

**Cognitive Bias Modification training to reduce social anxiety
using the Implicit VitalitY app (IVY)**

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A bachelor's thesis

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Abstract

This study researched the effect of Cognitive Bias modification on social anxiety. Affective empathy and implicit bias were researched to determine whether they had a moderating and mediating effect respectively. Participants (N = 22) were asked to fill in the LSAS before and after the CBM training to measure the change in self-reported explicit social anxiety. The Implicit Association Test was used to measure implicit bias also before and after the training. Affective empathy was only measured once at baseline through a subscale of the QCAE. It was hypothesized that CBM would reduce social anxiety and that affective empathy and implicit bias would have a moderating and mediating effect. CBM showed an insignificant effect on social anxiety ($p = 0.444$) and both affective empathy ($p = 0.167$) and implicit bias ($p = 0.469$) showed insignificant results after the moderation and mediation analyses. Implicit bias scores did change marginally significantly after the CBM training ($p = 0.094$). The results indicated that CBM training did not significantly improve social anxiety and affective empathy and implicit bias did not have a significant interaction on this effect. The main limitation of this study was the sample size due to many drop-outs (29 drop-outs out of 51). Technical issues were probably one of the main reasons for the number of drop-outs and for further studies the issues need to be resolved. It is concluded that further research is necessary to determine whether CBM can improve social anxiety. To tailor the training for every individual, researching the effect of personality traits on effectiveness is recommended.

Background

The prevalence rate of anxiety disorders in western countries such as the Netherlands are the highest compared to other disorders such as mood or substance related disorders (Baumeister & Härter, 2007). Within the domain of anxiety disorders, social phobia is the most common disorder. The prevalence rate of 7,1% of social anxiety in adults (Anxiety and Depression Association of America, 2020) only seems to increase rather than decrease, especially in students (Storrie, Ahern, & Tuckett, 2010). Of the students receiving counselling services, 41.6% of them are treated against anxiety (ADAA, 2020). These numbers are concerning, especially for young adults who often are students. Common symptoms reported include stress, sleepless nights due to worry, feeling depressed, and being unhappy (Dunley & Papadopoulou, 2019). The effects of mental illness are noticeable in many aspects of life, as mentally ill people on average perform worse in school, have a higher unemployment rate, and have a higher probability of substance use (Nami, 2022).

People with mental illness often feel ashamed to share their issues and therefore not always look for help they need (Kosyluk et al., 2016). The perceived stigma of people with mental illness is that the public views them negatively. Stigma being defined as an attribute or behavior, which is socially discrediting and results in that individual being perceived as unfavorable or abnormal by society (Vidourek & Burbage, 2019). This perceived stigma is being a barrier to many, as 36% of students with mental illness report that stigma is the main reason for not seeking care (Kosyluk, et al., 2016). Without treatment, recovery is not as likely, unless one is highly skilled in coping with their own emotions (Storrie, Ahern, & Tuckett, 2010). It seems like even though mental health services are provided for students, the services remain underutilized (Dunley, 2019).

As social anxiety is a common disorder which often is not treated in a clinical setting, it is interesting to look for a different approach. Generally, individuals diagnosed with social anxiety disorder are characterized by having an intense fear during social situations and tend to avoid such situations (American Psychiatric Association, 2021). Often, individuals with social anxiety do not recover spontaneously and therefore the symptoms persist and can become chronic (Grant et al., 2005). Cognitive behavioral therapy (CBT) is currently the first-line treatment (Leichsenring & Leweke, 2017). However, for CBT to be effective commitment and self-efficacy of the client is necessary (Urech et al., 2018). In addition, the relationship between client and therapist seems to be of importance (Urech et al., 2018). Since socially anxious people may even be too anxious to visit a therapist, they may get stuck and

not get treated. So, the effectiveness and reach of CBT is influenced by multiple factors, which may be difficult to adjust and require time and effort.

To increase the rate of socially anxious people seeking help, accessibility to services need to increase outside the clinical setting (Purdon, Antony, Monteiro, & Swinson, 2001). On a personal level, a manner of increasing the rate of help seeking, is to make it accessible in a non-clinical setting. In a cross-sectional survey of Atas and Celik (2019), university students reported to use their phones 4,74 hours a day on average. In addition to the rising awareness of social anxiety, a smartphone application can be used (Pescosolido, 2013). In an attempt to treat implicit cognitive biases, the eHealth application IVY was created (Wolbers et al., 2021). The IVY app utilizes Cognitive Bias Modification (CBM) and is easily accessible on a smartphone. eHealth interventions are convenient due to their low-cost, accessibility, and incomplexy (Deady et al., 2017). eHealth interventions can be applied in a smartphone application or computer. Especially the accessibility makes it effective to treat social anxiety in a comfortable setting, for example at home. There is evidence for eHealth being an effective tool to reduce anxiety (Deady et al., 2017), this will be further explored in this study.

There are two theories that explain the mechanisms of social anxiety, which determine the type of intervention used. Social anxiety can be approached as an implicit cognitive process or be explained by a regular more explicit cognitive model (Tanner, Stopa, & de Houwer, 2006). Clark and Wells (1995) propose a cognitive model which explains that socially anxious people make dysfunctional assumptions that are causing the feeling of fear or threat of social situations. Clark and Wells (1995) identified three categories of assumptions: excessively high standards for social performance, conditional beliefs concerning social evaluation, and unconditional beliefs about the self-implicit cognitive biases are thought patterns that lead to one's self-view to be biased, in this case as socially anxious. These assumptions are expressed when socially anxious people encounter a social situation. Other cognitive-behavioural models on social anxiety have similar basics to Clark and Wells (Mobini, Reynolds, & Mackintosh, 2013). So, cognitive models indicate that selective or biased negative appraisals of the self, cause the feeling of anxiety.

In CBT for anxiety the explicit cognitive processes as explained are generally emphasized. However, there is evidence to think that social anxiety is affected by more of an implicit cognitive process. The accumulation of the feeling of social anxiety could lead to a self-schema being developed of a socially anxious person (Wolbers et al., 2021). These self-schemas are rooted in the implicit system. Negative cognitive biases can be developed which play a key role in maintaining social anxiety in a person (Mobini, Reynolds, & Mackintosh,

2013). The difference with more explicit cognitive models like mentioned, is that an individual is often not aware of the implicit biases.

This implicit associations between of the self and anxiety can be measured by conducting an Implicit Association Task (IAT). In the IAT participants are asked to classify positive and negative words. The idea behind the IAT is that response times between positive and negative words, show implicit associations towards a concept (Tanner et al., 2006). This can be used to measure implicit bias towards social interactions. In a study of Egloff and Schmukle (2002), they attempted to validate the IAT for assessing anxiety, and evidence was found that both explicit and implicit anxiety could be predicted based on the IAT. So, above self-reporting questionnaires for anxiety, the IAT is a reliable tool to measure anxiety. If the cognitive bias is implicit, one's self-concept may also be distorted, in this case as socially anxious.

These implicit biases can refer to biases in interpretation and attention (Amir, Bomyea, & Beard, 2010). These biases affect each other, as reducing negative interpretation bias likely decreases attentional bias (Mobini, Reynolds, & Mackintosh, 2013). Attentional biases seem to be more of an automatic information processing, while interpretation biases are more consciously processed (Beck & Clark, 1997). There is evidence that these two types of implicit biases affect social anxiety (Mobini, Reynolds, & Mackintosh, 2013). To treat the implicit biases a different treatment is necessary than CBT. A technique used to correct maladaptive implicit biases is the Cognitive Bias Modification. CBM has the goal of breaking the biases, this is done by retraining thought patterns (Macleod & Mathews, 2012). CBM attempts to treat the self-schemas or other schemas that are rooted in the implicit cognition. In multiple studies on CBM to treat social phobia and general anxiety results were positive (Beard, 2014). These studies were mainly on implicit attentional bias, such as selectively attending to negative facial expressions in a group compared to positive facial expressions (Beard, 2014). Such biases create a world that is threatening. Therefore, it can be assumed that a similar training also affects social anxiety positively.

As evidence of the effectiveness of CBM in mental health is still emerging, we need a better understanding of the underlying mechanisms. One potential variable that could impact the scores on social anxiety is empathy. In a meta-analysis it can be seen that higher empathy scores correlate with higher social anxiety scores (Pittelkow, Rot, Seidel, Feyel, & Roest, 2021). The underlying mechanism that could explain this effect seems to be that highly empathic people can get overwhelmed by someone else's emotions and become distressed in early adolescence (Gambin & Sharp, 2016). People who are in such maladaptive distressed

states can fail in social interactions, which could lead to rejection. Therefore, high levels of empathy could contribute to the development or maintenance of social anxiety and various other disorders like depression, which seems to be a linear correlation (Tully, Ames, Garcia, & Donohue, 2014).

In the literature a distinction is described between affective empathy and cognitive empathy. Affective empathy describes the experience of emotion elicited by another person's emotional experience, and cognitive empathy is the ability to recognize and identify emotional states of others (Pittelkow et al., 2021). It seems like only affective empathy has an association with social anxiety (Morrison et al., 2016). In the current state of scientific research there is no significant evidence to believe that scores on affective empathy change by age (Cuff, Brown, Taylor, & Howat, 2016). In addition, empathy is often conceptualized as an 'ability' or 'capacity' which suggests that it is stable across time (Cuff et al., 2016).

To study the effect of empathy on social anxiety, it has to be determined whether empathy has a mediating effect (state-dependent) or a moderating effect (trait like). As, empathy is regarded as a stable trait, it would make sense to consider it a moderator. However, there are arguments to see empathy as a mediator. CBM leads to implicit cognitive control over emotions (Maclead & Mathews, 2012), but affective empathy is likely to not be affected according to the previous research, since the literature generally describes affective empathy as a trait and suggests that training does not significantly change affective empathy (Gambin & Sharp, 2016). So, even though CBM leads to more implicit cognitive control, participants are unlikely to feel less empathic after the training. An argument to support high affective empathy individuals to be more sensitive to implicit bias is that highly affectively empathic individuals feel responsible for others' emotions. The accumulation of this experience creates an implicit self-schema which could lead to a feeling of rejection in social interaction (Cuff et al., 2016), which is essentially created by high empathy. Therefore, affective empathy is expected to be a variable in the process of implicit bias and that is why affective empathy will be regarded as a moderator.

Additionally, the relationship between empathy and self-reported social anxiety at baseline will be tested. Implicit bias will also be tested against self-reported social anxiety. This will test whether implicit bias plays a mediating role in the pre and post-test of social anxiety, as implicit bias is expected to change after the CBM training. So, this study will cover the effects of CBM on social anxiety through the IVY app to determine whether there is an effect. Affective empathy will also be measured and a potential moderating relationship between affective empathy and social anxiety will be measured. Lastly, the mediating effect

of implicit bias to self-reported social anxiety will be measured. This leads to the following research question: “To what extent can social anxiety be reduced through CBM training by using the IVY app and does empathy moderate the effects?”. It is hypothesized that after the CBM training participants will have a more positive social anxiety self-concept and empathy is a moderator of this effect. The second research question is as follows: “Is a change in implicit bias a mediator of the CBM training effect?”. Implicit bias is hypothesized to have a mediating effect between to the CBM training.

Methods

Design

An experimental within-subject design is employed in this study, with participants completing a pre-test, completing the IVY training, and subsequently completing a post-test. The effect of the IVY app on the dependent variables implicit SA and explicit SA is tested by comparing the pre- and post-test measures.

Participants

51 participants participated in the study. The participants were recruited via the University of Twente Sona Systems, where students acquire credits for participating, and by sharing it through friends and families. 29 participants did not complete either the pre-test or post-test, therefore they were excluded from the analysis and data were analyzed from 22 participants. Of those 22 participants, 9 participants were male (41%), 13 were female (59%). The mean age of the participants was 24,00 (SD=7,78), ranging from 18 to 56 years. Participants who have not completed the training fully can be compared to those who have completed the training fully. Since only 3 participants of the ones who finished the pre- and post-test did not finish the IVY training, the sample is too small to compare it to the completely finished group. So, only participants who entirely completed the pre- and post-test and the IVY training were included in the dataset. Participants gave informed consent prior to the study. Ethical approval was granted by the Behavioural, Management and Social Sciences Ethics Committee at the University of Twente (record number: 220370).

Materials

The materials used in this study were the questionnaires used to measure social anxiety and empathy. In addition, the IAT was used to measure implicit bias of social anxiety. Internal consistency of the IAT is 0.65 and is generally considered valid (Sriram & Greenwald, 2009). The IAT is an association test that shows two categories on the top and bottom of a display, in this case being “Socially anxious and Other” and “At ease and Me” and in the middle of the

display a word that is associated with one of the two categories. For example, the words ‘‘I’’ or ‘‘Relaxed’’ in the middle of the screen have to be swiped to the ‘‘At ease and Me’’ side and words like ‘‘Them’’ and ‘‘Nervous’’ have to be swiped to the ‘‘Socially anxious and Other’’ side. Soscisurvey calculates IAT scores as d-scores based on a specific formula for the IAT that is according to Sriram and Greenwald (2009). The d-score is a score between -2 and +2, with higher scores indicating a more positive self-concept of social anxiety. The questionnaires and the IAT were constructed with the use of soscisurvey, on which the items can be added and the layout can be edited. As this study is using eHealth, participants required a smartphone or computer to download the IVY application. For the data collection the Sona system was used, on which students were credited for participating. SPSS was used to analyze the data and measure effects.

The Liebowitz Social Anxiety Scale is used to measure social anxiety. This scale is commonly used in clinical settings and has significant data to support its validity (Mennin et al., 2002). The scale consists of 24 items that measures fear and avoidance of social situations over the past week (Rytwinski et al., 2009). 11 items are related to social interaction and 13 items are related to public performance. Each item is rated on a 4-point Likert scale, 0 = none, 1 = mild, 2 = moderate, and 3 = severe. Internal consistency of the LSAS is excellent, $\alpha = 0.90$ (Dos Santos, Loureiro, de Souza Crippa, & de Lima Osorio, 2013). Higher scores refer to higher fear or anxiety and avoidance (Rytwinsky et al., 2009). The total score is calculated by summing the fear and avoidance ratings. Total scores from 55-65 indicate moderate social anxiety, 65-80 marked social anxiety, 80-95 severe social anxiety, and 95+ very severe social anxiety (Cuncic, 2020).

Empathy was measured by a subscale of the Questionnaire of Cognitive and Affective Empathy (Reiniers, Corcoran, Drake, Shryane, & Völlm, 2010). The QCAE measures both cognitive and affective empathy, however only affective empathy is relevant for this study, therefore the cognitive part is excluded. This questionnaire is used because it explicitly distinguishes the definition of affective empathy from empathy in general, therefore it is suitable for this study (Reiniers et al., 2010). The subscale of the questionnaire consists of 12 items on feelings towards certain situations like: ‘‘I usually stay emotional detached when watching a film’’. Participants are asked to rate each situation on how strongly they agree with the statement. The 4 point likert scale contains the following ratings, 1 = Strongly Disagree, 2 = Slightly Disagree, 3 = Slightly Agree, and 4 = Strongly Agree. Internal consistency of the subscale is $\alpha = 0.72$ (Reiniers et al., 2010), which can be considered as valid. Some items are

phrased negatively and have to be reversed before the analysis. After reversing them, the total and mean scores can be calculated, with high scores indicating higher level of empathy.

Procedure

The procedure of the study started with participants finding the questionnaires through the Sona System for students, sharing from friends, and social media. Participants were first asked to sign the ethical approval, then the Implicit Association Test was performed to determine implicit social anxiety levels, this took around five minutes. The IAT consisted of seven blocks of 40 items that had to be swiped. Next, questionnaires to measure social anxiety and empathy are completed in around ten minutes. Participants were asked to download the IVY app on their smartphone in the Play Store and to create an account or use their University of Twente credentials. The CBM training was started afterwards, this took four days with 2 training sessions of three minutes each a day. Participants got a notification at the beginning of the day around 12:00 and after they have finished the first session of the day, 4 hours later they would get another notification. But participants can perform the training anytime they want. The training was similar to the IAT with participants having to swipe a word associated with social anxiety or at ease to the right category. When the word is swiped to the wrong category, it shows in red that the answer is wrong. Each training consisted of 120 items that had to be swiped to the right category, 60 items to the negative and 60 items to the positive association. Participants can do the training at any place they prefer, each session took around three minutes. Immediately after the final training sessions, participants were given a link in the app to perform the IAT and the questionnaire on social anxiety again.

Data Analysis

SPSS was used to conduct statistical analyses. Before conducting analyses, the dataset was corrected and cleaned. Negatively scored items were reversed and incomplete data were excluded from the dataset. As the first step, descriptive statistics were conducted in order to gain a general overview of the dataset. Descriptive statistics were conducted for the pre- and post-test measures of explicit subjective social anxiety, implicit bias towards social anxiety, and for the scores on the empathy scale. So, after calculating the median of affective empathy scores and the median of the difference of pre and post-test of implicit bias, the dummy variables were computed to conduct the moderation and mediation analysis respectively. The two groups can now be compared, high scorers and low scorers on affective empathy and implicit bias. Implicit bias is calculated through the IAT using the formula of Sririam and Greenwald (2009) which computes a d-score. The d-score is between -2 and +2, with a higher score indicating a more positive self-concept of social anxiety.

Furthermore, the mean scores of the pre- and post-test of social anxiety and implicit bias were compared in order to gain insight into the effect of the IVY training app. A paired sampled t-test is conducted to compare the means pre- and post-test of the d-scores and the pre- and post-test of social anxiety. The same analysis is conducted between affective empathy and explicit social anxiety, and implicit bias. Here the average scores of social anxiety and implicit bias of the pre- and post-test are used. A moderation analysis is conducted to determine the effect of empathy on scores of social anxiety. Because it is a within-subject analysis without a control group, with affective empathy as a moderator, a repeated measures analysis is conducted with anxiety scores of as a variable with two levels of time and affective empathy as the between-subject. Affective empathy is here a dichotomous variable, high and low affective empathy, based on the median.

To calculate the mediating effect of implicit bias on social anxiety, a mediation analysis is conducted because implicit bias is a third variable that is state like and thus is expected to change over time. To conduct the mediation analysis the difference between pre- and post-test d-scores need to be computed. These scores are then used as the covariate in the repeated measures analysis, similar to affective empathy, also a dichotomous variable is used based on the median. Furthermore, correlation analyses are conducted between the variables as both dichotomies and total scores to look for significant correlations between affective empathy and social anxiety or implicit bias. After having conducted the analyses the significance of the relationship between the variables can be determined. Outliers and extremes in the dataset are also discussed. Lastly, the consistency of the participants' following of the schedule of the training is analyzed. Participants who deviated from the schedule of 4 days and 2 trainings each day are discussed whether this could have been a limitation in the study.

Results

Table 1

Descriptive statistics of the anxiety scores, implicit bias scores, and empathy scores.

<i>Descriptive Statistics</i>					
	N	Minimum	Maximum	Mean	Std. Deviation
Total anxiety score pre-test	22	21,00	90,00	50,5455	20,00649
Total anxiety score post-test	22	20,00	88,00	48,3636	21,96002
Pre-test d-score	22	-,6780	1,0992	,294787	,4644086
Post-test d-score	22	-,3600	1,0793	,484132	,3871538
Total empathy scores	22	28,00	42,00	35,1818	4,40386

Table 2

Frequencies of social anxiety scores pre-test and post-test

Social anxiety score pre-test		
	Frequency	Percent
0-55	13	59,1
55-65	5	22,7
65-80	2	9,1
80-95	2	9,1
Total	22	100
Social anxiety score post-test		
	Frequency	Percent
0-55	14	63,3
55-65	2	9,1
65-80	4	18,2
80-95	2	9,1
Total	22	100

Pre- and post-test observed results

Social anxiety scores from 0 to 55 are considered not socially anxious, 55 to 65 moderately socially anxious, 65-80 marked socially anxious, 80-95 severely socially anxious. Explicit social anxiety scores of the pre-test ($M = 50.55$, $SD = 20.01$) and post-test ($M = 48.36$, $SD = 21.96$) were insignificantly different, $t(21) = 0.779$, $p = 0.444$, so the CBM training did not have a significant effect on social anxiety outcome. The correlation was found to be significant between the pre- and post-test of implicit bias, $r = 0,808$, $p < 0.001$. The means of the pre-test ($M = 0.294$, $SD = 0.464$) and post-test ($M = 0.484$, $SD = 0.387$) d-scores of implicit bias are marginally significantly different, $t(21) = -1.753$, $p = 0.094$, but the

correlation is insignificant, $r = 0.303$, $p = 0.171$. The CBM training did significantly improve implicit bias of social anxiety. Additionally, the correlation between affective empathy total scores ($M = 35,18$, $SD = 4,40$) and explicit social anxiety at baseline ($M = 0.294$, $SD = 0.464$) is insignificant, $r = 0.214$, $p = 0.339$. Affective empathy as a dichotomy was found to be significantly different from explicit social anxiety at baseline, $t(21) = 11.814$, $p < 0.001$. Lastly, the correlation between affective empathy total scores and implicit bias at baseline is also insignificant, $r = -0.117$, $p = 0.606$.

Mediation and moderation analysis

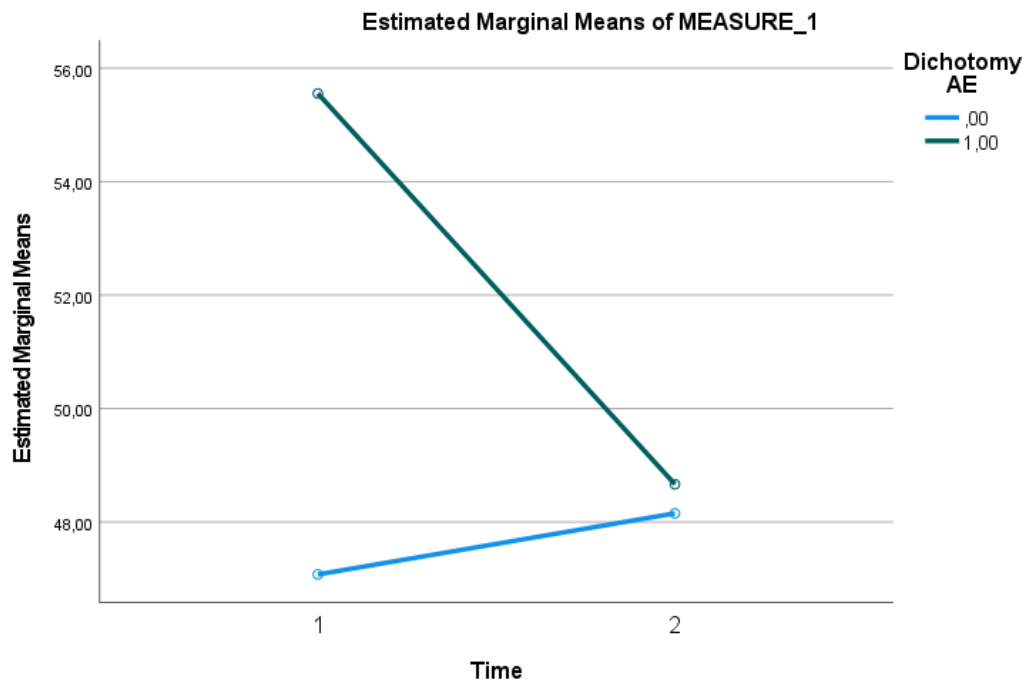
This analysis consisted of the moderation of affective empathy and the mediation analysis of implicit bias. To measure the effect of the third variables on social anxiety scores a repeated measures analysis is conducted with time as a factor and the pre- and post-test scores of social anxiety as variables. The mediation analysis with implicit bias (post d-score – pre d-score) as a covariate resulted in an insignificant effect, $F(1,1) = 0.546$, $p = 0.469$. The effect of time on social anxiety in the mediation analysis is insignificant too, $F(1,1) = 0.594$, $p = 0.450$. Analysis of dichotomous baseline affective empathy as a moderator on the change in social anxiety from pre to post presented insignificant results, $F(1,1) = 2.055$, $p = 0.167$ (Figure 1). Time is found to be an insignificant variable in the moderation analysis, $F(1,1) = 0.259$, $p = 0.616$. So, according to the results affective empathy and implicit bias had a statistically insignificant moderation and mediation effect on the CBM training.

Outliers in the dataset

There were some outliers in the data that show extreme change between the pre- and post-test. One participant scored 63 in the pre-test on social anxiety and improved to 26 in the post-test. The same participant showed a change in implicit bias from d-scores 0.556 to 0,461, which suggests a more negative self-concept bias towards social anxiety. Another participant scored 50 points in the pre-test on social anxiety and 76 in the post-test. The latter participant had an increase of d-score from -0.229 to 0.345. This shows a more positive implicit bias in the post-test. These two participants are examples of inconsistency between the observed changes in implicit bias and explicit social anxiety. Additionally, in the IVY dataset the consistency of participating in the CBM training was tracked. It can be seen that some participants have performed the training not according to 4 days with 2 trainings each day.

Figure 1

Moderating effect of affective empathy



Discussion

The focus of this study was to determine whether a CBM training through the IVY app helped participants to reduce their social anxiety. This was done by conducting the IAT to determine implicit bias on social anxiety, asking participants to fill in the questionnaires and exposing them to the CBM training. Furthermore, the moderating effect affective empathy and the mediating effect of implicit bias was analyzed. In addition, the relationship between affective empathy and social anxiety at baseline were tested. Both hypotheses that after the CBM training participants would have reduced social anxiety and that affective empathy plays a moderating role and implicit bias as a mediator cannot be confirmed, since there were no statistically significant effects found in all analyses. Meaning that CBM training did not significantly affect the participants' social anxiety and that the affective empathy and implicit bias did not significantly moderate or mediate the effect. A significant difference in mean scores was found between affective empathy and social anxiety at baseline (pre-test), suggesting that higher scores of affective empathy can predict higher scores of social anxiety.

Implicit bias scores were higher in the post-test compared to the pre-test, meaning that participants on average had a more positive association of themselves in regards to social anxiety after the CBM training. Even though the mean d-scores were insignificantly different

between the pre- and post-test, they were slightly more positive which suggests a trend. In the meta-analysis of Hallion and Ruscio (2011) similar results were found, CBM did have a significant effect on implicit bias. CBM was found to have a slight effect on explicit social anxiety, but only when the participant showed symptoms (Hallion & Ruscio, 2011). The results of this study using IVY suggest that there is no effect of CBM on explicit social anxiety. The nature of this study made that most participants were not particularly high scorers on social anxiety, which could explain why no significant effect is found. To further study the effect of CBM on social anxiety, a sample of high scorers and low scorers on social anxiety is necessary.

The further insignificant results are possibly caused by inconsistent participation in the training. So, even though the training was scheduled as 4 days of training with 2 trainings each day, some participants may have deviated from this schedule. Participants may have ignored the notifications or due to technical errors did not receive notifications. Evidently, it is possible that the CBM training is not effective in treating social anxiety, however further research is necessary to draw conclusions. Furthermore, the insignificant moderating effect of affective empathy is interesting to look at. It was hypothesized that there would be a small effect, based on previous research. Empathy was found to have a potential effect on implicit bias. Highly empathic individuals tend to have stronger associations of higher self-reflection and a ruminative thinking style, which are related to a more negative implicit self-concept of anxiety (Knight, Stoica, Fogleman, & Depue, 2019). This study using IVY found a similar trend, but the correlation was insignificant. So, there is a trend that can be observed, however there is perhaps a lack of validity in the measures. This trend is in line with previous research (Pittelkow et al., 2021).

When looking at the data, it can be seen that some outliers show massive differences in self-reported social anxiety, which is unlikely to be caused by the training and makes reliability of the data somewhat doubtful. It can also be argued that self-reported anxiety is a snapshot of the state in which the participant is in. Literature suggests that anxiety is composed of a trait and state dimension (Endler, Parker, Bagby, & Cox, 1991). The LSAS does not clearly distinguish between state and trait dimensions of anxiety, merely fear and avoidance (Schmits, Heeren, & Quertemont, 2014). The LSAS is however, a well-established scale that is commonly used in various settings. So, the state of the participants may have affected the reliability of the results, but an unambiguous conclusion cannot be drawn.

Similarly, a few participants showed extreme changes in implicit bias from pre-test to post-test. Previous research shows mixed evidence on the validity of the IAT. Schmukle and

Egloff, (2004) found promising results, the IAT might be a valid tool to measure state anxiety and trait anxiety. On the other hand, Karpinski and Hilton (2001) did not find a relationship between IAT scores and explicit assessment of those attitudes. Karpinski and Hilton (2001) did not specifically test for anxiety, perhaps the validity of IAT depends on the concept it is assessing. Therefore, the tendency to support IAT as a valid measurement is stronger. Another potential explanation for some of the extreme changes in scores is the lack of trying to react as quick as possible. Since there is no observer when the participants are performing the IAT, they may be unmotivated to score high.

When looking at the insignificant results of the mediation analysis, the significance of implicit bias as a mediator is considerably low. This suggests that according to this study implicit bias cannot be accounted for the difference of the pre- and post-test on social anxiety. Affective empathy does not have a significant moderating effect too, but the p-value is considerably lower than implicit bias. This could suggest that affective empathy can be accounted for some of the effect. The subscale used for measuring affective empathy was found to have acceptable internal consistency (Reiniers et al., 2010). The lack of significance of the effects may be caused by the lack of retaining participants.

Considering 51 participants started the pre-test, 22 participants who completed the entire study is quite slim. The drop-outs did not seem to have much different scores on the pre-test compared to the participants who did completely finish the study. So, the larger sample would probably not affect the trend, but would add significance to the data. A possible reason for the number of drop-outs may be the technical side of the study. Quite a few participants made remarks on some technical issues, complaints from a screen freezing when performing the training in the IVY app or not getting notifications anymore after the first day of training were common. These technical issues has given the participants struggles which led to drop-outs. To effectively research CBM a control group and a sample with high and low scorers of anxiety is necessary. That is one disadvantage of using an app on the smartphone, compared to clinical therapy. However, the accessibility of such an app makes it a desirable method.

For further research the technical issues need to be resolved to maintain validity and limit drop-outs. A potential addition to the questionnaires is to add a section on the mood of the participant in the moment. To prevent data from being invalid this needs to be taken into consideration also to limit extreme outliers. Resolving limitations of CBM with the IVY app or similar eHealth interventions is of major importance as this method of treatment, if conclusively found out to be effective, could treat many people with social anxiety. Finding

more variables like extraversion or agreeableness that explain for the effects of CBM is also necessary to tailor the CBM training to every individual's personality traits and current mental state. Currently, CBM training as an eHealth intervention is in development and the phenomenon of implicit bias and the effectiveness of CBM to treat social anxiety is still being researched.

Conclusion

Concluding, this study aimed to determine the effect of CBM on social anxiety. Results showed statistically insignificant improvement of social anxiety after the training. However, the trends were in line with previous research and the hypotheses. It seemed as if the small sample size prevented the study of finding significant results, with technical issues being of the reasons. Reproducing this study with two groups of high and low scorers on social anxiety could lead to more significant results. To account for the current anxiety state of the participant when filling in the questionnaire, adding items about distress levels at the moment of filling in the questionnaire are useful. Nevertheless, data suggested that social anxiety and implicit bias reduced, however CBM cannot be accounted for the effect in this study. So, a final conclusion cannot be drawn based on the results, but further research can build onto this study and perhaps find more evidence for CBM to be an effective treatment.

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