Improving Mood and Strengthening Implicit Positive Orientation through the Cognitive Bias Modification Platform of the TIIM App

Aishe Bingöl

Department of Behaviour Management and Social Sciences, University of Twente

Module 12: BSc Thesis PSY 2022/2023

First Supervisor: Dr Marcel Pieterse

Second Supervisor: Rick Pinkster

June 29, 2023

Abstract

Background. The recent concept of Positive Orientation (PO) is thought to be a promising way to conduct positive psychology interventions. Using Cognitive Bias Modification (CBM) is an appropriate tool to strengthen PO, as positive effects are more robust when PO is changed on an implicit level. This study aimed to (a) test whether the CBM training leads to an increase in implicit PO; (b) if mood is improved after the training for the intervention group and (c) whether the effect of CBM on mood is mediated by a change in implicit PO compared to a control group and the participant's baseline levels.

Methods. The study involved a non-randomised controlled experiment with a pre-and post-test design. Participants, who were mainly students ($N = 50$), filled out a questionnaire before and after the CBM training to assess their mood levels. They also did an Implicit Association Test before and after the training, which is a reliable tool to assess their implicit PO scores. The CBM training lasted three days, consisting of two daily sessions, and was done via the TIIM App, developed by the Dutch University of Twente.

Results. A Two-Way Repeated Measures ANOVA revealed a significant, yet marginally, stronger improvement of implicit PO in the intervention group compared to the control group. However, no significant effects were found for a change in mood levels or for a mediation of the change in implicit PO.

Conclusion. This study provides a first indication of how CBM can be used to strengthen implicit PO, namely through changing the self-concept of the participants in a positive direction. Future research is needed to investigate the concept of implicit PO in more depth and find a suitable way to design interventions that successfully target the right bias to improve mood and other psychological constructs. Gaining more insight into PO can help to develop interventions suitable to let students benefit from them daily.

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

Improving Mood and Strengthening Implicit Positive Orientation through the Cognitive Bias Modification Platform of the TIIM App

1. Introduction

1.1 The Effects of Mood

Being in a negative mood can have an adverse impact on people's mental health as well as on certain health behaviours (Ingram et al., 2020). A *negative mood* can be defined as a harmful or depressing experience for the individual in the current situation (Collins English Dictionary, 2023). The decrease in health behaviours includes, for example, a decreased sleep quality and an increase in drinking alcohol (Ingram et al., 2020). One at-risk group affected by such negative health behaviours are students, as they are more prone to drinking when in a negative mood (O'Hara et al., 2014). It was found that students often drink alcohol to cope with any negative events they experience in their personal or educational life (O'Hara et al., 2014). These studies make clear that being in a negative mood can have negative impacts on many areas of one's life.

On the other hand, being in a positive mood can enhance students' learning abilities (Bryan et al., 1996). It was shown that students, particularly students with learning disabilities, who were in a positive mood, showed improvements in academic performance (Bryan et al., 1996). Furthermore, a positive mood can lead to an improvement in memory (Hoffmeister et al., 2021), which is an essential ability for students. Since a negative mood is linked with depression, such as being in a depressed mood, it can influence students' abilities when it comes to concentrating in an academic context and understanding the learning materials (Mehta, 2022). If this is the case, overall academic performance can decrease. Therefore, strengthening students' positive mood should be a goal for interventions, which plan to help students in dealing with their problems such as learning difficulties and alcohol consumption.

1.2 Positive Orientation and Positive Psychology Interventions

Recently, research has focused on the impact of Positive Psychology and its *Online Positive Psychology Interventions* (OPPIs). Instead of solely emphasising the negative aspects of life, such as depression, Positive Psychology focuses on the aspects that make life worthwhile and allow people to flourish (Proyer et al., 2014). It is crucial to place an emphasis on well-being and life satisfaction in order for people to be happier and less likely to suffer from mental illness (Proyer et al., 2014). Therefore, the purpose of OPPIs is to improve well-being by, for example, lowering depression (Barnes & Mongrain, 2019). It has been demonstrated that using OPPIs to achieve these benefits is an effective strategy for boosting

well-being, and additionally having the advantage of being able to be self-administered (Proyer et al., 2014).

Including the concept of Positive Orientation in such interventions might be a promising approach. *Positive Orientation (PO)* refers to the ability of an individual to feel that living life is worthy and to have a positive outlook on the future (Costantini et al., 2019). In general, PO consists of the facets of optimism, life satisfaction, and self-esteem (Costantini et al., 2019). One example of why PO can influence mental health aspects concerns depression, which is a factor that students struggle with (Alessandri, Caprara, et al., 2012; Caprara, Alessandri, Colaiaco, & Zuffianò, 2013; Caprara et al., 2012, as cited in Costantini et al., 2019). PO can be seen as the opposite pole of depression and bad mood (Alessandri et al., 2012). Therefore, it is suggested that people high in PO evaluate their health and connection with friends more positively, as well as their ability to regulate their behaviour. As a result, people high in PO show fewer negative emotions and moods (Alessandri et al., 2012). Thus, people high in PO can benefit from positive effects on their behaviour and social connections. PO is a concept for which its facets are essential determinants of well-being and health behaviours (Alessandri et al., 2012). One aspect of well-being includes a positive mood.

1.3 The Influence of Optimism, Life Satisfaction, and Self-Esteem on Mood

The concept of PO consists of three different facets. These facets are optimism, life satisfaction, and self-esteem. The most important facet of PO, when it comes to mood, is Optimism (Segerstrom et al., 1998). *Optimism* can be defined as a general attitude towards a positive outcome in different situations in life (Schweizer et al., 1999). Studies show that Optimism can lead to a positive mood and even better health outcomes in students (Segerstrom et al., 1998). Optimistic individuals also show negative moods less frequently but have more health benefits, such as coping with the effects of stress on the body in a healthier way (Brydon et al., 2009). Therefore, it can be concluded that mood is linked to Optimism. As Optimism is a facet of PO, this shows to have an influence on the target group, which is why it is of relevance in this study. Additionally, as Optimism is part of PO, it can influence mood quickly (Segerstrom et al., 1998). Thus, if PO is improved, this will also improve the mood of the target group, namely students.

Another facet of PO is life satisfaction, which describes a person's evaluation of different aspects of one's life, which makes it meaningful (Alessandri et al., 2012). The influence of life satisfaction is positive, as it can improve physical health and lets people choose positive coping strategies to deal better with difficult situations (Alessandri et al., 2012). Research has shown that people who possess higher life satisfaction are able to

sufficiently maintain their positive mood and to better repair the negative mood that they experience (Thompson et al., 2007). However, it should be noted that the effect found is rather small and that it is also common that mood in general can act as a predictor of life satisfaction (Choi et al., 2023).

The next facet of PO is self-esteem, which describes people's orientation towards themselves (Brown & Mankowski, 1993). People with high self-esteem show lower depressive symptoms as well as increased mental and physical health (Alessandri et al., 2012). Additionally, people with high self-esteem have better strategies to achieve their goals and are less likely to give up when faced with difficulties (Alessandri et al., 2012). This can be especially beneficial for students pursuing their academic goals. It was also found that self-esteem moderates how people evaluate themselves based on what mood they are in. Hence, people who are in a positive mood and have high self-esteem tend to evaluate themselves more positively, such as by describing themselves as smart (Brown & Mankowski, 1993).

Based on these different findings from research, it is shown that the different facets of PO have positive influences on the well-being of people. When considering the effects of these facets on mood, it can be concluded that Optimism is expected to be the main component. Compared to the other two facets which influence mood more indirectly, Optimism shows to have the most direct influence on mood. Therefore, PO shows to be a construct which should be investigated when trying to improve mood.

1.4 The Dual-Process Model

Cognitive biases and psychological concepts, such as PO, have the ability to operate on an explicit or implicit level (Frankish, 2010), making it possible to improve mood. This can be further explained by the Dual-Process Model, which describes the human reasoning process and consists of two systems: System 1 and System 2 (Kahneman & Tversky, 1982, as cited in Frankish, 2010). System 1 is the older system that relies on heuristics and is fast, implicit, and driven by cultural stereotypes. System 2 is evolutionary more recent and analytic, rule-based, and explicit. It is, therefore, slower than System 1 while relying on personal beliefs rather than heuristics (Frankish, 2010). There also exists an interaction between the two systems since System 1 shapes and limits the conscious thinking of System 2. Implicit processes then not only have an influence on the way how people reason but also on their behaviour (Frankish, 2010). As System 1 works with stereotypes and attitudes, which activate automatically and operate on an implicit level, they are more difficult to change for people. They are unaware of these influences, making it hard for them to change. However, there is an opportunity to conquer the effects of these implicit processes on behaviour

(Frankish, 2010). Hence, there exist two systems which influence human reasoning processes, whereby the more unconscious System 1 can influence people's behaviour without them noticing it (Frankish, 2010). As System 1 has a great influence on the person, which is difficult to change alone, this implicit level should be further investigated.

Multiple biases have been found, which are related to the implicit System 1. One such cognitive bias, related to the self-concept, is the concept of implicit self-esteem (Krause et al., 2011). Thereby, *implicit self-esteem* relates to self-evaluations that occur automatically, compared to deliberate evaluations taken by assessing explicit self-esteem (Krause et al., 2011). Depending on whether people possess high or low implicit self-esteem, the way they view themselves and their future changes (Bosson et al., 2003). It was found that people high in explicit and implicit self-esteem only moderately show such self-enhancement tendencies, whereas people high in explicit but low in implicit self-esteem rate themselves and their future more favourable and successful (Bosson et al., 2003). These findings, which at first seem to contradict, are in line with other research, which found that underlying self-doubts are tried to be masked by overly positive, explicit, self-evaluations which is often seen in narcissistic people (Bosson et al., 2003). Overall, this demonstrates that implicit processes related to the self-concept can influence people to a great extent, which is why attention needs to be directed towards it.

1.5 Implicit PO

The concept of PO can also be measured implicitly. Explicit PO can be measured by filling out questionnaires but the risk is that participants tend to give answers that are socially desirable (Hai et al., 2014). By measuring PO on an implicit level, this problem can be tackled as people are not aware of this implicit influence compared to the influence of explicit PO (Costantini et al., 2019). The implicit level of PO can be seen as a cognitive bias that some people have. Biases can influence people without them being aware of the influence. An example of such a bias would be the Positive Memory Bias, which leads people to evaluate past experiences and behaviour of themselves more positively than it originally occurred, to maintain their well-being (Adler & Pansky, 2020). In this study, the Cognitive Bias Modification training will try to strengthen the implicit PO for the participants by changing the underlying self-concept in a positive direction, as it is assumed to be able to sufficiently change such implicit processes. Additionally, the aim is to strengthen it for people who do not have such a self-serving bias as the Positive Memory Bias.

As PO can influence people on an implicit level, the focus of this paper will be on

implicit PO. It may even be able to shape behavioural choices as seen in the study by Laurens et al. (2020), who focused on a different implicit bias and helped participants with drinking problems to lower their alcohol consumption after completing the intervention. Implicit PO can influence various aspects of people's life such as evaluating themselves or their behaviour (Hai et al., 2014). Therefore, implicit PO might have the ability to turn its short-term benefits on mood into long-term benefits for the students. Thus, implicit PO will be investigated, as it is promising to show valid responses, as well as having a positive influence on the participants' self-concept.

1.6 Cognitive Bias Modification and Implicit Association Test

Using a *Cognitive Bias Modification* (CBM) might help train and strengthen implicit PO. CBM is developed to train and change different kinds of biases (Jones & Sharpe, 2017). CBM targets automatic processes like attention or interpretation and is thereby able to shape biases (Jones & Sharpe, 2017). Recent studies already show that unconscious processes, like alcohol addiction, can be treated with such a CBM (Laurens et al., 2020). Therefore, training students to acquire implicit PO by letting them use CBM training can be the first step in helping them to acquire a positive mood and them being able to better cope with any stressors they might experience. By letting students do the CBM training via a mobile phone, they have the opportunity to do it in their own time and place (Jones & Sharpe, 2017). Thus, CBM can be a promising approach to train participants in acquiring implicit PO.

To check if implicit PO is fully trained, an *Implicit Association Test* (IAT) can be used (Costantini et al., 2019). The IAT is a measurement tool which can be used broadly. In the context of this study, the IAT is used with the categories of "self vs others", which detects the unconscious self-concepts of the participants, free from socially desirable answers and reactions (Greenwald et al., 1998). This can be done by checking the response time for certain concepts, meaning that strongly associated concepts will result in lower reaction times, and weakly associated concepts in higher reaction times (Egloff & Schmukle, 2002). Thus, using CBM and IAT might be beneficial ways to train and investigate implicit PO.

1.7 The TIIM App as a Training Method

To sufficiently train implicit PO, the TIIM App, with its integrated CBM platform, is used in the experiment to carry out the CBM training. The goal of the mobile CBM app is to modify the self-identity biases of the participants. Wolbers et al. (2021) gave breast cancer patients the opportunity to use such an application alongside their treatment and it was shown that it had positive effects on their well-being. The goal was to let patients identify themselves with vitality rather than fatigue. They achieved this by representing two two-dimensional

concepts: “Self and Others” and “Vitality and Fatigue”. The task for the patients then was to swipe words related to vitality into the “Self and Vitality” category and words related to fatigue into the “Others and Fatigue” category (Wolbers et al., 2021). As the goal of this study is to strengthen implicit PO, the concept of “Vitality” will be substituted with “Positivity”. Thereby, words related to positivity, such as “confident”, will be presented to the participants, while “Fatigue” will be replaced with “Negativity” and words associated with it. Overall, this will help to modify the self-identify bias of the students by changing their self-concept in a positive direction.

Second, participants are trained in approach-avoidance responses. Laurens et al. (2020) used this approach for patients with alcohol-drinking problems. In that study, patients had to swipe pictures of alcoholic drinks upward on their cell phones. This resembles the avoidance response, as patients are learning to push alcohol away from them. The approach response had the patients swipe pictures of non-alcoholic drinks downward on their phones, resembling the act of pulling more healthier options towards themselves (Laurens et al., 2020). In this study, the approach-avoidance response is changed to make the CBM platform suitable for training the participants in requiring implicit PO.

An existing intervention based on social anxiety will be used and adjusted as a blueprint to make the CBM platform suitable for this purpose. Therefore, the CBM platform will contain words related to PO in a positive and negative way, such as “confident” and “insecure” respectively. The goal is to change implicit PO by relating positive words towards oneself and negative words towards others. The approach-avoidance principle is applied by letting participants swipe positive words down on their phone screen, where the “Self and Positivity” category is displayed, and negative words are swiped upwards. This creates the motion of pulling positive words towards the participants, while negative words are pushed away. By doing this training, the association between “myself” and positively oriented words, should strengthen the implicit PO for the participants. This paper will investigate whether the training with the TIIM App and its integrated mobile CBM platform can influence the implicit PO levels of the participants. It will also be checked if CBM has an impact on mood and whether this relationship might be mediated by the change in implicit PO levels. Thus, the CBM platform is thought to be a suitable tool to help students identify themselves with positive stimuli.

1.8 Study Overview

The goal of this study is to find a potential solution to help students overcome

negative moods. Other interventions exist, which tried to improve the mood of students by letting them interact with pets such as dogs or by trying to include frequent yoga classes in their schedule at school (Grajfoner et al., 2017, Felver et al., 2014). Even though these interventions significantly improved the mood of the students, it becomes clear that such interventions are out of scope to realise for the majority of students and schools. Therefore, a need arises for a simple intervention from which the majority of students can sufficiently benefit even outside of their school schedule.

As implicit PO influences not only the mental but also the physical health of many people, it is relevant to study its effects more deeply (Alessandri et al., 2012). As students are an at-risk group for decreased health behaviours such as alcohol consumption, it is important to also find solutions which address their problems (O'Hara et al., 2014). This study tries to fill the gap by providing novel insights into how CBM can be effectively used to positively change the self-concept of participants towards implicit PO. CBM may be an effective tool to train such implicit processes in a positive direction (Amir et al., 2009). However, literature concerned with implicit PO is barely available until now. To add more knowledge to the literature, it will be checked if implicit PO can be trained and, if acquired, can influence mood in a way from which students can benefit.

An additional aim is to decrease the resulting difficulties from a negative mood, including factors such as decreased mental health and health behaviours. To decrease these difficulties, it is tried to enhance the mood of the students. This study aims to check if CBM training with the CBM platform can increase the implicit PO level of participants and whether this increase will then lead to an enhanced mood and ultimately to increased mental well-being and healthier behaviour. More studies need to be conducted, which assess the mediational effects of implicit processes on well-being factors such as mood (Wiers et al., 2011). Therefore, this study fills the gap in literature by providing insight into the effects of implicit PO on mood, as a psychological construct.

To assess if these effects will occur through the training, participants will be assigned to different groups. First, an intervention group completes the pre-and post-test measurements and the training, and second, a control group fills out the pre-and post-tests without receiving any training. As it was shown that students might benefit from interventions by increasing their mood and strengthening their implicit PO, they will be the sample in this study. To check if the experiment with the training has an effect on the mood level of the intervention group, the Patient Health Questionnaire-9 (PHQ-9) will be given to the participants in a pre- and post-test design. While this should measure the explicit mood level, the IAT will measure

PO on an implicit level. Overall, the aim is for participants to acquire a higher level of implicit PO as well as a better mood at the end of the intervention.

1.9 Research Questions and Hypotheses

The research questions that need to be answered in this paper are the following: (1) Does CBM training with the CBM platform have an effect on implicit PO and on mood? (2) Does the increase in implicit PO mediate the effect of CBM on mood?

Based on the reviewed literature, it is expected that CBM training with the CBM platform leads to an increase in implicit PO in the intervention group compared to the control group, post-training (H1). Next, it is expected that post-training, students from the intervention group will show a better mood than at baseline and in comparison to the control group (H2). Lastly, it is hypothesised that the effect of CBM on mood is mediated by the change in implicit PO (H3).

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 mood.

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 data which could be used in the analysis. This included three participants from the intervention group and one from the control group. No further exclusion was done. Thus, the intervention group consisted of 28 participants and the control group out of 22 participants. 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's 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 where students receive tokens for their participation, 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 in order 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 PHQ-9

A negative mood can be linked to depression and can therefore be sometimes also considered as a depressed mood (Marvin, 2011). To assess this type of mood, Spitzer, Williams, and Kroenke developed the PHQ-9. This questionnaire contains nine items, for which participants need to indicate how often they have experienced relevant symptoms over the last two weeks. The items are based on the DSM-IV criteria used to assess depression and include statements like "Over the last two weeks, how often have you been bothered by the problem of having little interest or pleasure in doing things?". Participants then answered these items by indicating a score on a scale from zero (not at all) to three (nearly every day). This scale was used as it is suited for the general population and because it can be self-administered without formal training (Marvin, 2011). However, the instruction of the scale was adopted to fit this study. The PHQ-9 scale asks participants about their thoughts and feelings during the last two weeks. As this study involves a shorter time frame, the instruction was changed to asking them about their thoughts and feelings during the last few days. The PHQ-9 can give more insight into the student's moods and can be filled out fast which suits the busy life of the students (Saliba et al., 2012).

Previous research has shown that the PHQ-9 has a high internal consistency with Cronbach's Alpha of $\alpha = .86$ and $\alpha = .89$, as well as a threshold for an increased negative mood indicated by a score of ten, which states a transition from a mild to moderate negative mood (American Psychological Association, 2011). In this study, the internal consistency of the PHQ-9 scale was analysed to ensure that the results are valid and reliable. For the participants, the PHQ-9 scale showed good internal consistency at baseline (Cronbach's $\alpha = .84$). As there exists a negative association between the severity of negative mood and health-related aspects such as mental health (Martin et al., 2006), this draws the line back to the decreasing mental health of students due to negative moods, which is why the PHQ-9 is a useful tool for this study.

2.3.2 Measuring Implicit PO with the PO-IAT

Implicit PO was measured using an 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 "I" 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 and blocks six and seven collectively. The resulting mean value of the two quotients was considered the index value or d-score, which indicates 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 blocks three/four), while a negative d-score indicated a stronger association between themselves and negative concepts (shorter reaction times in blocks six/seven). 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 CBM platform of the TIIM Application. As the CBM 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 platform. This suggests that the app is 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 positively towards 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 the State-Trait Anxiety Inventory (STAI), the Life Orientation Test-Revised (LOT-R) 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 implicit 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 STAI, LOT-R, PSS, PHQ-9 and the PO-IAT.

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 the 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 data obtained in this study was analysed using the statistical computer program RStudio (Version 4.3.0). In the first step, the data was scanned for missing values and participants who did not finish the first IAT were excluded from the data analysis. Afterwards, the descriptive statistics of the data set were analysed to get an overview of the data at hand. To be able to compare the intervention- and control group, the data was split according to these groups. After this general preparation of the data set, including renaming the variables to have a better overview, the implicit PO scores were analysed to check, whether there exists a change between before and after the intervention and between the two groups. After checking the assumptions, a two-way mixed ANOVA and a post-hoc test were conducted. The Kruskal-Wallis test was conducted to confirm the results non-parametrically.

In the following analysis, it was checked whether mood increases for the intervention group after the training. After turning the variables of Treatment and Measurement into factor variables, the assumptions for an ANOVA test were checked. Afterwards, a two-way mixed ANOVA was conducted.

In the last step of the data analysis, it was checked if the effect of the CBM training on mood is mediated by the change in implicit PO. First, the assumptions needed for a mediation analysis were checked. The mediation analysis was run by creating two linear regression models. The last step involved a causal mediation analysis, in which the change in implicit PO was treated as the mediator. The significance of the mediation effect was tested using the lm() function provided in RStudio with non-parametric bootstrap Confidence Intervals of 95%.

3. Results

3.1 Descriptive Statistics

The data sets' descriptive statistics were investigated and are presented in Table 2. It can be noted that the observed mean mood score for the total sample was positive at baseline (M = 6.79) and slightly improved after the intervention (M = 5.78). The same can be noted for the implicit PO score, which improved from M = .52 before the intervention to M = .68 after the intervention, for the total sample. The hypotheses were tested in the next step to get more insight into the different variables.

Table 2

Descriptive Statistics of Mood Scores and Implicit PO Scores with N = 50

	Minimum	Maximum	Mean	Std. Deviation
Total mood score pre-test	0	24	6.79	5.01
Total mood score post-test	0	24	5.78	4.06
Pre-test d-score	-.30	1.19	.52	0.37
Post-test d-score	.11	1.24	.68	0.03

Note. n = number of participants, d-score = implicit PO score, Std. = Standard, Minimum and Maximum for the total mood scores are related to the possible scores of the scale.

3.2 The CBM Training Effect on Implicit PO and Mood (RQ1)

Implicit PO (H1): First, five assumptions were checked on the data to ensure reliable outputs for the following ANOVA analysis. Three assumptions were clearly met: the data was normally distributed, and the homogeneity of variance, as well as the homogeneity of covariance, was ensured. However, the assumption of sphericity was violated and there were some outliers found in the data, three of these in the intervention group and one in the control group (see Appendix C). Despite that, the values observed were not extreme.

The results of the ANOVA showed a significant main effect of the between-subject effect of treatment ($F(1,34) = 5.16$, $p = .03$), indicating a significant difference in the mean implicit PO scores between the intervention- and control group. However, there was no significant main within-subject effect ($F(1,34) = 1.03$, $p = .32$), indicating no significant difference in mean implicit PO scores for the whole sample between pre-and post-test measures. Lastly, the interaction between treatment and measurement was found to be marginally significant at $\alpha < .05$, $p < .10$ ($F(1,34) = 3.35$, $p = .08$). For an overview of the

results see Table 3. A Kruskal-Wallis test confirmed the significant main effect of condition of the ANOVA non-parametrically $\chi^2(1) = 7.45$, $p = .006$.

Table 3

Results of Two-Way Repeated Measures ANOVA Examining the Effects of Treatment and the Change in Implicit PO on Score with N = 36

Effect	DFn	DFd	F	p	ges
Treatment	1	34	5.17	.03*	.09
Change in Implicit PO	1	34	1.03	.32	.01
Treatment x Change in Implicit PO	1	34	3.35	.08	.03

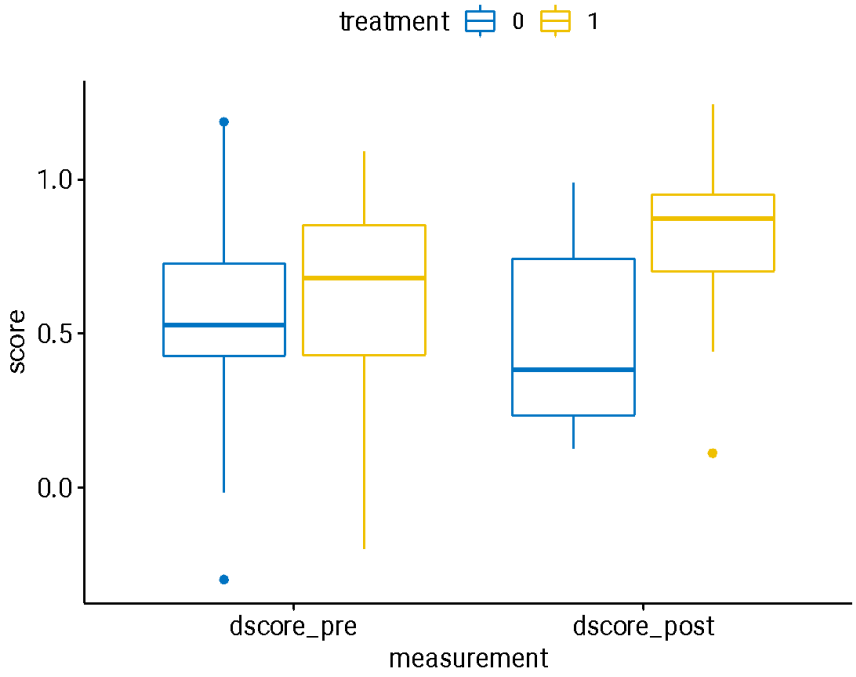
Note. DFn = degrees of freedom numerator, DFd = degrees of freedom denominator, F = F-value, p = p-value, ges = generalised eta squared, Treatment coded with 1 = intervention group, 0 = control group, Change in implicit PO = t0 – t1, * = significant.

After the multivariate ANOVA test of the whole model, a post-hoc test was conducted to get more insight into the differences between the groups and conditions and to check the simple effects. The results indicated a significant positive difference in implicit PO scores after the intervention between the intervention- and control group ($p = .002$), with the intervention group showing a mean implicit PO score of .81 ($SD = 0.27$) and the control group showing a mean of .49 ($SD = 0.28$). Additionally, the test showed a significant difference between the pre-and post-test on the implicit PO score in the intervention group ($p = .03$). Thus, the intervention group showed a larger increase in implicit PO levels after the intervention, while the control group showed no significant change over time. All *p*-values have been adjusted for multiple comparisons, meaning that the results of the ANOVA and the post-hoc test remain significant.

This increase in implicit PO after the CBM training is in line with the expected effect. Therefore, it can be concluded that the bias is corrected towards a more positively oriented self-concept. However, since the interaction effect in the ANOVA analysis remained marginally insignificant, the first hypothesis can only be partially accepted. A visualisation of the findings is displayed in Figure 1.

Figure 1

Boxplot with the Mean Implicit PO Scores for the Intervention- and Control Group Pre-and Post-Test



Note. n = 50, treatment 0 = control group, treatment 1 = intervention group, score = dscore, measurement = time point of observed dscore.

Improved Mood (H2): To check whether mood increased after the training, in the intervention group compared to baseline levels and the control group, a two-way mixed ANOVA test and a post-hoc tests were conducted. At first, the assumption check revealed that the data showed homogeneity of covariances, as well as independence. However, the assumption of normality was violated, and the data showed two outliers in the second mood measurement but without being severe (see Appendix C).

Next, the two-way mixed ANOVA was run, and the results are displayed in Table 4. Overall, none of the main effects or interaction effects were statistically significant.

Table 4

ANOVA Results for the Effect of Treatment and Measurement on Mood Scores with N = 36

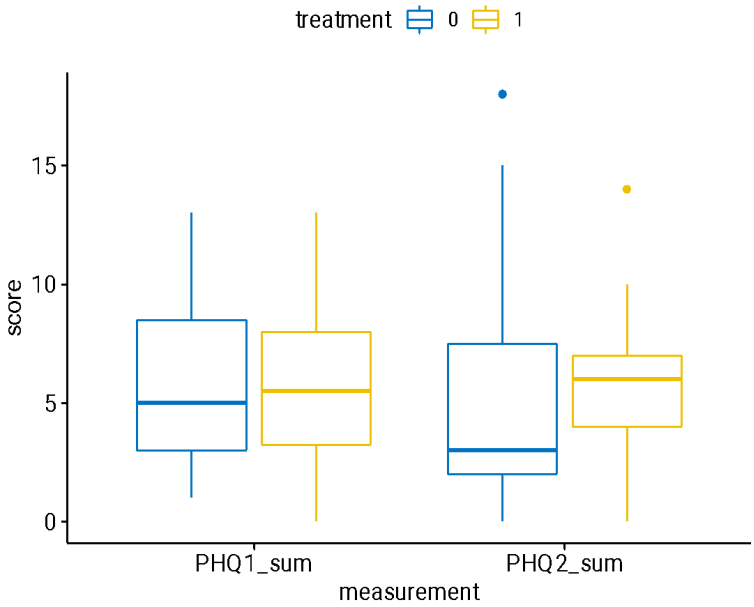
Effect	DFn	DFd	F	p	Partial eta-squared
Treatment	1	35	.01	.94	.0002
Measurement	1	35	.24	.66	.001
Treatment x Measurement	1	35	.12	.74	.0004

Note. DFn = degrees of freedom numerator, DFd = degrees of freedom denominator, F = F-statistics, p = p-value.

These results showed that there was no significant improvement in mood levels in the intervention group after the intervention and compared to the control group. Figure 2 shows a visualisation of the results. Hence, the model showed no effect. Therefore, the second hypothesis is rejected.

Figure 2

Boxplot with the Mean Mood Scores for the Intervention- and Control Group Pre-and Post-Test with n = 50



Note. PHQ1_sum = mood scores measured pre-test with the PHQ-9 scale, PHQ2_sum = mood scores measured post-test with the PHQ-9 scale.

3.3 The Mediation Effect of CBM on Mood by an Increase in Implicit PO (RQ2)

Change in Implicit PO as a Mediator (H3): To test the last hypothesis, the

assumptions needed for a mediation analysis were checked. Six assumptions were met: the normality of residuals, the absence of outliers, the absence of multicollinearity, the assumption of linearity, the independence of residuals, and homoscedasticity (see Appendix C).

To start the mediation analysis, it was first checked whether there is a significant relation between the intervention and the change in implicit PO level. The results revealed that there is a marginally significant relationship between the intervention and the mediator of change in implicit PO (a = .24, p = .08). However, it should be noted that the significance holds not true at the conventional level ($p < .05$), being consistent with the findings from RQ1.

The next step in the mediation analysis was to check whether the intervention and the change in implicit PO have an effect on the mood levels. The results showed that neither the direct effect of the intervention on mood (c' = .02, p = .99) nor the direct effect of implicit PO on mood (b= -1.58, p = .18) is significant. Hence, mood was not significantly influenced by either of the two variables.

At last, a causal mediation analysis was run to investigate the mediation effect of the change in implicit PO on the relationship between the intervention and mood (c = -.30, p = .74). The finding suggests that the intervention has no effect on mood through the mediator "change in implicit PO", as all p-values were greater than .05 (see Table 5).

Table 5

Causal Mediation Analysis

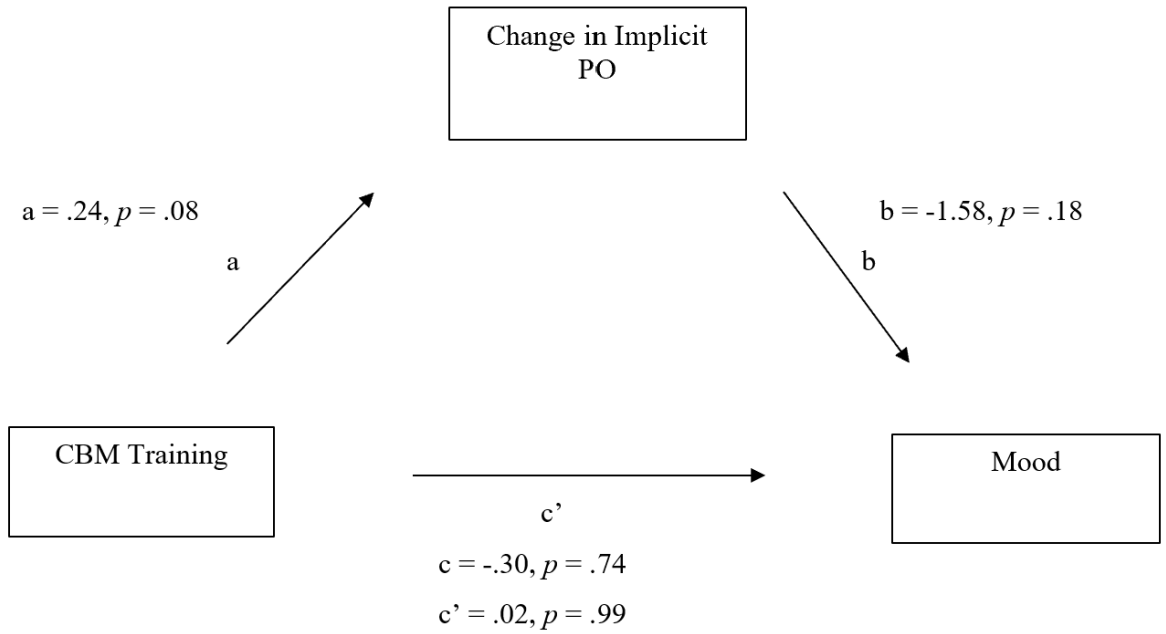
	Estimate	95% CI Lower	95% CI Upper	p-value
ACME	-.38	-1.31	.11	.17
ADE	.02	-1.75	1.75	.94
Total Effect	-.36	-2.13	1.37	.71
Prop. Mediated	1.04	-6.09	5.38	.69

Note. ACME = Average Causal Mediation Effect, path c'; ADE = Average Direct Effect, path c; CI = Confidence Interval.

To conclude, the mediation analysis showed a weak positive relationship between the intervention and the mediator change in implicit PO, which is consistent with the test for RQ1 (see Figure 3). However, these variables do not have an effect on mood. Additionally, it was revealed that the change in implicit PO is not a significant mediator on the effect on mood of the intervention. Therefore, hypothesis three can be rejected.

Figure 3

Mediation Analysis with Pathway Outcomes



Note. This figure illustrates the estimate coefficients and significance for the relationship between the CBM training and mood mediated by the change in implicit PO. a = estimate between CBM training and change in implicit PO, b = estimate between change in implicit PO and mood, c = indirect effect, c' = direct mediational effect between CBM training and mood mediated by change in implicit PO.

4. Discussion

This study aimed to investigate the effect of a mobile CBM app on implicit PO in university students, to gain more insight into CBM training and the novel concept of PO. Furthermore, it was tested whether the training consisting of six sessions over three days can positively change the mood of students. This was intended to be done by strengthening implicit PO to let students associate themselves with positivity rather than negativity. It was expected that training the implicit self-concept towards PO will lead to an increased positive mood for the participants, which is thought to benefit them in their academic performance and promote overall well-being and positive health behaviours. This study adds knowledge to the existing literature, as evidence in this domain is still lacking when it comes to investigating the concept of PO and, especially, its implicit counterpart. Additionally, this study adds evidence on simple interventions suitable for students to implement in their daily lives outside of school.

This study provides a first indication of how implicit PO can be strengthened through CBM. Thereby, the CBM training shows to be partially effective in modifying the cognitive bias of implicit PO. Hence, after the training, participants' self-concept is positively modified,

indicated by a stronger implicit PO level. However, in this study, implicit PO did not show any effects on the psychological construct mood. Participants' moods did not enhance after the training and the increase in implicit PO did also not mediate the mood levels.

4.1 Discussing the Research Questions

This study provides preliminary evidence that a brief CBM training can correct the implicit self-concept for the PO bias in a positive direction. This is in line with the findings of previous studies, which were able to show that CBM is an effective tool to target certain biases and unconscious processes (Jones & Sharpe, 2017; Wolbers et al., 2021). The intervention was able to modify the implicit PO of participants to a certain degree. Thus, even within a healthy sample, which is thought to have an average to high implicit PO level, a training response was found.

Improved Mood: The effect of this change in implicit PO was not yet visible on the psychological construct mood. However, this was assumed, as the facets of PO, namely Optimism, life satisfaction and self-esteem, are correlated with an increase in a positive mood (Segerstrom et al., 1998), indicating a first possibility for implicit PO to also improve mood. A possible explanation for the results might be the design of this study and the fact that participants already scored low on negative mood, indicating that a ceiling effect might biased the results. The design, especially the time frame in which the study took place, might be an explanation for why the mood levels did not increase for the participants in the intervention group. Participating in a training for three days with six sessions might not be enough time for the improved implicit PO to alter other cognitive or behavioural processes, which will then sufficiently show improvements in, for example, mood and health behaviour. Other studies in the field of CBM used a time frame of four weeks, incorporating eight sessions (Amir et al., 2009). Other researchers claim that a single session of CBM can effectively target the bias to be changed (Jones & Sharpe, 2017). However, the effects then were not found to be lasting when trying to improve mood (Koster & Hoorelbeke, 2015). While this study showed that a training of three days with six sessions is possible to change implicit PO to some degree, it had no effects on mood, as it is assumed that the bias is not strengthened enough.

Additionally, the issue of adherence should be taken into account. There exists the possibility that many participants did not complete all the required sessions indicated by participants who dropped out during the study. Therefore, the effects found in this study may be the result of less exposure than six sessions. This makes it challenging to find a suitable time for a follow-up measurement of mood. Other studies, using a different CBM method, have shown that participants from a clinical sample show changes in mood one week after the

CBM (Blackwell & Holmes, 2010). Indicating that a post-test directly after the intervention might not be suitable but too soon to reveal any delayed mood changes arrived from the intervention. Hence, improving the design of the study would, therefore, be necessary to improve the mood of the students. The aforementioned explanation also accounts for the fact that, for this sample, the change in implicit PO acts not as a mediator in the relationship between the CBM training and mood.

4.3 Implications

This study revealed a first insight into how implicit PO can be altered with a CBM training. The findings show that implicit PO, together with CBM training, is an interesting topic which deserves more research and attention in the future. By conducting more research in this direction, the findings can be of value to society and especially students, who were the target group in this study. Strengthening mood in students has positive effects, such as improving their academic performance (Bryan et al., 1996). Additionally, a positive mood for students can even lead to better health outcomes (Segerstrom et al., 1998). If future studies adopt the CBM training approach and make it useful for the purpose of improving such psychological constructs, students can benefit from a simple and effective intervention. This is in line with previous research, which revealed that CBM training is an effective, yet simple and inexpensive tool that can be used flexibly (Wolbers et al., 2021). Hence, designing implicit Online Positive Psychology Interventions to help students to deal better with difficulties and to overcome them by improving their mood, should be an important goal for future studies.

Another implication is concerned with underlying biases that might influence implicit PO. As PO is a novel concept, less literature is available about insight into such processes. In this study, the focus was on how a self-concept, changed into a positive direction, can influence mood positively. However, this effect was not found, which might be due to the focus on the self-concept bias. Costantini et al. (2019) state that a positive bias in self-evaluation can enhance the implicit and explicit PO levels of participants. While this study added marginally significant evidence to their findings by strengthening implicit PO through a self-concept modification, the effect this should have on mood was not found. In literature, other biases are known, which can influence people unconsciously (Amir et al., 2009). Related to mood, studies have shown that a CBM targeting an interpretation bias can effectively increase it (Koster & Hoorelbeke, 2015). Probing participants to interpret ambiguous situations positively instead of negatively, is therefore useful to increasing their mood and reducing the experience of depressive symptoms after a stressor in healthy

individuals (Koster & Hoorelbeke, 2015). Hence, targeting the self-concept bias might be useful to strengthen implicit PO, but it might not be suitable to also enhance mood. While there exists the theoretical possibility to enhance mood by strengthening PO (Segerstrom et al., 1998), more research is needed to confirm whether it is possible to also enhance mood through a change in implicit PO. This study revealed the first insight into implicit PO and whether mood can be changed by focusing on the self-concept of the participants. Future studies to expand on the results, as it is now known that a different underlying process related to implicit PO might be more sufficiently able to improve mood.

4.4 Strengths and Limitations

One of the study's strengths is the topic under investigation. The concept of implicit PO and how it can be strengthened through CBM is a topic for which rarely literature is available. There are findings in the literature, which are concerned with the theoretical aspect of PO, such as defining the concept and finding appropriate methods to measure it like the PO-IAT (Costantini et al., 2019). This study aimed to expand this field of knowledge by applying these theories to training, which can be implemented in the daily life of the participants. Therefore, this study revealed the first practical use of implicit PO together with a CBM.

Additionally, the results of the study are thought to be robust. It was shown that implicit PO was indeed marginally positively changed for the intervention group. This effect stayed significant when compared to the control group. The comparison with a control group allows the results to be more valid. Another aspect, which makes the results more robust is the generalisability of findings across different platforms that the participants used. Overall, this study fills the gap in the literature on the topic of implicit PO and CBM, for which future studies can add to design further research to test its effectiveness.

Nex to its strengths, there are also limitations of this study, which might have influenced the outcome. First, the exposure to the treatment for the participants was outside of the control of the researchers. Hence, participants needed to do the training by themselves without concrete guidance and feedback from a researcher. Therefore, it cannot be verified that all the participants followed the intervention according to the instructions, which might have led to an underestimation of the results. Additionally, no correction was made for other events that participants may have experienced during the study, which might have influenced their mood. The effect of the intervention could have been undermined by events such as stressful exam periods or other difficult personal circumstances for the students. Future research should keep this in mind and account for such confounding variables by asking

participants if any severe event happened over the intervention, which might have influenced their answers on the scales like the PHQ-9. Lastly, the sample size estimation was not met. It should be noted that based on the sample size, it is questionable whether the statements hold also true for the general population. Another issue related to the sample size is the lack of statistical power to test the hypotheses. Even though a small potential effect was found, it is likely that the other hypotheses had to be rejected while being significant. As the study dealt with a smaller sample size, caution should be applied to dismiss results as non-significant. Future research should test the hypotheses with a larger sample, using the sample size estimation calculation, to reveal potentially significant results for their specific study. Lastly, it was observed that participants dropped out during the study. This could lead to potential overestimations of treatment outcomes. It is therefore important to get insight into the reasons why participants dropped out. As the sample in this study consisted of a diverse group of students, it can be assumed that the reasons to drop out were random. However, this is just an assumption and future studies should examine the exact reasons to be able to design the training more sufficiently and tailored to the target group.

At last, another limitation regarding the sample exists. This study involved healthy participants instead of a clinical sample. As they already showed to more positive mood at baseline, the room for improvement by the intervention was limited. Therefore, the potential that a CBM might have in this context, was not fully reached and investigated. Hence, not only is a bigger sample needed in future studies, but also a sample consisting of people with complaints about their mood. Only by implementing these options, possible significant results can be generalisable and yield insight into how well a CBM can improve mood by strengthening implicit PO. Other recommendations for future research based on the strengths and limitations of this study will be presented in the following section.

4.5 Recommendations

A topic of interest for future research should be the conceptualisation of PO. In this study, it was defined as a concept which represents life satisfaction, optimism, and self-esteem (Costantini et al., 2019). In this paper, the facet of Optimism was of importance as it can positively influence mood (Segerstrom et al., 1998), which resembles the goal of this study. As PO is a relatively new concept, the question prevails over what it actually is and if studies are able to change it. It is essential to better understand this concept in order to develop interventions, which can effectively retrain this bias. One way to do so would be to investigate the correlations of the different facets and whether it is possible to put them under one term. Assessing these facets and correlations can yield more insight into what PO and

implicit PO are and how exactly they work. Only by fully understanding this concept, interventions can be designed to effectively apply this abstract concept to concrete situations and training methods from which other people, such as students, can benefit.

Another topic that should be addressed by future research is the time frame of the study. As the intervention lasted for three days and included six sessions, it is assumed that this was not enough time to allow implicit PO to reveal its effect on mood. Additionally, it is recommended to conduct the follow-up investigation not directly after the intervention. Thus, future research should add to the evidence provided in this study and design an intervention, which allows the change for psychological constructs and allows implicit PO to be strengthened more by, for example, adjusting the time frame of the intervention and including more sessions. This will reveal more insight into the question if implicit PO has the ability to act as a mediator in a relationship with a psychological construct.

4.6 Conclusion

Overall, it can be concluded that the concept of implicit PO for students in the intervention group can be positively changed. This can be achieved through CBM training within the TIIM App, which includes the CBM platform. However, the training and the alteration in implicit PO were not able to influence the mood of the students. As the study revealed some insights into this direction of research, more studies in the future with different methods and designs are needed. This will not only ensure the replicability of the results, but it will also lead to more insight into the area of implicit PO and, which designs are the most useful to make positive changes possible for the participants who are using the mobile CBM app. This can lead to potential advantages for its users, such as benefitting from the impacts of a more positive mood. This study serves to be a first draft to investigate, how implicit PO interventions can be conducted.

References

Adler, O., & Pansky, A. (2020). A "Rosy view" of the past: Positive memory biases. *Cognitive Biases in Health and Psychiatric Disorders*, 139–171. https://doi.org/10.1016/b978-0-12-816660-4.00007-6

Alessandri, G., Caprara, G. V., & Tisak, J. (2012). The unique contribution of positive orientation to optimal functioning. *European Psychologist*, *17*(1), 44–54. https://doi.org/10.1027/1016-9040/a000070

American Psychological Association. (2011, January). *Patient health questionnaire (PHQ-9 & PHQ-2)*. American Psychological Association. Retrieved March 28, 2023, from https://www.apa.org/pi/about/publications/caregivers/practice-settings/assessment/tools/patient-health

Amir, N., Beard, C., Burns, M., & Bomyea, J. (2009). Attention modification program in individuals with generalized anxiety disorder. *Journal of Abnormal Psychology*, *118*(1), 28–33. https://doi.org/10.1037/a0012589

Barnes, C., & Mongrain, M. (2019). A three-factor model of personality predicts changes in depression and subjective well-being following positive psychology interventions. *The Journal of Positive Psychology*, *15*(4), 556–568. https://doi.org/10.1080/17439760.2019.1651891

Blackwell, S. E., & Holmes, E. A. (2010). Modifying interpretation and imagination in clinical depression: A single case series using cognitive bias modification. *Applied Cognitive Psychology*, *24*(3), 338–350. https://doi.org/10.1002/acp.1680

Bosson, J. K., Brown, R. P., Zeigler-Hill, V., & Swann, W. B. (2003). Self-enhancement tendencies among people with high explicit self-esteem: The moderating role of implicit self-esteem. *Self and Identity*, *2*(3), 169–187. https://doi.org/10.1080/15298860309029

Brown, J. D., & Mankowski, T. A. (1993). Self-esteem, mood, and self-evaluation: Changes in mood and the way you see you. *Journal of Personality and Social Psychology*, *64*(3), 421–430. https://doi.org/10.1037/0022-3514.64.3.421

Bryan, T., Mathur, S., & Sullivan, K. (1996). The impact of positive mood on learning. *Learning Disability Quarterly*, *19*(3), 153–162. https://doi.org/10.2307/1511058

Brydon, L., Walker, C., Wawrzyniak, A. J., Chart, H., & Steptoe, A. (2009). Dispositional optimism and stress-induced changes in immunity and negative mood. *Brain, Behavior, and Immunity*, *23*(6), 810–816. https://doi.org/10.1016/j.bbi.2009.02.018

Choi, D., Lee, H. K., & Kim, D. Y. (2023). Mood management through Metaverse Enhancing Life Satisfaction. *International Journal of Consumer Studies*. https://doi.org/10.1111/ijcs.12934

Costantini, G., Perugini, M., Dentale, F., Barbaranelli, C., Alessandri, G., Vecchione, M., & Caprara, G. V. (2019). Assessing positive orientation with the implicit association test. *European Journal of Psychological Assessment*, *35*(1), 109–116. https://doi.org/10.1027/1015-5759/a000362

Egloff, B., & Schmukle, S. C. (2002). Predictive validity of an Implicit Association Test for assessing anxiety. *Journal of personality and social psychology, 83*(6), 1441. https://doi.org/10.1111/acer.12281

Felver, J. C., Butzer, B., Olson, K. J., Smith, I. M., & Khalsa, S. B. (2014). Yoga in public school improves adolescent mood and affect. *Contemporary School Psychology*, *19*(3), 184–192. https://doi.org/10.1007/s40688-014-0031-9

Frankish, K. (2010). Dual-process and dual-system theories of reasoning. *Philosophy Compass*, *5*(10), 914–926. https://doi.org/10.1111/j.1747-9991.2010.00330.x

Grajfoner, D., Harte, E., Potter, L., & McGuigan, N. (2017). The effect of dog-assisted intervention on student well-being, mood, and anxiety. *International Journal of Environmental Research and Public Health*, *14*(5), 483. https://doi.org/10.3390/ijerph14050483

Greenwald, A. G.; McGhee, D. E.; Schwartz, J. L. K. (1998). *Measuring individual differences in implicit cognition: The implicit association test.. , 74(6), 1464-1480.* https://doi.org/10.1037/0022-3514.74.6.1464

Hai, K., Devos, T., & Dunn, R. (2014). Mixed aspirations: Distinctions and relationships between the implicit and explicit self-concepts of college women. *Self and Identity*, *13*(5), 535–555. https://doi.org/10.1080/15298868.2013.879537

HarperCollins Publishers Ltd. (2023). *Negative mood definition and meaning: Collins english dictionary*. Negative mood definition and meaning | Collins English Dictionary. Retrieved February 17, 2023, from https://www.collinsdictionary.com/dictionary/english/negative-mood

Hoffmeister, J., Basso, M. R., Reynolds, B., Whiteside, D., Mulligan, R., Arnett, P. A., & Combs, D. R. (2021). Effects of diminished positive mood and depressed mood upon verbal learning and memory among people with multiple sclerosis. *Journal of Clinical and Experimental Neuropsychology*, *43*(2), 117–128. https://doi.org/10.1080/13803395.2020.1853066

Ingram, J., Maciejewski, G., & Hand, C. J. (2020). Changes in Diet, Sleep, and Physical Activity Are Associated With Differences in Negative Mood During COVID-19 Lockdown. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.588604

Jones, E. B., & Sharpe, L. (2017). Cognitive bias modification: A review of Meta-analyses. *Journal of Affective Disorders*, *223*, 175–183. https://doi.org/10.1016/j.jad.2017.07.034

Koster, E. H., & Hoorelbeke, K. (2015). Cognitive bias modification for depression. *Current Opinion in Psychology*, *4*, 119–123. https://doi.org/10.1016/j.copsyc.2014.11.012

Krause, S., Back, M. D., Egloff, B., & Schmukle, S. C. (2011). Reliability of implicit self–esteem measures revisited. *European Journal of Personality*, *25*(3), 239–251. https://doi.org/10.1002/per.792

Leiner, D. J. (2016). SoSci Survey (Version 3.4.10) [Computer software]. Available at https://www.soscisurvey.de

Laurens, M. C., Pieterse, M. E., Brusse-Keizer, M., Salemink, E., Ben Allouch, S., Bohlmeijer, E. T., & Postel, M. G. (2020). Alcohol avoidance training as a mobile app for problem drinkers: Longitudinal Feasibility Study. *JMIR MHealth and UHealth*, *8*(4). https://doi.org/10.2196/16217

Martin, A., Rief, W., Klaiberg, A., & Braehler, E. (2006). Validity of the brief patient health questionnaire mood scale (PHQ-9) in the general population. *General Hospital Psychiatry*, *28*(1), 71–77. https://doi.org/10.1016/j.genhosppsych.2005.07.003

Marvin, A. K. (2011, November 1). *Patient health questionnaire (PHQ-9)*. Strokengine. Retrieved March 7, 2023, from https://strokengine.ca/en/assessments/patient-health-questionnaire-phq-9/#Clientsuitability

Mehta, K. J. (2022). Effect of sleep and mood on academic performance—at interface of physiology, psychology, and Education. *Humanities and Social Sciences Communications*, *9*(1). https://doi.org/10.1057/s41599-021-01031-1

Nosek, B. A., Greenwald, A. G., & Banaji, M. R. (2005). Understanding and using the Implicit Association Test: II. Method variables and construct validity. *Personality and Social Psychology Bulletin*, *31*(2), 166-180. https://doi.org/10.1177/0146167204271418

O'Hara, R. E., Armeli, S., & Tennen, H. (2014). Drinking-to-cope motivation and negative mood–drinking contingencies in a daily diary study of college students. *Journal of Studies on Alcohol and Drugs*, *75*(4), 606–614. https://doi.org/10.15288/jsad.2014.75.606

Pieterse, M. E., & Bode, C. (2018, August 21-25). Cognitive bias modification to relieve fatigue symptoms: preliminary results from a self-identity fatigue IAT [Conference session]. In Psychology, Health & Technology. Paper presented at the 32nd EHPS Conference, Galway, Ireland.

Proyer, R. T., Gander, F., Wellenzohn, S., & Ruch, W. (2014). Positive psychology interventions in people aged 50–79 years: Long-term effects of placebo-controlled online interventions on well-being and depression. *Aging & Mental Health*, *18*(8), 997–1005. https://doi.org/10.1080/13607863.2014.899978

Saliba, D., DiFilippo, S., Edelen, M. O., Kroenke, K., Buchanan, J., & Streim, J. (2012). Testing the PHQ-9 interview and observational versions (PHQ-9 OV) for MDS 3.0. *Journal of the American Medical Directors Association*, *13*(7), 618–625. https://doi.org/10.1016/j.jamda.2012.06.003

Schweizer, K., Beck-Seyffer, A., & Schneider, R. (1999). Cognitive bias of optimism and its influence on psychological well-being. *Psychological Reports*, *84*(2), 627–636. https://doi.org/10.2466/pr0.1999.84.2.627

Segerstrom, S. C., Taylor, S. E., Kemeny, M. E., & Fahey, J. L. (1998). Optimism is associated with mood, coping, and immune change in response to stress. *Journal of Personality and Social Psychology*, *74*(6), 1646–1655. https://doi.org/10.1037/0022-3514.74.6.1646

The BMS Lab. (2023, March 27). *Twente Intervention and Interaction Machine (TIIM) - BMS LAB — Where Technology Meets Life*. BMS LAB — Where Technology Meets Life. https://bmslab.utwente.nl/equipment-facilities-and-services/software-of-the-lab/twente-intervention-interaction-machine-tiim/

Thompson, B. L., Waltz, J., Croyle, K., & Pepper, A. C. (2007). Trait meta-mood and affect as predictors of somatic symptoms and life satisfaction. *Personality and Individual Differences*, *43*(7), 1786–1795. https://doi.org/10.1016/j.paid.2007.05.017

Wächtler, M. W. (2019). *Testing Cognitive Bias Modification with the IVY Training App on Fatigue Self-Concept in Explicit and Implicit Vitality* [Bachelor Thesis]. University of Twente.

Wiers, R. W., Eberl, C., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2011). Retraining automatic action tendencies changes alcoholic patients' approach bias for alcohol and improves treatment outcome. *Psychological Science*, *22*(4), 490–497. https://doi.org/10.1177/0956797611400615

Wiers, R. W., Rinck, M., Kordts, R., Houben, K., & Strack, F. (2010). Retraining automatic action-tendencies to approach alcohol in hazardous drinkers. *Addiction*, *105*(2), 279–287. https://doi.org/10.1111/j.1360-0443.2009.02775.x

Wolbers, R., Bode, C., Siemerink, E., Siesling, S., & Pieterse, M. (2021). Cognitive Bias Modification Training to Improve Implicit Vitality in Patients With Breast Cancer: App Design Using a Cocreation Approach. *JMIR formative research, 5*(3), e18325. https://doi.org/10.2196/18325

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:

Name Researcher	*E-mail*
Aishe Bingöl	xxx@student.utwente.nl
L. L.	xxx@student.utwente.nl
R. N.	xxx@student.utwente.nl
L. W.	xxx@student.utwente.nl
M. P. (supervisor)	xxx@utwente.nl

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'

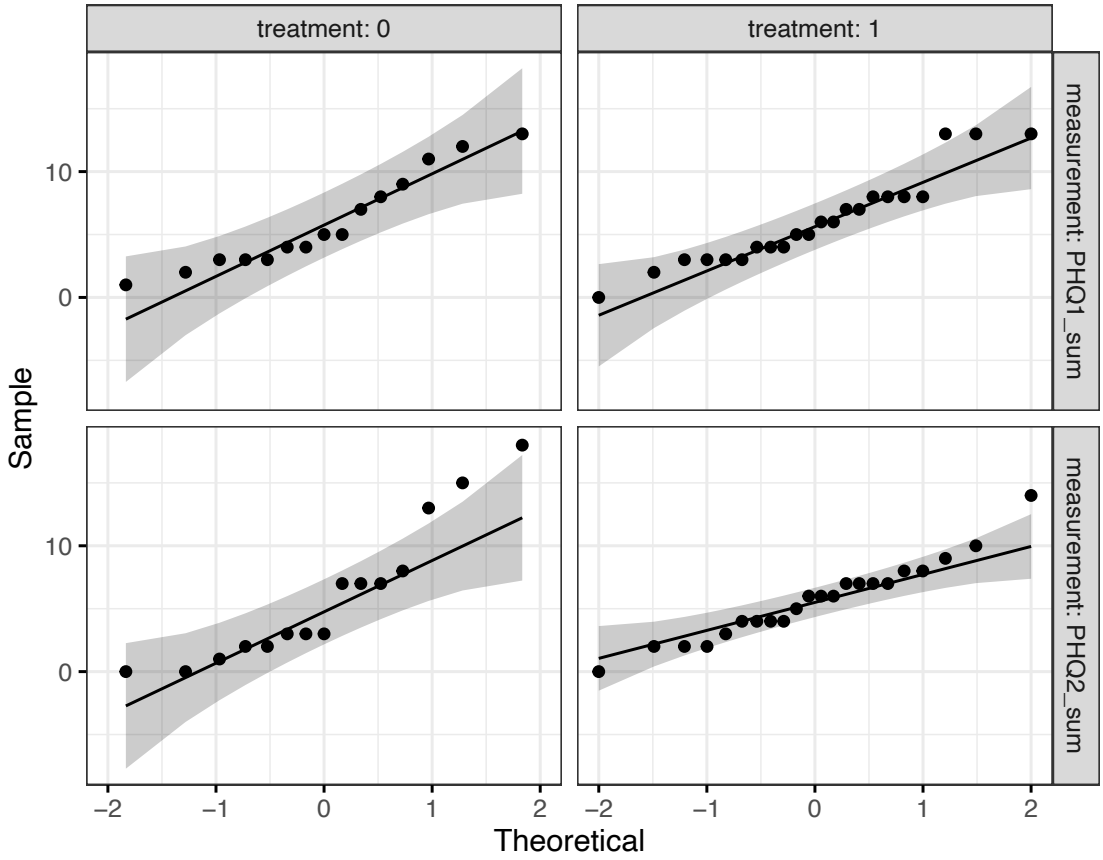
- Others
- Them
- They
- Their

Appendix C

Assumption Check

Hypothesis 1

Normality Assumption



Assumption of Homogeneity of Variance

measurement	df1	df2	statistic	p
<fct>	<int>	<int>	<dbl>	<dbl>
1 dscore_post	1	34	0.267	0.609
2 dscore_pre	1	34	0.0117	0.914

Assumption of Homogeneity of Covariances

```
> box_m(data_PO[, "score", drop = FALSE], data_PO$treatment)
# A tibble: 1 × 4
```

statistic	p.value	parameter	method
<dbl>	<dbl>	<dbl>	<chr>
1 0.0114	0.915	1	Box's M-test for Homogeneity of Covariance Matrices

Assumption of Sphericity

$ANOVA

	Effect	DFn	DFd	SSn	SSd	F	p
1	(Intercept)	1	34	26.57435456	4.692593	192.543459	1.458070e-15
2	treatment	1	34	0.71247381	4.692593	5.162201	2.952678e-02
3	measurement	1	34	0.07646694.	2.525612	1.029404	3.174647e-01
4	treatment:measurement	1	34	0.24882362	2.525612	3.349684	7.599635e-02

	p<.05	ges
1	*	0.78639661
2	*	0.08983768
3		0.01048257
4		0.03332298

Hypothesis 2

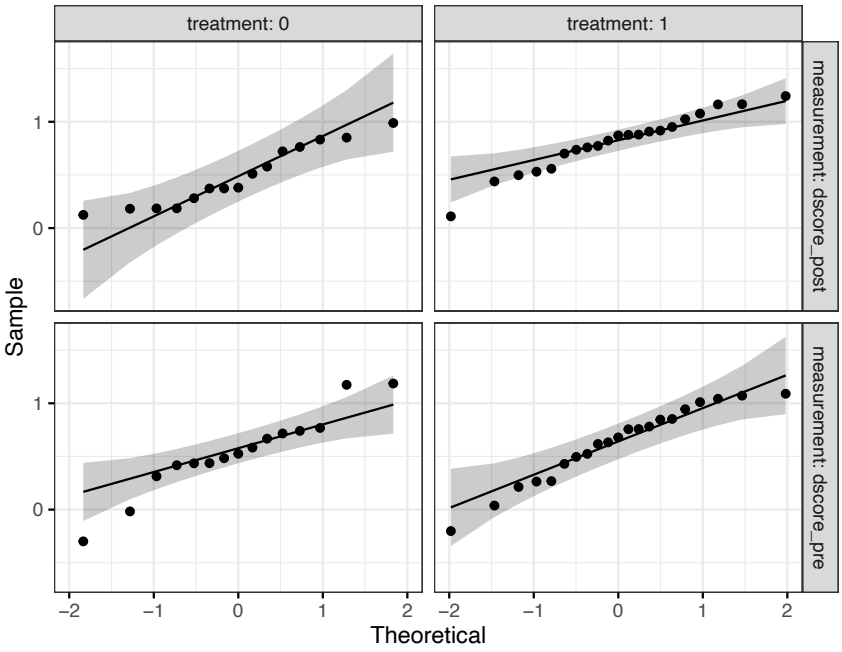
Assumption of Homogeneity of Covariances

```
> box_m(data_mood[, "score", drop = FALSE], data_mood$treatment)
# A tibble: 1 × 4
  statistic     p.value parameter method
      <dbl>   <dbl>     <dbl>       <chr>
1      4.12    0.0425         1       Box's M-test for Homogeneity of Covariance Matrices
```

Assumption of Sphericity

```
$ANOVA
                 Effect DFn DFd        SSn       SSd           F             p
1           (Intercept)   1  35 2496.5136773 995.6485 87.75986710 4.547997e-11
2             treatment   1  35  0.1893530  995.6485  0.00665632  9.354405e-01
3           measurement   1  35  0.8257166  119.0121  0.24283310  6.252448e-01
4 treatment:measurement   1  35  0.3932842  119.0121  0.11566004  7.358227e-01
  p<.05         ges
1     * 0.6913301551
2       0.0001698462
3       0.0007402302
4       0.0003527042
```

Normality Assumption



Hypothesis 3

Normality & Independence of Residuals Assumption

of residuals

Shapiro-Wilk normality test

data: residuals

W = 0.97164, p-value = 0.4545

Absence of Outliers Assumption

No Studentized residuals with Bonferroni p < 0.05

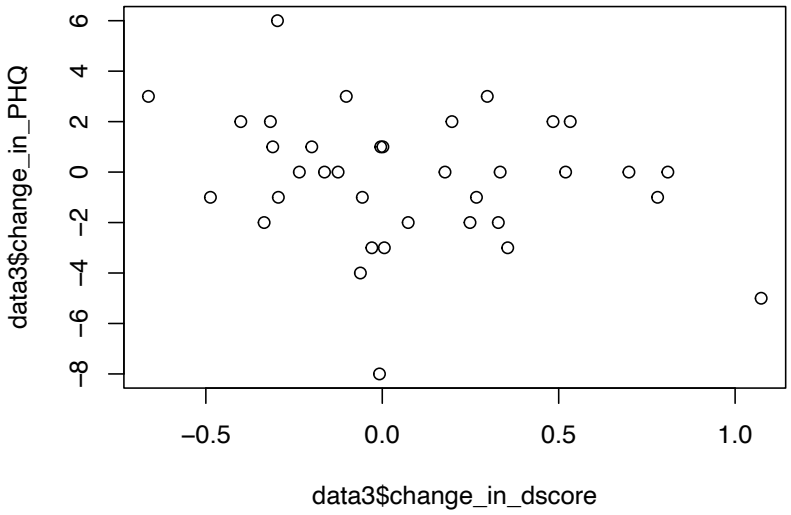
Largest |rstudent|:

	rstudent	unadjusted p-value	Bonferroni p
21	-3.426281	0.0016165	0.059811

Absence of Multicollinearity Assumption

```
> cor(data3[, c("change_in_dscore", "treatment")])
                change_in_dscore treatment
change_in_dscore        1.0000000 0.2994735
treatment               0.2994735 1.0000000
```

Linearity Assumption



Homoscedasticity Assumption