groups filled in the pre-tests on the SoSci website, consisting of the PSS-10, STAI, LOT-R, PHQ-9 scales, and the PO-IAT test.

After completing the pre-tests, the intervention group received instructions for downloading the TIIM App. After they downloaded the TIIM App and created an account, participants were assigned to the CBM training. Then, the participants could complete the first session, and the second session two hours after completing the first session of the day (see Table 1). The sessions could be done at any location and participants received a notification on their phone when the next session was available. If a session was not yet completed, participants received a reminder on their phones three and six hours after the

session got available. After three days, the intervention and the control group received an email to complete the post-tests, which were identical to the pre-tests. If not completed, they received a reminder email to complete the post-tests after one day.

Table 1
Overview of sessions in the TIIM app

Session number	Days of the CBM training	Availability
Session 1	Day 1	Directly after filling in the pre-tests
Session 2	Day 1	2 hours after completing session 1
Session 3	Day 2	1 day after the start of the intervention
Session 4	Day 2	2 hours after completing session 3
Session 5	Day 3	2 days after the start of the intervention
Session 6	Day 3	2 hours after completing session 5

2.5. Data Analysis

The generated data was analysed using R version 4.3.0 in RStudio 2023.03.0. First, irrelevant data was identified and removed from the data set. Data of four participants was eliminated as they did not finish the first part of the survey (n = 50). The data set was imputed by replacing missing values and extreme outliers with means. Afterwards, demographic data, pre- and post-test scores (D-scores and LOT-R scores) of the intervention and control group were analysed. Descriptive statistics were computed, including means, standard errors, standard deviations, minimum and maximum scores as well as 95% CI.

To test for the first hypothesis, the mean difference between D-scores pre and post intervention were computed. A repeated-measures ANOVA test was run with D-scores as dependent variable, group as the between-subjects independent variable, and time (pre- and post-intervention) as within-subjects variable to examine mean differences and effects. Afterwards, a non-parametric Kruskal-Wallis test for validation and a post-hoc test was conducted to compare within-group differences in the outcome between time points and differences on between-group level in the outcome at each time point.

Secondly, the mean difference between pre- and post-test scores of the LOT-R was computed. To investigate the relationship between levels of explicit optimism and training app usage, relevant assumptions were tested and a repeated-measures ANOVA test was performed with LOT-R scores as dependent variable, group as between-factor and time (pre- and post-intervention) as within-factor to examine mean differences and effects. Afterwards,

a non-parametric Kruskal-Wallis test for validation. Finally, a post-hoc test was conducted and within-group changes in the outcome across time and differences on between-group level in the outcome at each time point were compared.

Lastly, after checking relevant assumptions, a mediated linear regression analysis was performed with *Y* and *M* predicting *Y*. Therefore, for each time point the role of implicit PO as mediator (*M*) in the relationship between training app usage as dependent variable (*X)* and explicit optimism as predictor (*Y*) was explored. To rule out any further effects, a final moderation analysis investigating influences of low and high levels of explicit optimism as moderator (*M*) on the training's effect (*X*) on implicit PO as predictor (*Y*) was conducted.

For all analyses, relevant statistical assumptions were checked beforehand. Despite violations of assumptions, ANOVA designs were used for testing considering the robustness of F-test to non-normality (Blanca et al., 2017). However, other violations need to be considered when interpreting the results.

3. Results

4.1. Descriptives

Starting with the control group, participants scored a mean D-score of .40 indicating their implicit PO bias pre intervention. Their post intervention D-score of .49 implied no strong differences. Pre intervention, the experimental group showed a slightly higher mean D-score of .48 compared to the control group. Post intervention, participants in the intervention group scored .71 on implicit PO which is noticeably .23 higher than at baseline and compared to the control group (post D-score = .49).

Testing for explicit optimism, the control group scored a mean of 20.9 on the LOT-R scale in the pre-test and 21.6 in the post-test (see Table 2). Again, no strong differences were detected in the control group pre and post intervention. Based on the LOT-R scale, scores from 19-24 suggest a high level of optimism (and low level of pessimism). The intervention group showed a LOT-R score of 20.6 in the pre-test and a score of 22.7 in the post-test. Both groups showed high levels of optimism before the intervention and showed increased levels in the post-test. However, the control group's score increased by .7 and the intervention group's score increased by 2.1 points on the scale. For further investigation, the established hypotheses were tested.

Table 2

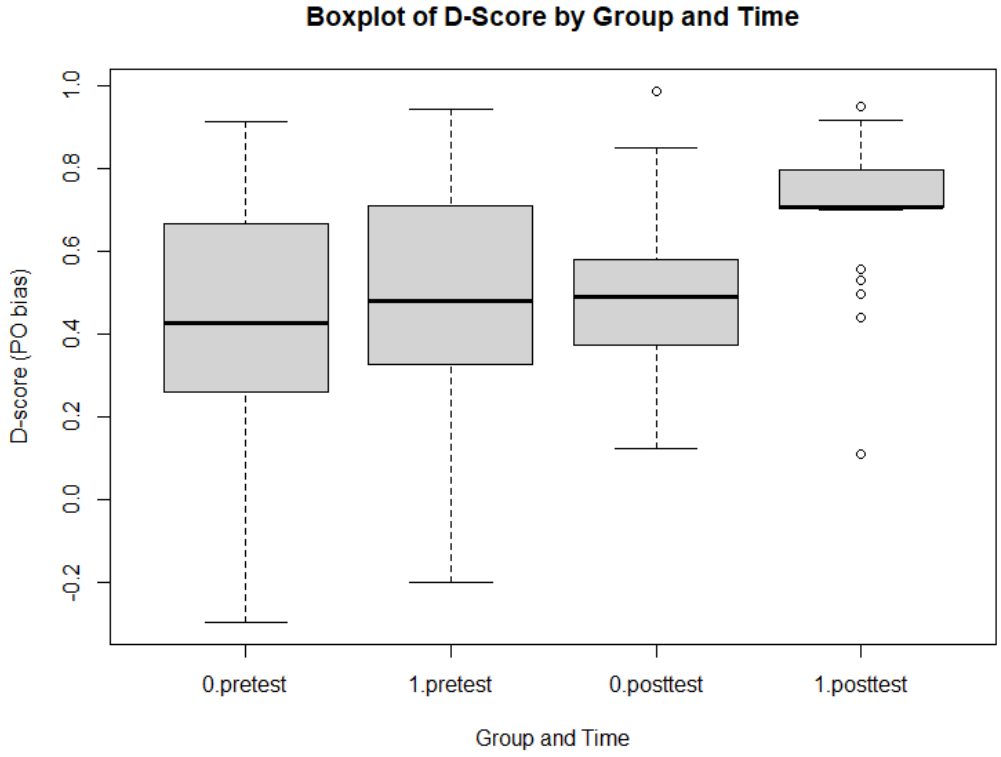
Estimated Marginal Means, Standard Errors, Minimum and Maximum Scores, and Confidence Intervals of Study Variables by Time and Group

	Control Group (n = 22)					Intervention Group (n = 28)				
Test/ Questionnaire	*M* (SE)	Min.	Max.	95% CI	SD	*M* (SE)	Min.	Max.	95% CI	SD
PO bias (D-score), pretest	.40 (.07)	-.30	.91	.40	.33	.48 (.05)	-.20	.94	.48	.28
PO bias, posttest	.49 (.5)	.12	.99	.49	.23	.71 (.03)	.11	.95	.71	.17
LOT-R, pretest	20.9 (1.00)	12	30	20.9	4.69	20.6 (.89)	10	29	20.6	4.69
LOT-R, posttest	21.6 (.98)	13	30	21.6	4.60	22.7 (.57)	16	30	22.7	3.04

Notes.n = sample size, D-score = implicit PO score, *M* = mean score, SE = Standard Error, Min. = minimum score, Max. = maximum score, CI = confidence interval, SD = standard deviation.

Figure 1

Boxplot of Pre- and Post-Test D-scores of Intervention group (1) and Control group (0)



4.2. CBM Effect on Implicit PO

To answer the first research question "What is the effect of the PO training app on implicit Positive Orientation compared to baseline levels and the control group?", a two-way repeated-measures ANOVA test was performed to evaluate the effect of the PO training app on the PO bias score (D-score) over time and compared to the control group. First, assumptions for normality, absence of outliers, homogeneity of variance and sphericity of the data were tested: The Shapiro Wilks test showed normal distribution ($p > 0.05$). However, for the posttest D-scores of the intervention group, the p-value of .0003 indicated abnormal distribution. In total, 12 outliers were detected of which eight belonged to the posttest D-scores of the intervention group. Homogeneity of variance was met for pretest scores but was violated for posttest scores. Homogeneity of covariances was met. However, sphericity was violated ($*p < .05$).

For the ANOVA test, the variable "treatment" consisted of the intervention group (1) and the control group (0) while the variable "time" indicated the D-scores (implicit PO) before and after the intervention. Based on the ANOVA results, treatment and time showed significant main effects on implicit PO ($*p < .05$), indicating significant mean differences between the treatment groups and pre and post intervention. However, the interaction effect of treatment and time displayed only a non-significant effect on implicit PO (see Table 3).

Table 3

ANOVA table showing the effect of PO training app on implicit PO.

	ANOVA results				
	Df	Sum Sq.	Mean Sq	F value	P value
treatment	1	.54	.54	8.20	.005*
time	1	.69	.69	10.52	.002*
treatment:time	1	.13	.13	1.91	0.17
Residuals	94	6.33	.07		

Note. Df = Degrees of freedom, Sq. = squared. The main effects of treatment and time were significant: $*p < .05$.

A followed non-parametric Kruskal-Wallis-Test was run investigating the d-score post intervention by group and found no significant differences ($p = .27$).

To gain more insight into the relations of treatment and time, a post-hoc test was conducted to examine simple main effects of the treatment at each time point (see Table 4). The analysis suggested that there was a significant effect of the treatment at the posttest time point ($F(1, 48) = 15$, $^{***}p < .001$). The effect size (ges) was .24, indicating a moderate effect size. The p-value was adjusted using the Bonferroni correction, and the adjusted p-value remained significant ($p.adj = .0007$). This implies that there was a difference in scores between the two treatment groups after the intervention.

The post-hoc test for the effect of time at each level of the treatment groups suggested a significant interaction effect between time and treatment group ($^{***}p < .001$) (see Table 5).

The results of the non-parametric test indicated no effects, whereas the post-hoc test indicated interaction effects between treatment and time. However, the ANOVA test lacked a significant interaction effect with significant direct effects. Therefore, the hypothesis assuming that the effect of the CBM training on implicit PO will be significant compared to baseline levels and the control group after the intervention cannot be fully accepted. However, considering a significant interaction effect between time and treatment group based on a post-hoc test, a partial acceptance of the first hypothesis is suggested.

Table 4

Post-hoc Test for Treatment Effect on D-scores at the time points pretest and posttest (DV = D-score; IV = time; between-factor: treatment).

Time	*M*		DFn	DFd	F	p	p< .05	ges	p.adj
D-score, posttest	Control (*n* = 22)	.49	1	48	15	.0003	***	.24	.0007
	Intervention (*n* =28)	.71							
D-score, pretest	Control	.40	1	48	.79	.38	ns	.02	.76
	Intervention	.48							

*p < .05, **p < .01, ***p < .001

Notes. DFn = degrees of freedom for the numerator (between-group), DFd = degrees of freedom for the denominator (within-group), ges = generalized eta squared, p.adj = p-value adjusted using the Bonferroni correction, .y. = dependent variable, *n* = sample size.

Table 5

Post-hoc Test for Effect of Time at Each Level of the Treatment Groups (DV = D-score; IV = treatment group; within-factor: time (pre and post intervention).

Treatment	*M*		Effect	DFn	DFd	F	p	P < .05	ges	p.adj
0	Pretest	.40	Time	1	21	1.11	.3	ns	.02	.61
	Posttest	.49								
1	Pretest	.48	Time	1	27	14.4	.0008	***	.20	.0002
	Posttest	.71								

*p < .05, **p < .01, ***p < .001

Note. Treatment (0 = control group, 1 = intervention group).

4.3. CBM Effect on Explicit Optimism

Regarding the second hypothesis "After the intervention, the experimental group's score on explicit Optimism will be significantly higher than the before the intervention and compared to control group's score.", a two-way mixed ANOVA and post-hoc test was performed. During the assumption testing, five outliers in the post-test LOT-R scores (indicating the level of explicit optimism) were detected (see Figure2). The Shapiro-Wilk test showed normal distribution except for the post-test LOT-R scores of the intervention group (*p < .05). Additionally, homogeneity of variance was violated in the post-test LOT-R, whereas the Box's M-test revealed that homogeneity of covariances was met. After conducting the Mauchly's sphericity test, violated sphericity was found for treatment group effect and interaction effect between group and time.

The ANOVA results revealed no significant main effects or interaction effects between treatment and time indicating to reject the second hypothesis (see Table 6). A followed non-parametric Kruskal-Wallis test on the post LOT-R scores per group was performed, suggesting non-significant effects between the treatment groups (p = .26).

To further investigate the relationship between treatment and time, a final post-hoc test was performed to test for simple main effects of the intervention group before and after the intervention. A significant improvement of LOT-R scores was detected for the intervention group (*p.adj = .02) (see Table 7).

Considering the unsignificant interaction effects of time x treatment found during the ANOVA testing, the second hypothesis cannot be fully accepted. However, an analysis based on simple testing suggests a partial acceptance as significant increases of mean LOT-R scores were found for the intervention group.

Table 6

ANOVA table showing the effect of PO training app on explicit Optimism.

	Effect of PO Training App on Explicit Optimism				
	Df	Sum Sq.	Mean Sq	F value	P value
treatment	1	4.2	4.21	.32	.63
time	1	55.5	55.45	3.04	.08
treatment:time	1	12.3	12.27	.67	.41
Residuals	96	1750.2	18.23		

Table 7

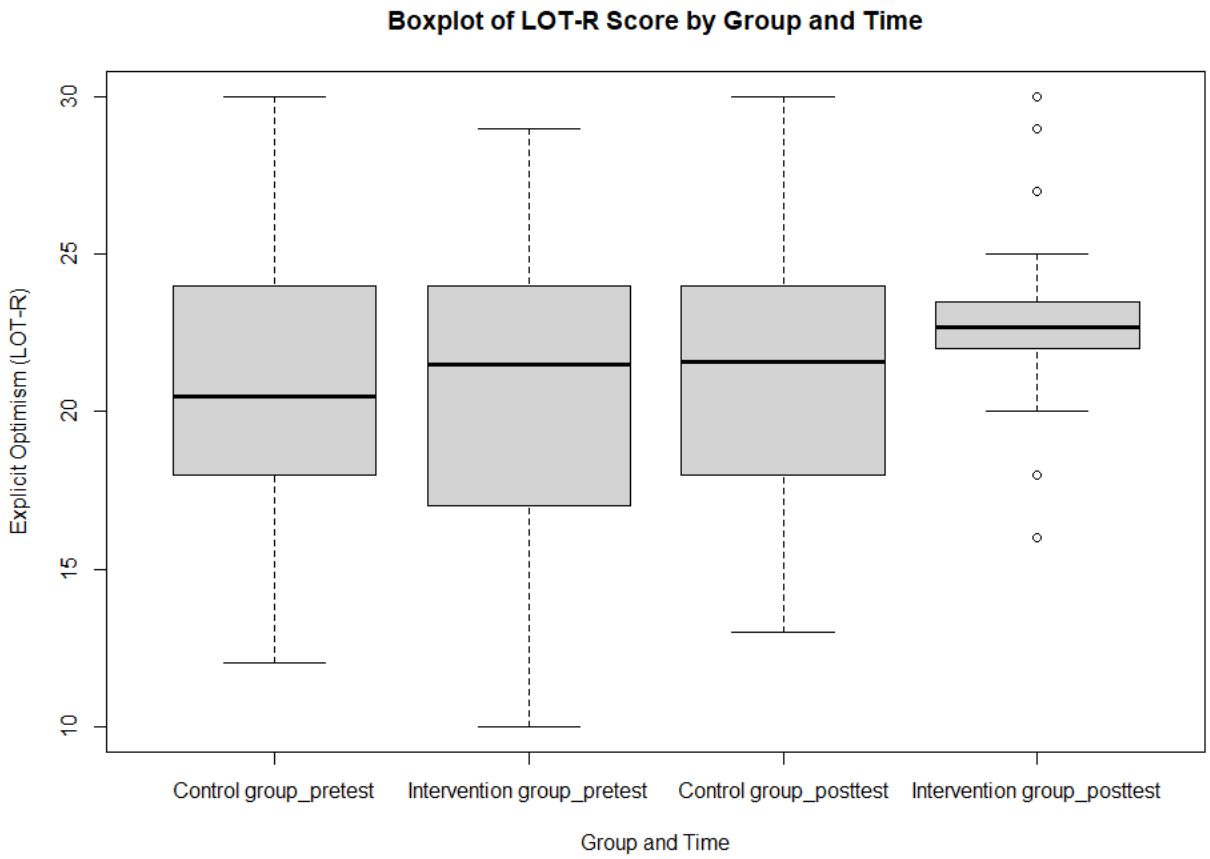
Post-hoc Test for Effect of Time at Each Level of the Treatment Groups (DV = LOT-R score; IV = treatment group; within-factor: time (pre and post intervention).

Treatment	*M*		DFn	DFd	F	*p*	*p* < .05	ges	p.adj
0 (*n* = 22)	Pretest	20.9	1	21	1.24	.28	ns	.006	.55
	Posttest	21.6							
1 (*n* =28)	Pretest	.48	1	27	7.66	.01	*	.07	.02
	Posttest	.71							

Note. Dependent variable = LOT-R score; **p* < .05. Treatment: 0 = control group; 1 = intervention group.

Figure 2

Boxplot of Pre- and Post-Test LOT-R scores of Intervention group (1) and Control group (0).



4.4. Mediating Effect of Implicit PO on CBM Effect on Explicit Optimism

To answer the third research question "Is the effect of the PO training app on explicit Optimism explained by a change in implicit Positive Orientation?", the relationship between the training app usage, implicit PO and explicit optimism was explored by conducting a mediation analysis. Accordingly, the following assumptions were checked and found to be met: linearity, normality of residuals, absence of outliers and multicollinearity, constant variance of residuals, and homoscedasticity. However, the assumption of independence of residuals was violated as the Durbin-Watson test revealed a p-value of .02, which is less than the significance level of 0.05. Therefore, there is evidence to suggest that there is a positive autocorrelation in the residuals, meaning that the residuals are not independent.

First, the effect of the intervention on implicit PO was tested. According to the results shown in Table 8, there is no significant effect to be identified which is consistent with prior results.

Table 8.

Mediation Analysis – Step 1: Path a (independent variable = treatment; mediator = implicit PO) (n = 28).

	B	SE	*t*	*p*
Intercept	.09	.07	1.16	.25
Treatment	.14	.10	1.43	.16

Note. B = unstandardized regression coefficients, SE = standard errors of the coefficients.

Afterwards, the effect of the intervention and the effect of PO change on explicit optimism was examined (see Table 9). Based on the results, no significant effect was observed suggesting that the change in implicit PO does not affect explicit optimism.

Table 9

Mediation Analysis – Step 2: Paths c' and b (independent variable = treatment; mediator = implicit PO; dependent variable = Explicit Optimism)

	Estimate	SE	*t*	*p*
Intercept	.57	.77	.73	.47
Treatment	1.19	1.05	1.14	.26
Change in D-score	1.54	1.48	1.04	.31

Lastly, a causal mediation analysis was performed in order to examine the potential mediating effect of the change in implicit PO on the relationship between the usage of the training app and optimism. The mediation analysis was run with explicit optimism as dependent variable (*Y*), implicit PO as mediator (*M*) and treatment as independent variable (*X*). No significant effects were identified as all p-values exceeded the alpha value of .05. (see Table 10). The results suggest a slight positive but non-significant mediation effect of .22 on explicit optimism. Similarly, the direct effect of 1.19 implies a non-significant small positive effect which is not mediated by implicit PO.

Based on the results of the conducted mediation analysis, the third hypothesis expecting implicit PO to mediate the CBM training effect on explicit optimism can be rejected as no significant effect were found.

Table 10

Results of Causal Mediation Analysis: Path c (explicit optimism as dependent variable (Y), implicit PO as mediator (M) and treatment as independent variable (X)).

	Estimate	95% CI Lower	95% CI Upper	*p*
ACME	.22	-.12	1.00	.26
ADE	1.19	-.74	3.14	.26
Total Effect	1.41	-.47	3.32	.14
Prop. Mediated	.16	-.59	1.88	.30

Note. ACME = Average Causal Mediation Effect, ADE = Average Direct Effect, CI = Confidence Interval.

Finally, to exclude further possibilities of any interaction effect, a moderation analysis was conducted to briefly investigate any moderating effects of low and high levels of explicit optimism at baseline on implicit PO. Independent variables were treatment groups and optimism groups (low and high level). Dependent variable was the change in D-scores across time and treatment groups. However, no significant effects were found (p = .93) and assumptions of potential mediation as well as moderation effects were rejected.

4. Discussion

4.1. Summary

The aim of this pilot study was to gain insights into how levels of implicit PO can be possibly increased by using a CBM training app through a mobile phone in six days for three days. Additionally, explicit optimism was chosen as additional outcome measure to investigate the potential efficacy of CBM methods on an explicit level and further explore the relationship of implicit PO and explicit optimism. As optimism is one of the three main components of PO and correlates with the other components on an explicit level, potential influences of implicit PO as mediator on the training's effectiveness on explicit optimism were examined.

Consequently, a CBM training app was designed to modify the implicit PO bias of the intervention group by training with repetitive association tasks in which positive stimuli were unconsciously associated with oneself in two sessions a day for three days. 50 students participated in a non-randomized controlled experiment and were divided into one intervention group (n = 28) and one control group (n = 22). After conducting the experiment, the following research questions were examined: 1) What is the effect of the PO training app on implicit PO? 2) What is the effect of the PO training app on explicit optimism? 3) Is the effect of the PO training app on explicit optimism explained by a change in implicit PO?

The first hypothesis predicted significantly higher D-scores in the intervention group compared to baseline levels and the control group post intervention. This hypothesis was partially rejected as the main test did not reveal a significant interaction effect between

treatment and time. However, the post-hoc test suggested a significant interaction effect and revealed a strong effect of treatment within the intervention group, indicating a possible training effect and a partial acceptance of the hypothesis. In the field of CBM interventions, prior studies varying from one session to eight sessions over a period of one day to four weeks found CBM trainings to be effective (Amir et al., 2009; Jones & Sharpe, 2017).

Observing CBM training effects on PO is in line with the findings of previous research which reduced maladaptive cognitive biases related to disorders such as anxiety and depression (Hallion & Ruscio, 2011). According to Seligman and Csikszentmihalyi (2000), the training effect may be also partially explained by the technique of "positive self-talk" which relates to the idea of positive self-associations. Positive self-talk defines cognitive processes in which an individual expresses their thoughts and feelings about themselves or their environment in a silent or audible manner (Sabzipour et al., 2023). Positive self-talk as inner speech is related to automatic and involuntary thought processes, a mechanism closely related to implicit self-concept biases functioning in System 1 of the dual process theory (Thomaes et al., 2020, Kahneman, 2003).

However, since the first hypothesis was not fully accepted, it is important to acknowledge violated assumptions and potential errors in the procedure of data analysis. Considering that multiple missing values and outliers have been replaced by mean values, the results need to be interpreted with caution. Consequences of the use of mean imputation might have led to deterioration of the classification accuracy and an underestimate of standard errors, as variance of imputed variables was reduced. As a result, most hypothesis tests and calculations of confidence intervals might have been invalidated leading to issues in detecting effects and differences or unprecise and misleading interpretations of results. Additionally, relationships and potential correlations between variables are likely to not preserve after mean imputation leading to distortion of relationships by either weakening existing relationships or inflate correlations artificially (Allison, 2009; Berglund & Heeringa, 2014; Horton & Kleinman, 2007).

The second hypothesis claimed that the intervention group will score significantly higher in explicit optimism than at baseline and compared to the control group post intervention. As the main tests revealed no significant interaction effects, the second hypothesis was mainly rejected. However, given the explorative nature of this study, the simple tests showed a significant increase of LOT-R scores within the intervention group suggesting a partial acceptance of the hypothesis.

A possible explanation for the rejection of the hypothesis could be that CBM training is more effective in increasing levels of self-esteem than optimism. However, regarding the mean changes in the intervention group, LOT-R scores increased significantly after the intervention by 2.1 points, whereas control group's scores did not. Considering the lack of significant effects on implicit PO in the main analysis, this tendency implies that CBM interventions might prompt participants into using cognitive restructuring on an explicit level, rather than modifying an actual implicit bias. However, another explanation could be that increased levels of implicit PO (as found in the intervention group based on simple testing) enhance positivity bias in self-reporting questionnaires such as the LOT-R as confounding effect (Caprara et al., 2013).

The third hypothesis predicted a mediating effect of implicit PO on the training's effectiveness on explicit optimism. No significant results were found after conducting a mediation analysis. Therefore, the last hypothesis was rejected. This finding implies that the effect of the training on explicit optimism is not explained or influenced by implicit PO.

4.2. Strengths of this study

Strengths of this study are the inclusion of a control group for comparison and increased causality when interpreting the results and the differentiation of explicit and implicit outcome measures to investigate the CBM intervention's influence on both levels. Considering that the concept of implicit PO is relatively new and the developed CBM training suggested some effect on implicit PO, this pilot study was to some extent successful and gives valuable indications for future research.

In addition, some delays of three to four days between completing the CBM training and answering the post-questionnaires increased the validity of observed effects sustainable over time.

4.3. Limitations & Implications for future research

The developed PO-IAT was replicated based on a study by Costantini et al. (2016) but modified and therefore, does not provide any psychometric test data on validity or reliability. Consequently, the results for implicit PO scores might lack validity and reliability as well. Conducting a split half reliability test of the PO IAT could give more insights into its reliability, while potential correlation between PO and optimism scores could imply validity (Pronk et al., 2022, Greenwald et al., 2009). It is important to acknowledge that the similarities between the PO-IAT and the CBM training regarding their tasks and choice of words might have led to a trained response behaviour as effect, rather than resulting from an

intervention effect (changing the implicit cognitive bias). Although, the CBM and PO-IAT operated on different platforms (PC and mobile phone) and asked participants different type of tasks (using either letters on the keyboard or mobile touch screen to categorize), this raises the question how effective the CBM training is in targeting implicit measures. A systematic review and meta-analysis targeting the efficacy of CBM interventions by Fodor et al. (2020) found that CBM interventions consistently showed benefits to a small extent, but state that the reliability of these insights is questionable because of heterogeneity and risk of bias. Additionally, the amount of conducted and reporting of CBM trials is still very limited to make strong assumptions about the effectiveness of CBM methods on implicit biases (Fodor et al., 2020; Cristea et al., 2016).

Overall, the CBM training could be possibly improved by adding more positive stimuli that compose implicit PO and relate to personal features that one desires to have or to further strengthen. As mentioned before, positive self-talk (e.g., saying “I am confident” or “I deserve happiness”) might be a contributing factor to training effects. A study on pregnant adolescents by Punsuwun et al. (2017) found that positive self-talk led to significant higher mean scores in self-esteem and psychological well-being compared to pre-test scores and higher than the control group. Recently, beneficial effects of positive self-talk to decrease depression in students have been observed (Sabzipour et al., 2023). Over the years, self-talk has become a well-established cognitive technique used by athletes in enhancing sport performances (Walter et al., 2019).

Considering the beneficial effects of positive self-talk, the CBM training could be further modified by instructing the intervention group to express paired negative and positive stimuli audibly. For instance, when the stimuli “confident” shows up, the participant would drag it to the category “positivity/me” and say “positivity/me confident” to strengthen their connection on an implicit level. Moreover, based on the participant’s self-concept, the participant might be more resistant to positive associations contributing to an implicit PO if they are perceived as untrue statements about themselves (Bulteau et al., 2023).

To further investigate the sustainability of a training effect, future research could add follow-up questionnaires to their intervention design.

Furthermore, the sample size (n = 50) was rather small leading to a lack of statistical power of results. It is therefore recommended for future research to replicate the study with a larger sample to get more valid measures and increase statistical power.

Additionally, the CBM training intervention was conducted over three days which is a short period of time to expect significant effects. Future research could carry out the study over a longer period as previous studies on CBM indicated that the effect sizes on cognitive bias are larger depending on the period of time the training was conducted.

As mentioned before, the violations of assumptions as well as mean imputation are likely to have affected computed results which, therefore, should be interpreted with caution. Additionally, the LOT-R does not refer to any given time frame which makes answers more sensitive to be affected by participant's daily moods. In future studies, it might be a good addition to add a time interval to the questionnaire to avoid strong changes in the scores based on daily short-term events that affect the participant's mood.

4.4. Conclusion

In conclusion, the pilot study showed that the CBM training evoked non-significant positive mean changes in implicit PO and explicit optimism in the intervention group compared to baseline levels and the control group. Further, simple testing suggested a significant positive interaction effect on implicit PO and a strong treatment effect on explicit optimism within the intervention group. The study gives many indications for future research. Although, the data set was rather small, the intervention period short (three days) and overall, results lack statistical power and need to be interpreted with caution, the tendency of mean differences of pre- and post-intervention scores show promising implications for developing more effective, valid, and reliable CBM training interventions aiming at increasing student's implicit PO in the future.

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Appendices
Appendix A:

Informed Consent Form

Welcome.

You have been invited to participate in a study about the use of the mobile eHealth Application IVY as a tool to increase Positive Orientation in students. Positive orientation is the ability to have a positive view of yourself and your future. The purpose of this research is to gather insight into the current level of Positive Orientation of students and the effect of the IVY Application on Positive Orientation. Besides that, we are interested in the effect of the app on other aspects of mental well-being. The participants are distributed in two groups. Group 1 will be asked to answer the questionnaires twice, which will take approximately 90 minutes in total. Group 2 will be asked to answer questionnaires twice and additionally, use the IVY Application for 3 days in a row. This will take approximately 120 minutes in total. To inform you which group you are in, we will contact you by your given mail address. This study is conducted by the students Aishe Bingöl, Laureen Lhotak, Romy Nijhuis and Lytske Wijma from the Faculty of Behavioural, Management and Social Sciences at the University of Twente.

This research has been reviewed and approved by the BMS Ethics Committee/domain Humanities & Social Sciences. There are minimal burdens and risks associated with participation in this study. Filling in the questionnaires is not likely to cause any psychological discomfort. However, participants might experience some technical difficulties. These difficulties are minimised by having performed pilot tests with different phones beforehand. Besides that, participants can contact the researchers when experiencing troubles with the app.

Your participation in this study is entirely voluntary and you are allowed to withdraw at any time during the process without any negative consequences, and without providing any reasons. Additionally, you are free to ask any questions. During your participation in this study, you may be asked questions that you may experience as (very) personal. You are free to refuse to answer any questions you do not feel comfortable answering.

The nature and purpose of this study, including the data collection, are for educational purposes only. In order to obtain a clear picture of the participant sample of this study, you

will be asked certain questions about your demographic information. The data that is gathered will be handled anonymously and stored in a folder that only the researchers of this study can access. The data will be deleted after the final report is submitted.

Study contact details for further information:

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Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee of the Faculty of Behavioural, Management and Social Sciences at the University of Twente by ethicscommittee-bms@utwente.nl

- I hereby confirm that I am 18 years old or older and have read and understood the information. My participation in this study is voluntary.
- No, I do not consent and will not participate in the study.

Appendix B

List of Stimuli Used in the Experiment

List of Positive Stimuli for Category 'Positivity'

- High esteem
- Confident
- Happy
- Satisfied
- Positive
- Optimistic

List of Negative Stimuli for Category 'Negativity'

- Low esteem
- Insecure
- Unhappy
- Dissatisfied
- Negative
- Pessimistic

List of Pronouns for Category 'Me'

- I
- Me
- Myself
- Mine

List of Pronouns for Category 'Others'

- Others
- Them
- They
- Their