Effects of a Cognitive Bias Modification Intervention on Explicit and Implicit Social Anxiety and the Influences of Adherence, Baseline Levels and Impulsiveness: The IVY Application

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Abstract

Background: Social Anxiety (SA) involves anticipation of negative evaluation by others, leading to avoidance of social situations or experiencing them with fear. Different cognitive biases play a role in SA. *Aim:* This research is a pilot study in investigating the effect of a Cognitive Bias Modification (CBM) intervention on explicit and implicit SA, conducted in the IVY application during eight sessions. Stimuli associated with low SA are paired with oneself, and stimuli associated with high SA with others. This aims to strengthen a non-anxious self-concept. The effectiveness of IVY in reducing SA symptoms is investigated, as well as the influence of adherence to the training, baseline scores, and impulsiveness scores. *Methods:* Twenty-five participants completed the Liebowitz Social Anxiety Scale (LSAS) for measuring explicit SA, and an IAT for measuring implicit SA in D-scores before and after the intervention. Among participants, 17 completed the entire intervention and 8 completed it partly. Based on that, they were divided into groups to make inferences about the influence of adherence. Baseline scores were divided in low and high and the differences between them were compared. The Barratt Impulsiveness Scale Short Form (BIS-15) was used to measure impulsiveness levels. Paired samples t-tests, Wilcoxon signed-rank tests, and repeated measures analyses were conducted. *Results*: Results showed significant reductions only in the adherence group. Participants with higher implicit SA at baseline showed a significant reduction in implicit SA, no such effects were found for explicit SA. The influence of impulsiveness scores was non-significant. *Discussion:* Participants who completed the entire intervention significantly reduced in SA symptoms. Those with higher implicit SA at baseline benefitted greater from it than those low at baseline. This suggests potential of IVY in reducing SA symptoms for individuals higher in SA when adhering to the intervention.

Keywords: social anxiety, dual attitudes, IVY, cognitive bias modification, online intervention, adherence, baseline, impulsiveness

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Introduction

Social Anxiety and Social Anxiety Disorder

Social Anxiety (SA) is an experience that includes intense fear of negative evaluation by others in social situations. Individuals high in SA have extreme self-consciousness of how they are supposedly seen by an audience, which mismatches their perception of what this audience expects of them. The consequence is a negative self-image that leads them to anticipate rejection, embarrassment, or humiliation (Morrison & Heimberg, 2013; Gilboa-Schechtman, Keshet, Peschard & Azoulay, 2019).

According to Rapee and Heimbergs (1997, as cited in Heuer, Rinck & Becker, 2007) cognitive-behavioural model of the maintenance of SA, three types of symptoms are involved in the experience of SA. When confronted with a potential threat, socially anxious individuals experience physical arousal symptoms such as shaking or sweating, behavioural symptoms manifested in avoidance of situations, and cognitive symptoms leading to dysfunctional thoughts such as fearing to appear incompetent or boring (Heuer et al., 2007; Jefferies & Ungar, 2020; Davey, 2014). A recurring factor is avoidant behaviour. If social situations continue to be avoided, there is no opportunity for disconfirming dysfunctional beliefs. This way, cognitive symptoms will not be reduced. This leads to avoidance of future social situations or to experiencing them with intense fear, which may be expressed in physical arousal symptoms. Socially anxious individuals regularly overestimate how strongly these symptoms are perceived by others. They do not only fear that others notice their anxiety symptoms, but also that they will draw generalizable conclusions about their personality based on them (Roth, Antony & Swinson, 2001). People with SA symptoms thus are highly self-conscious of how they think they are perceived by others (Jefferies & Ungar, 2020; Davey, 2014).

SA can be caused by different genetic, developmental or cognitive factors, which may contribute to different extents to the onset and maintenance of SA. A tendency for anxious

behaviours can be inherited, or be generated by experiences with one's social system during development (Davey, 2014). The prevalence of SA differs according to different sources: a 3 - 7.5% prevalence was found in the Western population (Fehm, Beesdo, Jacobi & Fiedler, 2007), and a 10% prevalence of severe SA in British university students (Russell & Shaw, 2009).

The consequences of SA can become problematic and impact the individual's functioning. Socially anxious individuals can have impaired social relationships, underperform at work, and tend to be less productive (Davey, 2014). If an individual's social and/or occupational functioning is significantly impaired over a longer period, it may even be classified as Social Anxiety Disorder (SAD), sometimes also called social phobia (Davey, 2014). SAD is highly comorbid with other disorders, particularly major depression or a substance use disorder (Koyuncu, İnce, Ertekin & Tükel, 2019). It is important to note that all symptoms described in this research can apply to both SA and SAD, but the severity and the amount of distress and difficulties it causes for the individual are crucial in determining whether it can be classified as SAD.

Explicit and Implicit Social Anxiety

Dual-Process Theory

Substantiate research has shown that individuals process information about themselves and their environment in two different ways: in an explicit and in an implicit manner. This has since been described as the dual-process theory, with the implicit and explicit attitudes towards a social object sometimes described as dual attitudes (Back, Schmukle & Egloff, 2009; Teachman & Allen, 2006). The dual attitudes can be assessed independently and can, but do not necessarily, overlap (Teachman & Allen, 2006). By investigating both, a profound estimation of an individuals' attitude towards a certain object of study can be assessed. The dual-process theory also applies to SA, thus, there are an implicit and an explicit component of SA that can be assessed (Gamer, Schmukle, Luka-Krausgrill & Egloff, 2007).

Explicit Social Anxiety

The explicit component is conscious, accessible to the self, and can be regulated. Humans can actively retrieve and reflect upon these explicit attitudes (Teachman & Allen, 2006). It may result in consciously expressed attitudes about oneself, such as "Others don't like me", "Others think negatively about me", or "I feel insecure in groups" (Gilboa-Schechtman, Keshet, Livne, Berger, Zabag, Hermesh, & Marom, 2017). Explicitly experienced SA may therefore lead to anticipated and experienced fear in social situations, based on presumably negative beliefs that others hold about the own person, as well as avoidance of social situations.

Implicit Social Anxiety

The implicit component is unconscious, thus inaccessible to the self, automatic, and cannot be regulated. It accounts for decreases in social performance that are seemingly unexplainable to the self. Several implicit cognitive biases have been identified that amplify SA. These include for instance interpretation and attention biases, as well as self-identity biases. Interpretation biases are a tendency to interpret ambiguous cues negatively (Morrison & Heimberg, 2013). In SA, it entails that individuals interpret their performance in social situations more critically and are more likely to interpret cues from their social environment negatively (Davey, 2014). Attention biases relate to increased attention towards potentially threatening stimuli. This leads to mainly attending to cues from others that confirm pre-existing beliefs about poor social performance (Mogg & Bradley, 2016).

Another form of biases that put more emphasis on one's self-concept are self-identity biases. Our self-concept holds beliefs that we have about ourselves, regardless of whether they are objectively wrong or right (Mercer, 2012). In SA, the self-concept includes negative perceptions about ourselves in relation to our social environment (Gilboa-Schechtman et al., 2019). Self-identity biases describe the tendency to evaluate one's self-concept negatively. This is closely related to the increased self-focused attention highly socially anxious people

experience, which is a tendency to shift their attention inwards onto themselves during social situations. By doing so, they become increasingly focused on their own anxiety responses. This distracts them from objectively engaging in the social situation and focusing on the social task and can lead to actual impairment of their performance and eventually, confirmation of their negative self-concept (Davey, 2014; Morrison & Heimberg, 2013). As the self-concept plays a central role in SA, tackling and modifying these biases may be crucial in decreasing implicit and explicit SA.

Assessing Explicit and Implicit Social Anxiety

Explicit self-concepts can be assessed using self-report questionnaires. For SA, a possible measurement scale is the Liebowitz Social Anxiety Scale (LSAS). The outcomes of the LSAS differentiate between non-generalized SA (NGSA) and generalized SA (GSA) (Rytwinski et al., 2009). Even though the DSM-5 does not distinguish between NGSA and GSA anymore, the concept remains clinically relevant for assessing symptom severity (Nagata, Suzuki & Teo, 2015). GSA is diagnosed if social interaction fears and behavioural avoidance occurs over a wide range of social situations. It is associated with greater functional impairment, higher comorbidity with other disorders, and lower health-related life quality than NGSA. In NGSA, also called performance anxiety, the fears occur in only a specific or a limited range of situations. This usually involves performance situations, such as public speaking (Kessler, Stein & Berglund, 1998; Stein, 2006).

Implicit cognitions operate outside of one's awareness and need to be assessed differently. An effective tool for assessing implicit self-concepts is the Implicit Association Test (IAT), which was first introduced in literature by Greenwald, McGhee and Schwartz in 1998. The IAT measures implicit processes by comparing the response times on two discrimination tasks. The assumption is hereby that for strongly associated concepts, the response time will be shorter than for weakly associated concepts (Egloff & Schmukle, 2002).

The IAT was shown to be resistant to the forces of an individual to present oneself in a socially desirable way. Thus, the IAT has also been able to detect stereotypes and prejudices an individual holds without awareness, and in assessing self-concepts that are unconscious and not accessible to the self (Greenwald et al, 1998). In a past study by Tanner, Stopa & De Houwer (2006), the IAT has been shown to capture SA effectively: the participants were divided into a high and low SA group based on baseline scores. While both groups showed biases in associating positive words with "me" and negative words with "others", this association was weaker in the high SA group.

In this study, stimulus words related to high or low SA are paired towards others and oneself, respectively, as well as towards the congruent combinations "others/socially anxious" and "me/socially at ease" and the incongruent versions "others/socially at ease" and "me/socially anxious". The response times result in implications about biases associated with one's self-concept.

Cognitive Bias Modification and IVY

Next to exposure therapy, social skills training or drug treatment, cognitive restructuring is a common way to treat SA. It modifies cognitive biases and can diminish SA symptoms to improve social behaviours (Asnaani, Rinck, Becker & Hofmann, 2014; Davey, 2014). One way to do this is by Cognitive Bias Modification (CBM). CBM aims to modify learnt thought patterns and targets specifically unconscious, automatic mental processes outside of one's awareness (Wolbers, Bode, Siemerink, Siesling & Pieterse, 2021; Jones & Sharpe, 2017). It works by implicitly training individuals in tackling their maladaptive cognitive beliefs by directly changing the targeted bias in a specific direction (Jones & Sharpe, 2017; Asnaani et al., 2014). Engaging in CBM leads participants to interpret ambiguous stimuli in a certain direction that matches their training, for instance associating them with a positive or negative valence (Jones & Sharpe, 2017). CBM was shown to be effective in reducing

anxiety disorder symptoms (Asnaani et al., 2014; Jones & Sharpe, 2017). Potential benefits of treating SA with a CBM technology include the reduction of barriers that particularly high SA individuals experience, such as anxiety in the waiting room, anxiety in anticipation of seeing a psychologist, or anxiety in calling to make an appointment (Beard, Weisberg & Primack, 2011).

One technology working with CBM is the IVY application, short for Implicit Vitality. It can increase perceived self-control in patients and was suggested to be used alongside clinical treatment (Wolbers et al., 2021). IVY combines two approaches: the IAT paradigm, which includes the same stimuli as the used IAT, and an approach-avoidance paradigm. An approach-avoidance paradigm works by approaching positively evaluated stimuli, and by avoiding negatively evaluated stimuli. By adding the approach-avoidance dimension, the stimuli are swiped either towards or away from oneself. This aims to capture cognitive embodiment (Wolbers et al., 2021). Together, the paradigms aim to modify one's self-identity biases. IVY was originally developed to modify fatigue biases in breast cancer patients and was shown to be well-accepted among users. The original version works with two opposing poles: "fatigue/others" and "vitality/me". The goal is to modify cognitive biases by relating stimuli words related to fatigue (e.g. "tired") with "others", and stimuli words related to vitality (e.g. "strong") with "me". Users swipe the "vitality" stimuli towards oneself, the "vitality/me" pole; and "fatigue" stimuli away from oneself, to the "fatigue/others" pole. The eventual goal is to decrease their self-concept of fatigue and increase their self-concept of vitality.

To tackle biases towards SA, the app will be modified by replacing the "fatigue" and "vitality" stimuli by stimuli related to "socially anxious" (high SA) and to "socially at ease" (low SA). High SA stimuli are paired with "others", while low SA stimuli are paired with "me". In this way, the association between being socially calm and oneself is aimed to be strengthened. In this research, it will be investigated if and to what extent IVY can influence

implicit biases towards SA, and whether their explicit self-concept towards SA is affected as well. Additionally, three variables that possibly influence the outcomes of the training will be explored: adherence to the training, SA scores at baseline, and the personality trait impulsiveness.

Possible Influences on IVY Training

Adherence

An important factor determining any intervention's success is adherence by the users. In contrast to drug treatments, where users are more closely monitored and likely experience direct physical benefits, online interventions rely more heavily on self-governed treatment continuation by the user. It is therefore common for participants to drop out of online interventions along the way. Due to the high prevalence of dropouts in online interventions, participants who did not complete the entire intervention are advised to be kept in the analysis regardless. In case of high dropout rates, however, analyses including the dropouts may lead to an underestimation of the intervention effect (Eysenbach, 2005). This implies that greater adherence leads to greater effects. This is supported in a study by Chiu and Eysenbach (2010), in which continuation of an online intervention had a direct decreasing effect on perceived burdens in dementia caregivers. Participants who continued to use the intervention thus more greatly benefitted from it.

In the current study, it will be investigated whether these findings hold for an IVY intervention treating SA. The dose-response relationship, thus the influence of the amount of exposure to the intervention on its effect, is investigated by comparing participants who adhered to the entire intervention, and those that did not.

Baseline Levels

Baseline levels refer to the scores of SA before the intervention, thus those assessed during the pre-test. In a study by Eberl et al. (2013), baseline levels seemed to influence the

strength of the intervention effect. They assessed approach-bias of alcohol-addicted individuals, thus their tendency to react faster to stimuli related to alcohol than to unrelated ones. They received a CBM treatment, and in post-test scores, it was shown that for participants with higher biases at baseline, the intervention effect was significantly stronger.

This study will therefore investigate whether higher SA scores at baseline lead to greater reduction in SA in post-test measures. This is useful for making inferences about whether individuals high in SA, and thus those who experience greater suffering, can particularly benefit from the IVY intervention.

Impulsiveness

Impulsiveness entails differing strengths of impulses, as well differing abilities to restrain those impulses (DeYoung & Rueter, 2010). Impulsive individuals thus have stronger impulses, weaker inhibition to restrain them, or both. They struggle to refrain from engaging in urges and risk-taking behaviours that feel rewarding on the short-term but can cause harmful long-term consequences (Nicholls et al., 2014). Research by Nicholls, Staiger, Williams, Richardson and Kambouropoulos (2014) has found an interesting subtype among socially anxious individuals: the approach-motivated subtype. This subtype is related to increased levels of impulsiveness, risk-taking behaviours, sensation seeking, and high reward sensitivity. Those individuals are therefore likely to keep engaging in approach behaviours despite their negative consequences (Nicholls et al., 2014).

Research has shown that highly impulsive, socially anxious individuals might be considerably harder to treat, as they display greater functional impairment and difficulties in completing and benefitting from treatment (Kashdan & McKnight, 2010). The decreased response to treatment in highly impulsive individuals may be related to impaired self-regulatory behaviours that cause difficulties in attending prolonged treatment. It is possible that highly impulsive individuals have higher willingness to participate in a treatment that can be

integrated into their everyday life, like IVY, as it requires less effort than traditional treatment and may reduce the resistance to engage in it continuously. Therefore, it will be investigated whether individuals higher in impulsiveness respond better and benefit more greatly from IVY.

Study Outlook

This study aims to investigate whether a CBM training in IVY can successfully decrease implicit and explicit SA symptoms. To adjust the existing fatigue version of IVY, fatigue stimuli will be replaced by stimuli related to SA. It will be worked with a sample without selection requirements, thus no participants will be screened for their SA levels beforehand. The treatment effect will be investigated among all participants, as well as among subgroups of differing adherence, baseline levels, and impulsiveness. Participants' SA levels will be assessed in a pre- and post-test, with the LSAS as explicit and the IAT as implicit measurement. Their levels of impulsiveness will be assessed in the pre-test using the Barratt Impulsiveness Scale Short Form (BIS-15). The intervention is expected to decrease both explicit and implicit SA in participants and to be more effective for participants who complete the entire intervention, participants with higher SA at baseline, and participants higher in impulsiveness.

Research Questions and Hypotheses

1. What is the influence of a CBM intervention on SA?
    - Hypothesis 1: Implicit SA biases towards SA in the post-test are significantly weaker than at baseline.
    - Hypothesis 2: Explicit SA experience in the post-test is significantly lower than at baseline.
2. Is there a dose-response relationship between adherence and outcome SA?
    - Hypothesis 3: The effect of the CBM intervention on implicit SA bias is stronger for participants who adhered to the entire intervention compared to those who did not.

- Hypothesis 4: The effect of the CBM intervention on explicit SA is stronger for participants who adhered to the entire intervention compared to those who did not.

3. How do baseline SA scores influence the effect of the CBM intervention?

- Hypothesis 5: After the intervention, there is a greater reduction in implicit SA for participants with high baseline implicit SA.
- Hypothesis 6: After the intervention, there is a greater reduction in explicit SA for participants with high baseline explicit SA.

4. Is there a correlation between SA and impulsiveness?

- Hypothesis 7: There is a significant positive correlation between impulsiveness and implicit SA.
- Hypothesis 8: There is a significant positive correlation between impulsiveness and explicit SA.

5. How does trait impulsiveness influence the effect of a CBM intervention on SA?

- Hypothesis 10: The effect of a CBM intervention on implicit SA bias is expected to be stronger for participants with higher impulsiveness scores.
- Hypothesis 9: The effect of a CBM intervention on explicit subjective SA experience is expected to be stronger for participants with higher impulsiveness scores.

Methods

Design

A quasi-experimental within-subjects design was employed in this study, with participants completing a pre-test, then completing the IVY training, and finally completing a post-test. The effect of the IVY app as independent variable on the dependent variables explicit SA and implicit SA was tested. A within-between-subjects design was used to test the effects of the variables adherence, baseline scores, and impulsiveness on the intervention effect.

Participants

Fifty-four participants were recruited for the study via SONA systems, where they received 0.75 credits for their participation, and via a purposive sampling method through participants known to the researcher. Three participants were excluded for not completing the entire pre-test. Pre-test data of those 51 participants was used for investigating RQ 4. Then, 26 participants were excluded for not completing the post-test, and data of the remaining 25 participants was used for further analysis. The mean age of the participants was 23.8 years (SD = 7.37), ranging from 18 to 56 (median = 22). All demographics can be found in Table 1. 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 with the number 220370.

Table 1

Demographics

		N	Percent
Gender	Female	14	56%
	Male	11	44%
Nationality	Dutch	6	24%
	German	14	56%
	Other	5	20%
Occupation	Student	21	84%
	Employed	2	8%
	Other	2	8%
Adherence	Complete	18	68%
	Incomplete	7	32%

Materials

Participants completed the pre- and posttests using the platform SoSci Survey (soscisurvey.de), a German platform for creating online questionnaires. The pre-test included the LSAS, BIS-15 and IAT (see below), the post-test included the LSAS and the IAT only. The CBM intervention was completed using the Twente Intervention and Interaction Machine (TIIM) application, which was developed by the University of Twente and is available for download from the Google Play or Apple Store. The same stimuli were used for IVY and the IAT (Table 2). IAT has a measuring function, while IVY has a training function. Participants required a smartphone or tablet to complete the questionnaires and download the TIIM application. SPSS was used for data analysis.

IVY application

The CBM training was conducted through the IVY application, which is embedded in TIIM. In this study, the original fatigue poles and stimuli have been replaced by SA stimuli. One pole is “socially anxious” (high SA), paired with the “others” category. The other pole is “socially at ease” (low SA), paired with the “me” category. Stimuli related to “socially

anxious", "socially at ease", "me" and "others" (see Table 2) are swiped towards their corresponding pole. In this manner, IVY aims to decrease participants' implicit self-concept towards SA. The intervention included eight training sessions with 120 stimuli each. They were aimed to be completed within four days with two sessions per day. Since some participants completed the entire IVY intervention and others only partly, they were divided into an "adherence" group of 17 people, and a "non-adherence" group of 8 people.

Table 2

IAT/IVY stimuli per object category

Objects (Attitude object)	**Stimuli** (Evaluative object)
Me	Me, I, Myself, Mine
Others	Others, They, Them, Their
Socially at ease	Confident, Calm, At ease, Relaxed, Easygoing, Liked, Comfortable, Accepted
Socially anxious	Tense, Worried, Shy, Nervous, Embarrassed, Rejected, Insecure, Inferior

Liebowitz Social Anxiety Scale (LSAS)

For measuring explicit SA experience, participants filled out the self-report version of the LSAS. The LSAS consists of four subscales: (1) fear in and (2) avoidance of performance situations, and (3) fear in and (4) avoidance of social situations. Participants were presented with 24 scenarios, and for each were required how much fear they experience in these situations, and how frequently they avoid these situations. This results in 48 items in total, scored on a 4-point Likert scale ranging from 0 to 3. Low scores indicate low SA, and high

scores indicate high SA. The overall scores range between 0 and 144. Scores until 30 indicate that SA is unlikely, scores between 30 and 60 indicate the likelihood of NGSA, scores between 60 and 90 indicate likelihood of GSA, and scores above 90 indicate severe SA (Mennin, Fresco, Heimberg, Schneier, Davies & Liebowitz, 2002; Rytwinski et al., 2009). This scale has proven to be valid and reliable in assessing SA with very good internal consistency (Heimberg et al., 1999; Beard et al., 2011). In this research, the summed score of all subscales was used. See Appendix A for the full questionnaire.

Barratt Impulsiveness Scale – Short Form (BIS-15)

Participants' impulsiveness levels were measured using the BIS-15. The BIS-15 is a short version of the BIS-11 (30 items), consisting of 15 items on three subscales: attentional impulsiveness, non-planning impulsiveness, and motor impulsiveness (Karakaş-Çelik, Edgunlu, Şenormanci & Çamsari, 2016). Items are scored on a 4-point Likert scale from 1 to 4. Six items are scored reversed, and the scores are summed into an overall score ranging from 15 to 60. Higher scores imply higher impulsivity. In a similar age group (mean age 27), scores of around 33 were considered average (Spinella, 2007). The BIS-15 has shown very good correlation with the BIS-11, as well as good validity and reliability (Mathias et al., 2019). In this research, the sum of all subscales was used. See Appendix B for the full questionnaire.

Implicit Association Test (IAT)

The IAT was used to measure implicit bias towards SA. The respective stimuli for the evaluative objects were matched with the attitude objects (Table 2) in congruent and incongruent ways in a total of seven rounds (Table 3). This resulted in a measurement of participants' self-identification with being socially anxious or socially at ease. The stimuli were selected by extracting frequent words used in validated SA questionnaires, specifically the LSAS and the SAQ-30 (Heimburg & Becker, 2002; Caballo, Arias, Salazar, Irurtia & Hofmann, 2015). See Figure 1 for an example IAT task.

The IAT results in values of association strength, called D-scores. D-scores are calculated using the practice blocks 3 and 6, and test blocks 4 and 7. The response times from both practice blocks, as well as from both test blocks, are taken together and the standard deviations are calculated for both groups. Then, the differences in average response times between practice and test blocks are calculated and divided by the standard deviations (Greenwald et al., 1998). D-scores usually range between -2 and +2. The D-score value is positive if the association between "Me" and "Socially at ease" or "Others" and "Socially anxious" (low SA) is stronger than the association between "Me" and "Socially anxious" or "Others" and "Socially at ease" (high SA). Thus, negative scores imply bias towards being socially anxious (high SA), while positive scores imply bias towards being socially at ease (low SA). Whenever it is referred to "scores", the numerical meaning is addressed; when referred to SA only, the amount of experienced SA is addressed.

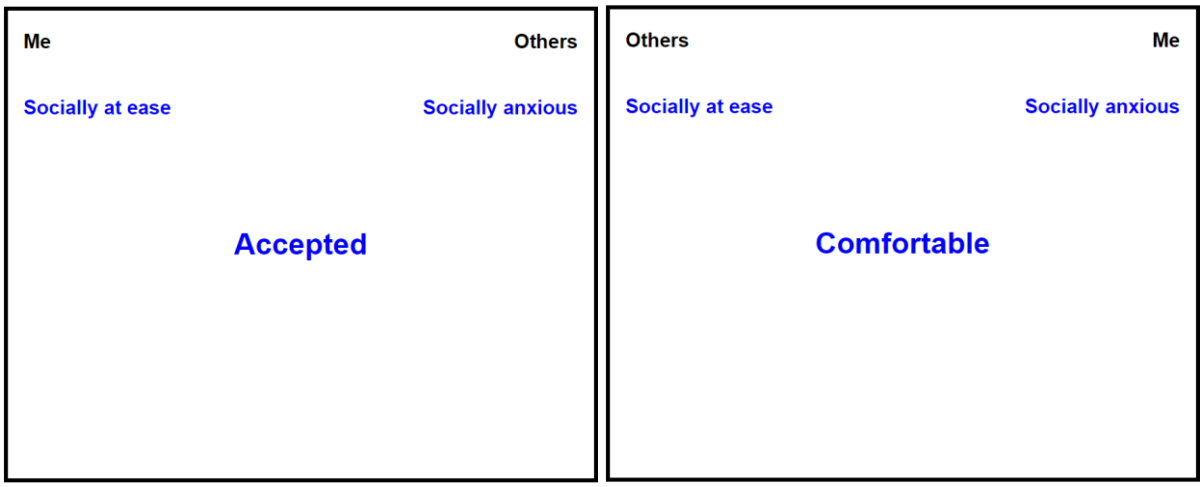
Table 3

IAT Rounds and Categories

Round	Categories		Congruency	Response number
	Left	Right		
1 = Practice	Me	Others	Congruent	20
2 = Practice	Socially at ease	Socially Anxious	Congruent	20
3 = Practice	Me/Socially at ease	Others/Socially anxious	Congruent	20
4 = Test	Me/Socially at ease	Others/Socially anxious	Congruent	40
5 = Practice	Others	Me	Congruent	20
6 = Practice	Others/Socially at ease	Me/Socially Anxious	Incongruent	20
7 = Test	Others/Socially at ease	Me/Socially Anxious	Incongruent	40

Figure 1

IAT blocks rounds 3 and 6



Procedure

Participants started the study by using SoSci for giving informed consent and completing the pre-test. During the pre-test, the LSAS and BIS-15 were completed first, and afterwards, the IAT was conducted. Then, participants were asked to download the TIIM application. After creating an account, they were asked to the study code or scan a QR code previously provided on SoSci to gain access to the study. On TIIM, they were introduced to the duration and procedure of the CBM intervention. On the day after the last training session, they received the link to complete the post-test on SoSci via e-mail.

Data Analysis

Before conducting analyses, the dataset was prepared. Negatively scored items were reversed and data with missing values was excluded from the dataset. The average explicit SA scores, D-scores, and impulsiveness scores were calculated. For participants who completed the post-test twice, the first administration was used and the second one was deleted.

After preparation, descriptive statistics were conducted for the pre- and post-test explicit SA scores, D-scores, and for impulsiveness scores. This was done separately among all participants, only pre-test data, and among the adherence and baseline groups.

Research Question 1: Intervention effect on explicit and implicit SA

The mean average scores for the pre- and post-groups were compared in order to gain insight into the intervention effect. Two Shapiro-Wilk tests were run to test for normality for the difference scores between pre- and post-test measures in explicit and implicit SA. A paired samples t-test was run for explicit, and a Wilcoxon signed-rank test for implicit test scores. Since the effect is expected to go in a specific direction, ergo lower explicit and implicit SA in post-test measures, one-sided significance at $p < .5$ was used to make inferences about statistical significance. The results yielded the difference in means between pre- and post-measures.

Research Question 2: Influence of adherence

The file was split based on the variable "adherence" to investigate both groups separately. Two Shapiro-Wilk tests were run to test for normality of the difference scores in explicit SA scores and D-scores in both groups. Four paired samples t-tests were run to compare mean scores for explicit and implicit SA in both groups. Since the effect is expected to go in a specific direction, ergo lower explicit and implicit SA in post-test measures, one-sided significance at $p < .5$ was used to make inferences about statistical significance. The results yielded the difference in means between pre- and post-measures.

The data split was undone, and the dataset restructured from wide into long format. The variable "time" was created by transposing the two variables for pre- and post-test scores for both explicit and implicit SA into two restructured variables: explicit SA and implicit SA. For further insights into the group differences, two repeated measures ANOVAs were conducted with time as independent within-subjects, and adherence as independent between-subjects variable, and (1) implicit SA and (2) explicit SA as dependent variables. The outcomes gave insights into the significance of the differing effects between the adherence and non-adherence group.

Research Question 3: Influence of baseline scores

The median for both explicit SA and implicit SA was calculated to perform a median split. For explicit SA, scores below the median were categorized as "low" (low explicit SA), and scores above the median were categorized as "high" (high explicit SA). For implicit SA, this was done reversed, since scores above 0 imply bias towards being socially at ease (low implicit SA), and scores below 0 imply bias towards being socially anxious (high implicit SA). In both cases, "low" baseline scores thus equal low SA, and "high" baseline scores equal high SA. This resulted in the variable "baseline" of two levels: (1) low and (2) high. Then, two repeated measures ANOVAs were run. Time (pre/post) served as independent within-subjects

variable, and baseline scores (low/high) as independent between-subjects variable. Their interaction effect on the dependent variables implicit/explicit SA was tested.

Research Question 4: Correlation impulsiveness and SA

Only pre-test measures were used for this analysis. Two Pearson's correlations were run between impulsiveness and (1) implicit SA and (2) explicit SA. The results yielded an indication about whether SA and impulsiveness co-occur.

Research Question 5: Influence of impulsiveness

The median score for the sum scores of impulsiveness was calculated to perform a median split. Participants below the median were categorized as "low impulsiveness", and participants above the median were categorized as "high impulsiveness". Two repeated measures ANOVAs were run. The interaction effect between the independent within-subjects variable time (pre- and post-measures) and the independent between-subjects variable impulsiveness (low or high), on the dependent variables implicit/explicit SA was tested.

Results

Descriptives

Participants showed a decrease in mean explicit SA scores in the post-test in all groups except for the non-adherence group. In all groups, they showed a decrease in implicit SA (increase in D-scores) in the post-test. Participants in the high baseline groups had a greater decrease in explicit and implicit SA than the low baseline group, but this difference was greater in implicit SA (Figure 4 and 5). Impulsiveness scores were considered average. See Tables 4 and 5 for the full descriptives.

Table 4

Descriptives between groups

		Pre-test		Post-test	
		Mean	Standard deviation	Mean	Standard deviation
Explicit SA	All (N = 25)	49.64	19.37	46.52	22.09
	Adherence (N = 17)	51.53	17.15	45.41	20.16
	Non-adherence (N = 8)	45.63	24.22	48.87	27.11
	Only pretest (N = 51)	47.31	18.04		
Implicit SA (D-scores)	All (N = 25)	.33	.48	.54	.39
	Adherence (N = 17)	.27	.47	.55	.41
	Non-adherence (N = 8)	.44	.51	.50	.36
	Only pretest (N = 51)	.31	.44		
Impulsiveness	All (N = 25)	33.00	5.36		
	Only pretest (N = 51)	34.35	6.08		

Table 5

Descriptives per baseline level

		Pre-test		Post-test		Mean difference
		Mean	Standard deviation	Mean	Standard deviation	
Explicit SA	High baseline	66.33	12.31	61.17	18.84	5.16
	Low baseline	34.23	8.70	33.00	15.43	1.23
Implicit SA (D-scores)	High baseline	-.08	.29	.43	.44	-.51
	Low baseline	.70	.24	.63	.33	-.07

Analyses of Research Questions

Intervention effect on explicit and implicit SA (RQ1)

Implicit SA (H1): A Shapiro-Wilk test was run, with $p = .039$. The data was therefore considered not to be normally distributed, and a Wilcoxon signed-rank test was conducted. A non-significant increase in D-scores (decrease in implicit SA) was found, $Z = -1.44$, $p = .15$. Based on this analysis, hypothesis 1 is rejected.

Explicit SA (H2): A Shapiro-Wilk test was run, with $p = .669$. The data was therefore considered to be normally distributed, and a paired samples t-test was conducted. A non-significant decrease in mean explicit SA scores was found between pre- and post-test measures, $M = 3.12$, $SD = 12.85$, $t(24) = 1.21$, $p = .24$. Based on this analysis, hypothesis 2 is rejected.

Influence of adherence (RQ 2)

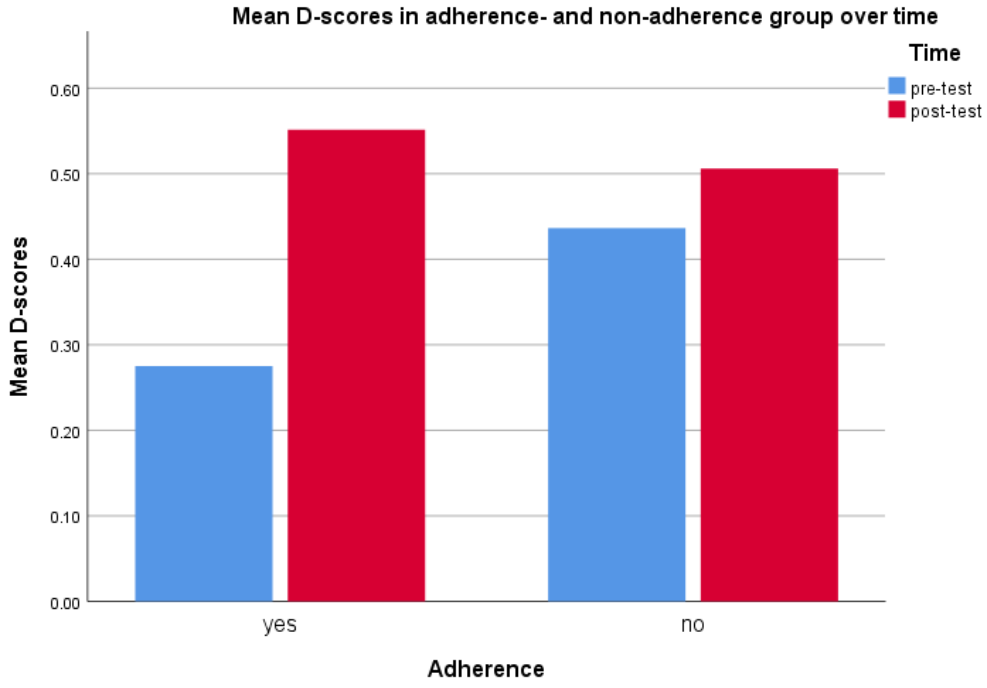
Implicit SA (H3): A Shapiro-Wilk test was run, with $p = .15$ for the *adherence* group, and $p = .20$ for the *non-adherence* group. The data was therefore considered to be normally distributed, and paired samples t-tests were run. In the *adherence* group, a significant decrease

in implicit SA scores was found between pre- and post-test measures, M = -.28, SD = .51, $t(16)$ = -2.24, p = .02. In the *non-adherence* group, no significant differences in implicit SA scores were found between pre- and post-test measures, M = -.07, SD = .55, $t(7)$ = -.356, p = .37. See Figure 2 for the differences between groups.

A repeated measures ANOVA was run with time as within-subject factor and adherence as between-subjects factor, and D-scores as dependent variable. The interaction between time and adherence was shown to be non-significant, $F(1, 23)$ = .85, p = .37. The paired samples t-tests support the hypothesis, while the repeated measures analysis does not. Hypothesis 3 can therefore only partially be accepted.

Figure 2

D-scores between adherence groups over time



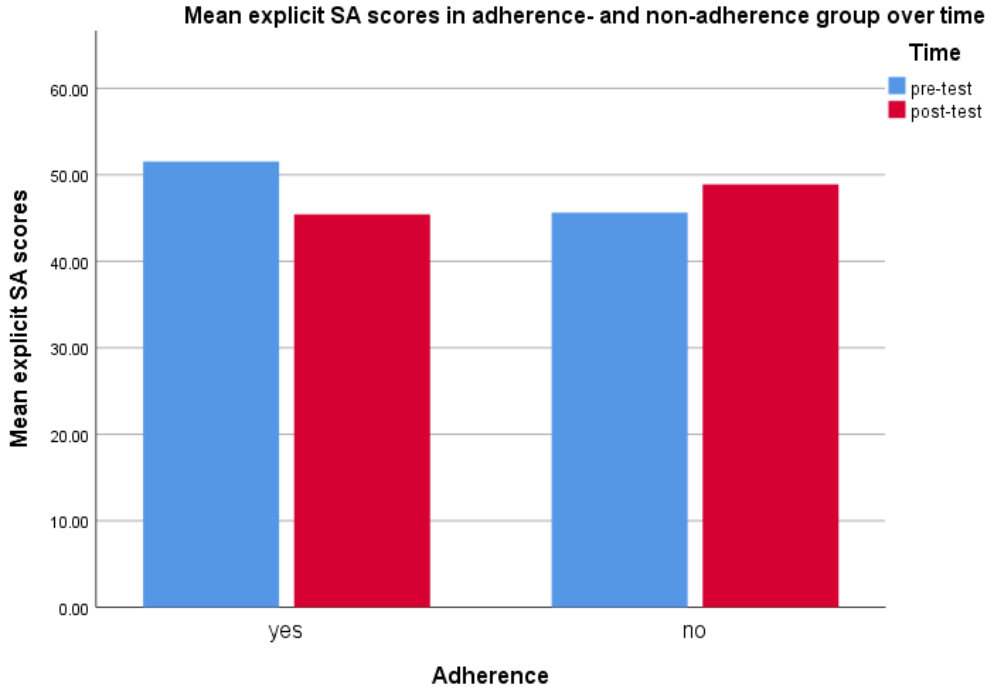
Explicit SA (H4): A Shapiro-Wilk test was run, with p = .39 for the *adherence* group, and p = .61 for the *non-adherence group*. The data was therefore considered to be normally distributed in both groups, and paired samples t-tests were conducted. In the *adherence* group, a significant decrease in explicit SA scores was found between pre- and post-test measures, M = 6.12, SD =

12.43, $t(16) = 2.03$, $p = .03$. In the *non-adherence* group, no significant differences in explicit SA scores were found between pre- and post-test measures, $M = -3.25$, $SD = 12.03$, $t(7) = -.76$, $p = .23$. See Figure 3 for the differences between groups.

A repeated measures ANOVA was run with time as within-subject factor and adherence as between-subjects factor, and explicit SA scores as dependent variable. The interaction between time and adherence was shown to be marginally significant, $F(1, 23) = 3.15$, $p < .10$. Hypothesis 4 can therefore be partially accepted.

Figure 3

Explicit SA scores between adherence groups over time

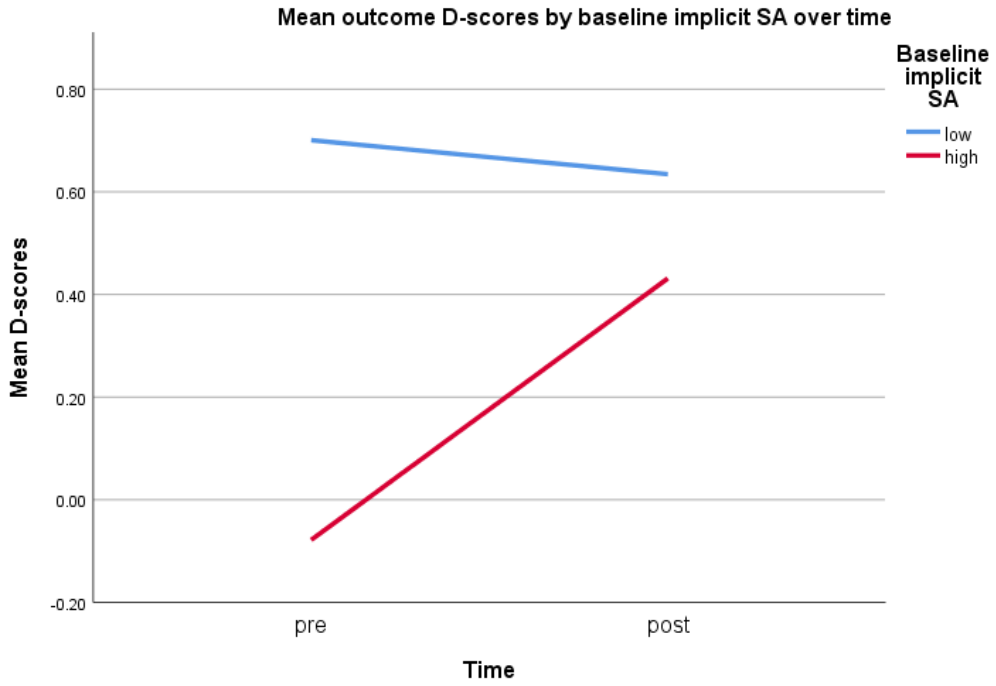


Influence of baseline scores (RQ 3)

***Implicit SA (H5)*:** The interaction effect between time and baseline implicit SA on outcome D-scores was significant, $F(1, 23) = 10.74$, $p = .003$. The difference in D-scores per baseline scores (Figure 4) was therefore considered significant. Hypothesis 5 is accepted.

Figure 4

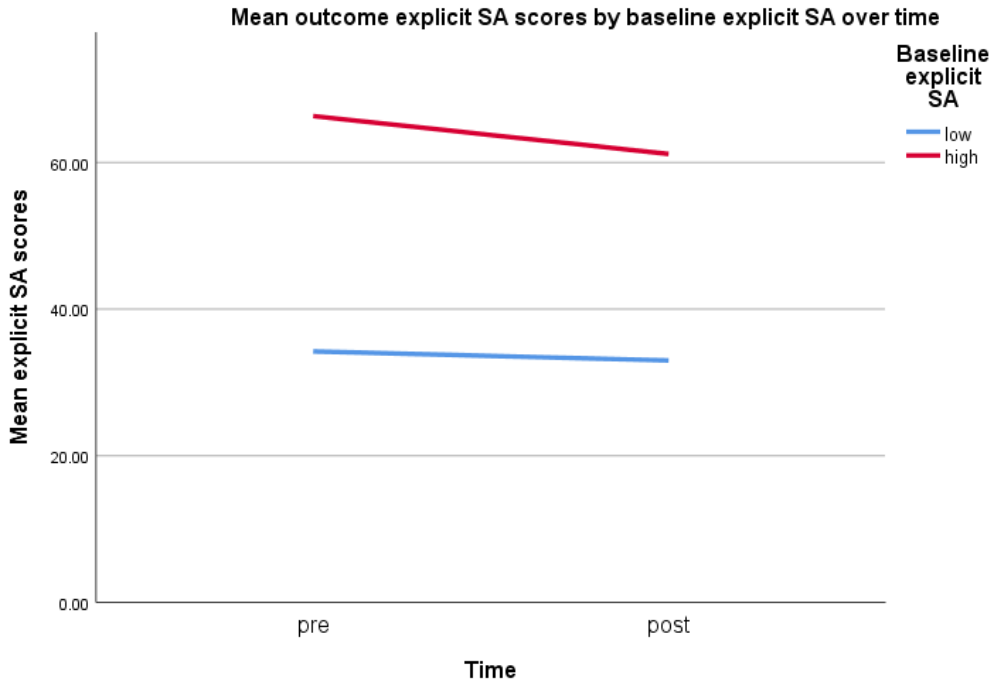
Outcome D-scores by baseline D-scores in pre- and post-test



***Explicit SA (H6)*:** The interaction effect between time and explicit baseline scores on explicit outcome scores was non-significant, $F(1, 23) = .575$, $p = .45$. The difference in explicit SA scores per baseline scores (Figure 5) was therefore considered non-significant. Hypothesis 6 is rejected.

Figure 5

Explicit SA scores by baseline explicit SA in pre- and post-test



Correlation impulsiveness and SA (RQ 4)

Implicit SA (H7): Impulsiveness levels were found not to be significantly correlated with D-scores; $r(49) = .095$, $p = .51$. Hypothesis 7 is therefore rejected.

Explicit SA (H8): Impulsiveness levels were found not to be significantly correlated with explicit SA scores; $r(49) = .11$, $p = .44$. Hypothesis 8 is therefore rejected.

Influence of impulsiveness (RQ 5)

Implicit SA (H9): The interaction effect between time and impulsiveness on D-scores was shown to be non-significant, $F(1, 23) = .928$, $p = .35$. Hypothesis 9 is therefore rejected.

Explicit SA (H10): The interaction between time and impulsiveness on explicit SA scores was shown to be non-significant, $F(1, 23) = .09$, $p = .77$. Hypothesis 10 is therefore rejected.

Discussion

General discussion

The purpose of this study was to investigate the effect of a CBM intervention in the IVY training app on implicit and explicit SA. It was expected that the CBM intervention leads to an overall decrease in both explicit and implicit SA, with stronger effects for participants who completed the entire study, participants with higher baseline SA scores, and participants with higher impulsiveness scores. Further, higher impulsiveness was expected to be associated with both higher explicit and implicit SA scores. To test the hypotheses, participants were asked to complete a pre-test, the IVY intervention, and a post-test. Afterwards, their scores were analyzed using multiple paired samples t-tests, a Wilcoxon signed-rank test, ANOVA repeated measures tests, and correlation analyses. Results showed decreases in explicit and implicit SA after the intervention, but the differences were deemed insignificant. In the adherence group, however, significant decreases of explicit and implicit SA were found. Baseline levels seemed to significantly decrease implicit SA, but not explicit SA. No relationship of impulsiveness and SA or influence on the intervention effect were found.

Research Question 1 and 2: Influence of the IVY intervention and adherence

In both groups, participants were on average biased towards being socially at ease. Explicit scores in all groups implied NGSA, thus SA related to certain performance situations. In different studies with people with high SA or GSA, their LSAS total score usually ranged between 69 and 85 (Baker, Heinrich, Kim & Hofmann, 2002; Adler et al., 2009; von Glischinski et al., 2018). Therefore, the sample is not considered to be high in SA, and not to meet the threshold for GSA. The results throughout the whole sample showed a decrease in both explicit and implicit SA after the intervention. The analyses, however, showed that those decreases were non-significant. This implies that the effects cannot be attributed to the intervention effect. A limiting factor hereby is that the sample included participants who

dropped out of the intervention and therefore did not finish it. This can undermine the actual intervention effect, as discussed by Eysenbach (2005).

To circumvent this limitation, the sample was divided based on adherence to analyze the differences between adherence and non-adherence. The results showed that participants in the adherence group displayed significantly lower biases towards being socially anxious, as well as lower explicit SA after the intervention. These effects were not found in the non-adherence group. We may therefore assume that the intervention did actually have an effect, and that adherence to it is crucial for the effect to take place. To further investigate this assumption, additional analyses in whether the differences in group means are significant were conducted. The results showed no significant differences in implicit SA. For subjective explicit experience, the difference between the groups was close to significant. Important to note is that this marginal significance was examined as well to partly compensate for the small sample size, but interpreted with caution. We can therefore carefully suggest that the second analysis supports the notion that adherence influences explicit outcome scores. We did not find such further support for implicit scores. Overall, the findings suggest that we did find decreases in implicit biases and explicit experiences in the adherence groups that could not be found in the non-adherence group. Moreover, we found stronger support for a strengthening effect of adherence on explicit SA scores. However, we cannot conclude with certainty that they are attributed to the effect of the CBM intervention and adherence due to the weak interaction.

Number and continuity of sessions is crucial for success of the intervention, and one might argue that reason for the lack of interaction could be the total number of sessions in an intervention, and the regularity in which they were completed. Based on a study by Eberl et al. (2014), however, the total number of sessions used in the IVY intervention seems appropriate. Eberl et al. (2014) investigated the ideal number sessions needed in a CBM intervention aimed at re-training biases in alcohol approach tendencies. They found that six sessions are the ideal

number for the maximum improvement to happen, and having slightly more sessions kept improving the training effect in some participants. This is supported by a smartphone CBM intervention that improved anxiety and depression scores after completing at least five sessions (Beard, Ramadurai, McHugh, Pollak & Björgvinsson, 2020). The number of eight completed session in IVY, therefore, is likely not the cause for a lack of interaction patterns. What could contribute to the lack of interaction, though, is the irregularity in which they were completed. The sessions were not completed daily and consecutively, as originally intended (see Limitations). In the study by Beard et al. (2020), improvements in anxiety and depression vanished after a 1-month follow-up, during which training sessions were not completed daily anymore, but only three times per week on average. This suggests that while sessions are completed daily, thus very frequently, the intervention effect is enhanced. With less regularity, and especially differing regularity among participants, it becomes more difficult to see clear interaction patterns and intervention effects. Another limiting factor is the low statistical power caused by the small size of the non-adherence group. The group is too small to conclude about relevance of adherence of the training. Therefore, the current results could be due to non-specific effects, for example differing contexts an individual might find oneself in at the second administration.

The following argumentation is to be viewed in the light of the discussed limitations suggesting that we cannot for sure attribute the effects to IVY. Yet, while interpreting the results with caution, they offer promising insights into the potential of the intervention. Specifically the finding that the intervention could decrease explicit SA scores, as shown in the adherence group, provides new insights. A previously experiment in IVY, as reported by Wächtler in 2019, found reductions in implicit scores only. Wächtler, however, investigated fatigue bias instead of SA. We could therefore consider that in SA, the modification of one's implicit self-concept has a more direct influence on explicit SA experience. To understand this

connection better, one needs to remember that one essential contributing factor for the maintenance of SA is the perception of how oneself is perceived by others. In Rapee and Heimbergs Cognitive-Behavioural Model of Social Anxiety, the mental representation of oneself as seen by the audience is a central factor in the onset of SA symptoms and is used to compare oneself to the assumed standard a certain audience expects. If there is a mismatch, it leads to cognitive, behavioural and physical SA symptoms (Heimberg, Brozovich & Rapee, 2010). Assuming participants' self-concept was successfully altered towards being more socially at ease, this would result in a smaller gap between perceived presentation of oneself and expectations by an audience; ultimately resulting in decreased SA in social situations as described in the LSAS. Implicit bias in SA and explicit experience are therefore assumed to be heavily connected.

Looking at the amount of reduction from a clinical perspective, the reductions in explicit SA scores in the adherence group do not pass the threshold of significant clinical reduction. Von Glischinski et al. (2018) identified a reduction of 30% from the original score in the LSAS to be an ideal response to treatment. Here, a reduction of only about 12% among the adherence group and 7% in the whole sample took place. We can therefore not conclude that IVY caused a clinically significant reduction in explicit SA. However, an important notion is that the clinical response rate refers to response to a treatment as a whole, not a single component. CBM is usually used as a supplementary element within a broader treatment plan. This is illustrated in studies by Eberl et al. (2013; 2014) or Beard et al. (2020), who used a CBM treatment in addition to regular addiction treatment. If we utilized IVY as a supplement within a broader treatment plan, a reduction of 7-12% by this component only seems promising. Relevant to consider is that the aforementioned ideal response rate applied to a sample with diagnosable GSA, when in the current sample, participants met criteria for NGSA at most. No

further literature is currently available for making implications about a significant reduction in NGSA.

In the current study, no generalizable conclusions can be made about the intervention effect and the influence of adherence due to its limitations. The results, however, offer promising insights into a potential treatment effect. A study with a larger sample and daily sessions needs to be done to draw more reliable conclusions.

Research Question 3: Influence of baseline scores

Next, it was investigated whether scores at baseline influenced the intervention effect by conducting repeated measures analyses. Participants with higher baseline implicit SA had a significantly greater decrease in implicit biases than those with lower baseline scores. No such effects were found in explicit SA measures. This implies that participants with a highly biased self-identity towards SA benefit greatly from the intervention, while reductions in subjective explicit SA experience remained relatively stable regardless of baseline scores. The assumption that stronger bias towards SA at baseline predict outcome scores is supported by a study by Eberl et al. (2013). In a large sample of alcohol-addicted individuals, they found a significantly stronger intervention effect for participants with high approach bias at baseline. They also suggested that it might be easier to influence ambiguous biases, rather than making existing ones even stronger (Eberl et al., 2013). In the present study, this implies that training self-identity biases that are already low in SA even more to the low SA pole is more difficult than training high SA biases towards a more positive self-concept. Implications of this are that the IVY intervention can be effective in reducing negative biases, but not necessarily in strengthening already positive biases. Based on this, it makes more sense to use IVY for highly biased, socially anxious individuals.

The lack of interaction between baseline explicit SA levels and explicit outcome scores implies that the intervention is equally effective for individuals who subjectively experience

either high or low SA. Individuals who knowingly experience high SA may therefore not consciously notice greater reductions in those experiences, as compared to those who do not feel as much SA. This may, however, again be due to the low statistical power. Eberl et al. (2013) reported that they found a lack of direct, explicit improvement after re-training biases in a first study as well, but when replicating it with a significantly larger sample (N > 500), those improvements were found. Conducting the IVY training again with a larger sample would therefore give more reliable insights into the influence on explicit outcomes.

In a future study, other biases relevant for SA, such as interpretation and attention biases, could be investigated as predictors for effectiveness of IVY. This could provide insights into whether reducing self-identity biases can also influence SA biases that are not directly connected to one's self-concept, but are inevitably involved in developing and experiencing SA.

Research Questions 4 and 5: Influence of impulsiveness

Finally, the correlation of SA scores with impulsiveness and the influence of differing impulsiveness scores on the intervention effect were investigated. In a community sample of a similar age group, mean scores of around 33 on the BIS-15 were considered normative (Spinella, 2007). Similar scores were assessed in this study, and the present sample was therefore considered to be average on impulsiveness. There were no significant correlations found between impulsiveness and SA, and neither seemed the effect of the intervention to be moderated by impulsiveness. This is against the initial hypotheses and contradicts previously conducted studies by Nicholls et al. (2014) or Kashdan and Hofmann (2008), who found high impulsiveness level in a subgroup of individuals with GSA.

The notion that they found high impulsiveness in a subgroup of people with GSA, though, displays why the current sample was not suitable for making predictions about the correlation of impulsiveness and SA. As described by Nicholls et al. (2014), the approach-

motivated socially anxious individual is characterized by high impulsiveness. It was therefore hypothesized that higher levels of SA correlate with higher levels of impulsiveness, and that higher levels of impulsiveness strengthen the intervention effect. It was not considered, however, that in order to find evidence for or against this hypothesis, the use of a non-selective sample was not ideal. As impulsiveness was expected to be especially prevalent among people with high SA, ergo in the approach-motivated subtype as described by Nicholls et al. (2014), the relationship between impulsiveness and SA should be investigated in a more selected sample of individuals with GSA. It was contemplated doing a split among the participants to categorize them below or above the median impulsiveness score, however that was considered ineffective since only most participants displayed average impulsiveness scores. Therefore, based on the present sample, no generalizable conclusions about the influence of impulsiveness could be drawn.

Strengths and Limitations

This research provided novel insights into using IVY as a treatment for SA, while considering influences of several subgroups. Specifically having participants with differing adherence to the intervention added greater value to interpreting the intervention effect. The differentiation between explicit and implicit SA offered insights on SA from different perspectives and emphasized the importance of considering both conscious and unconscious attitudes in treating SA.

One limiting factor were the technical issues that were encountered with the TIIM application. Participants repeatedly stated that the application either logged them out, did not send notifications anymore, or kept crashing entirely. This made it difficult, and for many not possible, to complete the entire IVY training. This resulted in having only 25 out of 54 recruited participants who completed pre- and post-test and (part of) the intervention. Out of those 25, eight completed the intervention partly, leading to unequal sizes between the adherence groups.

Those limitations had implications on the statistical power of the analyses and make it difficult to draw generalizable conclusions.

Further, the fact that participants were logged out or did not receive notifications, resulted in them not completing the IVY trainings within the preferred time frames. It was intended to complete the trainings daily on four consecutive days. However, due to the technical difficulties, the trainings were completed irregularly, with a couple of days in between. The training was thus not as regular as intended, and the effect might be altered.

Another limiting factor is the sample selection. The results would provide stronger insights into the effectiveness of IVY in treating SA in a sample of highly socially anxious individuals.

Conclusion

The present research is a pilot study in testing the effectiveness of the IVY app in other areas than fatigue. The results suggest that when adhering to the entire intervention, IVY has potential in reducing both explicit SA experience and internalized SA biases in one's self-concept in a sample of participants with a tendency for NGSA. Specifically participants with high SA biases seemed to benefit more greatly from the intervention. No influences of impulsiveness on the intervention effect were found. Considering that CBM is usually used as a supplementary element in a broader treatment plan, the potential of IVY as a treatment for SA seems promising. However, due to the low statistical power caused by little participants, it was not possible to draw final conclusions.

Future use

The potential of IVY found in this study can be used to set up future experiments. In future studies, a larger sample should be drawn from a group of individuals high in SA or diagnosed with GSAD (LSAS score higher than 60). They could be divided into an experimental group receiving the IVY intervention, and a control group that does not receive

treatment. This way, the statistical power of the analyses would increase and the effectiveness of IVY in restructuring biases in highly socially anxious individuals could be more clearly investigated. Further, this would lead to more clarity in differing intervention effectiveness among the discussed subgroups. Based on these results, implications on how to integrate IVY into a broader SA treatment plan could be drawn.

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Appendix

Appendix A

Liebowitz Social Anxiety Scale

Fear

0 = None

1 = Mild

2 = Moderate

3 = Severe

Avoidance

0 = Never (0%)

1 = Occasionally (1%–33%)

2 = Often (33%–67%)

3 = Usually (68%–100%)

	Fear	Avoid
1. Telephoning in public		
2. Participating in small groups		
3. Eating in public places		
4. Drinking with others in public places 5. Talking to people in authority		
6. Acting, performing, or giving a talk in front of an audience		
7. Going to a party		
8. Working while being observed		
9. Writing while being observed		
10. Calling someone you don't know very well		

11. Talking with people you don't know very well		
12. Meeting strangers		
13. Urinating in a public bathroom		
14. Entering a room when others are already seated		
15. Being the center of attention		
16. Speaking up at a meeting		
17. Taking a test		
18. Expressing a disagreement or disapproval to people you don't know very well		
19. Looking at people you don't know very well in the eyes		
20. Giving a report to a group		
21. Trying to pick up someone		
22. Returning goods to a store		
23. Giving a party		
24. Resisting a high pressure salesperson		

Appendix B

Barratt Impulsiveness Scale – Short Form

Response Categories:

1 = Rarely/Never

2 = Occasionally

3 = Often

4 = Almost always/Always.

Items:

1. I plan tasks carefully.*

2. I do things without thinking.

3. I don't pay attention.

4. I concentrate easily.*

5. I save regularly.*

6. I squirm at plays or lectures.

7. I am a careful thinker.*

8. I plan for job security.*

9. I say things without thinking.

10. I act on impulse.

11. I get easily bored when solving thought problems.

12. I act in the spur of the moment.

13. I buy things on impulse.

14. I am restless at lectures or talks.

15. I plan for the future.*

Note. *Reversed items