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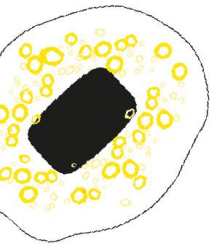

# The SAB app
## – Testing the Effectiveness of Cognitive Bias Modification Training on Implicit Social Anxiety Bias and Explicit Social Anxiety: What is the role of Perceived Social Self-Efficacy?


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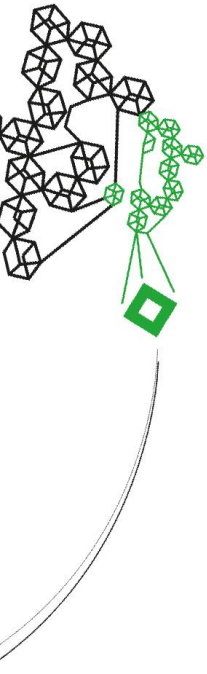

**Abstract**

**Background and aim:** Cases of Social Anxiety (SA) are increasing. Still there remains a lack of available treatment options. In recent years, cognitive bias modification (CBM) has emerged as a novel treatment for malleable cognitive biases. Contrary to existing Cognitive-Behavioural Therapy (CBT) it focuses on underlying cognitions, that implicitly reinforce disorders. CBM aims to reduce explicit SA symptoms by addressing underlying implicit SA self-concept biases and retraining the automatic association between oneself and SA. The role of Perceived Social Self-Efficacy (PSSE) was further explored since prior studies found a negative correlation between self-efficacy and anxiety and social self-efficacy determines whether one feels capable of managing social interactions.

**Methods:** 25 participants (44% male, 56% female, mean age = 23.80, sd = 7.37) completed a pretest including demographic questions, an IAT as a measure for implicit SA bias, the LSAS as a self-report measure for explicit SA and the PSSE scale to measure the level of Perceived Social Self-Efficacy. Afterwards, they participated in up to two training sessions a day for 4 days using the Social Anxiety Bias app (SAB app). Lastly, the pretest measures were repeated in a posttest.

**Results:** A marginally significant reduction in implicit SA bias ($p = .055$) was found between pre- and posttest. It was non-significant for explicit SA. PSSE could not be proven to be a mediator or moderator for the effect on SAB training on implicit SA bias or explicit SA. However, PSSE was found to be a predictor for the pretest ($p = .002$) and posttest ($p < .001$) level of explicit SA.

**Discussion:** This study provides initial support that CBM has the potential to reduce at least implicit SA biases. Possibly the effects were not able to extent from implicit to explicit effects due to the relatively short study duration of four days. The exploration of the role of PSSE leads to the conclusion that CBM seems to achieve its effect by implicit mechanisms, and PSSE, as an explicit construct, does not interact with it.

**Future recommendations:** Future research including a control group and a larger sample is suggested to validate the current results. Further studies are needed to investigate whether the found effects are prolonged and can be extended to explicit SA symptoms. Other mediating or moderating variables besides PSSE should be explored.

*Key words:* Cognitive Bias Modification, Implicit Social Anxiety, Explicit Social Anxiety, Social Anxiety Self-Concept Bias, Perceived Social Self-Efficacy

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**The SAB app – Testing the Effectiveness of Cognitive Bias Modification Training on Implicit Social Anxiety Bias and Explicit Social Anxiety: What is the role of Perceived Social Self-Efficacy?**

Estimates of the prevalence of mental health disorders worldwide are increasing, with currently around 10.7% of the population affected by mental health problems (Dattani et al., 2018). Among these, anxiety disorders were found to be the most prevalent mental health issue (Dattani et al., 2018; Kessler et al., 2005). In students and young people, Social Anxiety (SA) is widespread. A recent survey study reports a prevalence rate of 36% (Jefferies & Ungar, 2020). Individuals suffering from SA fear social situations due to a feeling of being scrutinized and the anticipation of humiliation and embarrassment (Stein & Stein, 2008). Affected individuals experience distress enduring interpersonal encounters or even avoid them completely (Stein & Stein, 2008). This has far-reaching consequences, as individuals with SA are found to have fewer friends, are more likely to be bullied, are less likely to marry, and more likely to divorce (Leigh & Clark, 2018). SA is not only linked to impaired social functioning in relationships but also impaired performance in the workplace or in academic contexts. It can result in severe societal costs, for example, due to reduced productivity or school dropouts (Leichsenring & Leweke, 2017). Moreover, comorbidity can be found with other anxiety disorders, depression, and substance abuse (Ruscio et al., 2007). Overall, the quality of life of affected individuals is decreasing (Leichsenring & Leweke, 2017). Nevertheless, a survey among students revealed that it is common to refrain from seeking support as it is anticipated to be stigmatized or not taken seriously (Russell & Topham, 2012). Affected individuals often do not receive SA-specific treatment (Ruscio et al., 2007).

Besides the relatively high threshold for treatment uptake, current CBT-based treatments might have limited effectiveness as they do not target implicit processes (Beard, 2011). Dual-system models provide a theoretical framework explaining how maladaptive cognitions, such as those contributing to SA, are established in the first place. It is suggested that behavioural outcomes and attitudes are determined by explicit and implicit cognitions (Serenko & Turel, 2019). Explicit beliefs are deliberate. Explicit SA can be measured using self-reports assessing SA symptoms (Schnabel et al., 2008). On the other hand, implicit beliefs are below the level of awareness and lead to automatic responses outside of conscious control. They are acquired through associative learning and can thus be biased. The automatic association of oneself with SA, a SA self-concept bias, can be assessed using an implicit

association test (Schnabel et al., 2008). Existing biases can be targeted by strengthening or weakening the underlying associative structure. Subsequently, a corresponding change in the explicit attitude can be expected, according to Gawronski and Bodenhausen (2006). Therefore, interventions targeting implicit cognitions are promising to reduce implicit SA biases and explicit SA.

Due to the increasing need for mental health support, research is consistently exploring opportunities for treatment. One novel method, that is aimed at implicit cognitions and has recently gained interest is Cognitive Bias Modification (CBM). CBM is a method that is used to retrain cognitive biases by asking individuals to respond counterintuitively to stimuli. Implicit cognitive processes underlying maladaptive biases can be modified by systematic practice and associative learning (Hertel & Mathews, 2011). In this study CBM training will be implemented in an app, the SAB app. It was developed based on the existing Implicit Vitality app, which is aimed at retraining fatigue biases (Wächtler, 2019). Using new stimuli categories its effectiveness of CBM training within the SAB app for SA self-concept biases will be tested.

Previously, CBM apps have already proven to be effective in decreasing cognitive biases in anxiety (Beard et al., 2012; Hakamata et al., 2010; Hirsch et al., 2018; Liu et al., 2017). Moreover, even though CBM targets implicit anxiety biases, a review of various meta-analyses reported that 8 out of 10 meta-analyses found a significant improvement in anxiety symptoms (Jones & Sharpe, 2017). Most studies focused on either interpretational or attentional biases. CBM for interpretation bias (CBM-I) is training participants to evaluate ambiguous stimuli positively. Attention Bias Modification (ABM) aims to direct participants' attention towards positive stimuli and avoiding negative stimuli. Jones and Sharpe (2017) found that both methods (CBM-I and ABM) were able to decrease anxiety biases and symptoms in adults.

Aside from interpretational and attentional biases, a self-concept bias appears promising. Self-concept refers to all cognitions and attributions one possesses about oneself, explicit and implicit (Asendorpf et al., 2002). Self-concepts are linked to behavioural outcomes and contribute to the maintenance of maladaptive behaviour, according to studies in various domains, such as substance self-concepts and fatigue (Lenaert et al., 2018; Lindgren et al., 2016). The association between one's self-concept and drinking, for example, is generated by repeated alcohol consumption. Biases are learned and the thought process of associating oneself with alcohol becomes automatic and fast. One is more likely to view oneself as a drinker when exposed to alcohol frequently. This is affecting one's perception of

oneself and behavioural intentions to drink. The learned automatic association of oneself with alcohol reinforces risky drinking behaviour in the future. Studies show that stronger alcohol-related self-concepts predict higher alcohol consumption and alcohol-related problems (Lindgren et al., 2016).

Likewise, a SA self-concept bias, associating oneself with SA, possibly facilitates SA symptoms and avoidance behaviour. An experimental study by Hirsch et al. (2018) found that participants with a negative mental self-image reported higher SA levels. Nordahl et al. (2017) report that individuals with SA have a biased self-perception evaluating themselves more negatively in association with social situations, which then further facilitates SA. Using CBM, the automatic association between self and SA can be retrained. It is aimed at strengthening positive associations between self and social interactions and weakening associations between self and SA. This in turn is supposed to lower levels of implicit and explicit SA.

This research not only investigates the effectiveness of CBM on SA self-concept biases but also explores the impact of self-efficacy on the interaction between SAB training and implicit SA bias and explicit SA. Self-efficacy refers to the perception of one's own capabilities. According to research addressing the link between self-efficacy and anxiety, it is stated that self-efficacy determines the perceived capability to exert control over potential threats or threatening situations (Bandura, 1988). Having a feeling of control due to perceived self-efficacy reduces anxiety arousal (Bandura, 1988). More specifically, social self-efficacy can be defined as the perceived ability to manage social situations (Smith & Betz, 2000). Feeling unable to manage social situations elicits stress in individuals with SA. Prior studies have found a negative correlation between levels of (social) self-efficacy and anxiety or even social avoidance (Muris, 2002; Tahmassian & Moghadam, (2011). Therefore, it will be first established whether PSSE correlates to SA and further explored in how far PSSE influences the effect of CBM training on SA. Due to the hypothesized correlation, it is imaginable that the pre-existing level of PSSE is a predictor for the effect of CBM on implicit SA bias (Fig.3) and explicit SA (Fig.4), and thus acts as a moderator. Feeling capable to interact with others is related to lower levels of SA. Alternatively, these findings suggest that it is worthwhile to investigate whether PSSE is a mediator and whether CBM has an effect on implicit (Fig.1) and explicit SA (Fig.2) by increasing the PSSE. Participants who use CBM improve their perception of themselves and their ability to succeed in social situations. They learn to associate themselves with being relaxed and capable of managing social situations, which is a positive experience of gaining control. They repeatedly learn that thinking about a social

situation at the same time leads to thinking of themselves as being "accepted ", "calm ", "at ease " etc.. Experiencing this, increases the confidence needed to be able to deal with social situations. The explicit evaluation of one's confidence in social interactions is based on the underlying implicit cognitions (Gawronski & Bodenhausen, 2006). Additionally, participating in CBM training raises awareness that one's self-concept can be altered, whilst illustrating the opportunity to decrease SA by participating. Consequently, identifying oneself with positive attributes is increasing social self-efficacy and hence SA (bias) is hypothesized to be reduced.

Concluding, existing literature suggests that CBM training is suitable to alter SA self-concept biases and possibly explicit SA. Therefore, this study aims to investigate the effects of the CBM training within the SAB app on SA. Furthermore, literature implies that effects can be explained by the level of PSSE or CBM is effective by increasing PSSE.

Deriving from the provided background, the following research questions are investigated in this research:

**Effects of CBM on implicit SA bias and explicit SA**

**RQ1:** Is there an effect of SAB training on implicit SA bias and explicit SA?

**HP1.1:** There is a significant reduction in implicit SA bias between pre- and posttest.

**HP1.2:** There is a significant reduction in explicit SA between pre- and post-test.

**Correlation between PSSE and implicit SA bias and explicit SA**

**RQ2.1:** Is the pre-existing level of PSSE a predictor for the pre-existing level of implicit SA bias?

**HP2.1:** There is a significant negative correlation between the pre-existing level of PSSE and the pre-existing level of implicit SA bias.

**RQ2.2:** Is the pre-existing level of PSSE a predictor for the posttest level of implicit SA bias?

**HP2.2:** There is a significant negative correlation between the pre-existing PSSE and the posttest level of implicit SA bias.

**RQ2.3:** Is the pre-existing level of PSSE a predictor for the pre-existing level of explicit SA?

**HP2.3:** There is a significant negative correlation between the pre-existing level of PSSE and the pre-existing level of explicit SA.

**RQ2.4:** Is the pre-existing level of PSSE a predictor for the posttest level of explicit SA?

**HP2.4:** There is a significant negative correlation between the pre-existing level of PSSE and the posttest level of explicit SA.

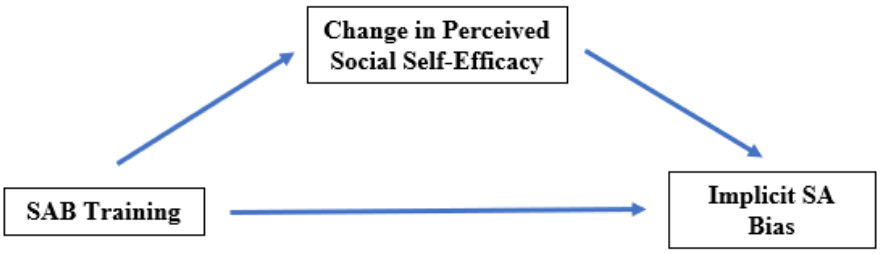
**PSSE as a Mediator**

**RQ3.1:** Is the effect of SAB training on implicit SA bias mediated by the change in PSSE?

**HP3.1:** The change in PSSE is a predictor of the effect of SAB training on implicit SA bias.

**Figure 1**

*Model of hypothesized relationships – Mediation*

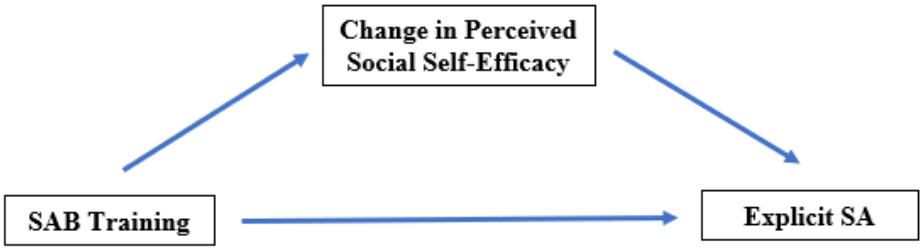



**RQ3.2:** Is the effect of SAB training on explicit SA mediated by the change in PSSE?

**HP3.2:** The change in PSSE is a predictor for the effect of SAB training on explicit SA.

**Figure 2**

*Model of hypothesized relationships – Mediation*




**PSSE as a Moderator**

**RQ4.1:** Is the effect of SAB training on implicit SA bias moderated by the pre-existing level of PSSE?

**HP4.1:** The pre-existing level of PSSE is a moderator for the effect of SAB training on implicit SA bias.

**Figure 3**

*Model of hypothesized relationships – Moderation*


**RQ4.2:** Is the effect of SAB training on explicit SA moderated by the pre-existing level of PSSE?

**HP4.2:** PSSE is a moderator for the effect of SAB training on explicit SA.

**Figure 4**

*Model of hypothesized relationships – Moderation*


## Methods

### Participants

54 participants participated in the study. The participants were recruited via convenience sampling using "SONA" the test subject pool of the University of Twente and from the personal network of the researchers. There were no initial exclusion criteria. However, due to missing posttests, 29 participants had to be excluded, and data was analyzed from the remaining 25 participants. Of those 25 participants (Table 1), 11 participants were male (44.0%) and 14 were female (56.0%). The mean age of the participants was 23.80 (SD=7.37), ranging from 18 to 56 years. Participants gave informed consent prior to the study. For the request 220370 ethical approval was granted by the Behavioural, Management and Social Sciences Ethics Committee at the University of Twente.

**Table 1**

*Baseline Measures and Demographics*

| | | N | Percentage |
|---|---|---|---|
| **Pretest d-scores (implicit SA bias)** | *M* = .33 (*sd* = .48) | 25 | 100% |
| **Pretest LSAS score (explicit SA)** | *M* = 49.64 (*sd* = 19.37) | 25 | 100% |
| **Gender** | Male | 11 | 44.0% |
| | Female | 14 | 56.0% |
| **Age** | *M* = 23.89 (*sd* = 7.371) | 25 | 100% |
| | 18 | 1 | 4.0% |
| | 19 | 2 | 8.0% |
| | 20 | 5 | 20.0% |
| | 21 | 3 | 12.0% |
| | 22 | 4 | 16.0% |
| | 23 | 3 | 12.0% |
| | 25 | 1 | 4.0% |
| | 27 | 3 | 12.0% |
| | 28 | 1 | 4.0% |
| | 29 | 1 | 4.0% |
| | 56 | 1 | 4.0% |
| **Nationality** | Dutch | 6 | 24.0% |
| | German | 14 | 56.0% |
| | Other (Argentinian, Chinese, Cypriot, Indian, Russian) | 5 | 20.0% |

| | | | |
|---|---|---|---|
| **Occupation** | Employed | 2 | 8.0% |
| | Interning | 1 | 4.0% |
| | Student | 21 | 84.0% |
| | Other | 1 | 4.0% |

Note. *M* = mean; *sd* = standard deviation

**Material**

The link to access the study was provided using the test subject pool of the University of Twente "SONA". Participation was rewarded with 0.75 credits, which must be collected by students in order to obtain their degree. Further participants from the researcher's personal surroundings were provided with the link without any compensation. The web application "soSci Survey" was used for all measurements. The survey project consisting of pre- (https://www.soscisurvey.de/IVYanxiety/**)** and post-test (https://www.soscisurvey.de/IVYanxiety/?q=A2), included an informed consent form, demographic questions, several questionnaires as well as an Implicit Association Test (IAT). It could be completed using a laptop, tablet, or smartphone. The statistics program "IBM SPSS Statistics version 27" was used to analyze the data.

***Liebowitz Social Anxiety Scale (LSAS)***

The LSAS (Appendix A) was used to measure participants' explicit SA. It includes 24 items describing a specific social situation. Each item (f.e. "Using a telephone in public") had to be answered by indicating the level of fear ("None ", "Mild ", "Moderate " or "Severe ") and avoidance ("Never ", "Occasionally ", "Often " or "Usually ") on a four-point Likert-scale. A low score indicating a low level of explicitly perceived SA symptoms, a high score indicating higher levels of explicit SA and symptoms. The LSAS provides a good test-retest reliability, a high internal consistency, and was found to be sensitive to changes due to treatment (Baker et al., 2002).

***Perceived Social Self-Efficacy Scale (PSSE)***

To measure participants social self-efficacy the PSSE (Appendix B) was used. The scale developed by Smith & Betz (2000) aims to measure the perception of self-efficacy in various social situations. It consists of 25 items (f.e. "Start a conversation with someone you don't know very well") and participants have to rate each on a five-point Likert scale ranging from "No Confidence " to "Complete Confidence ". The higher the score the more capable you feel to succeed in social situations and therefore the higher the level of PSSE. It provides

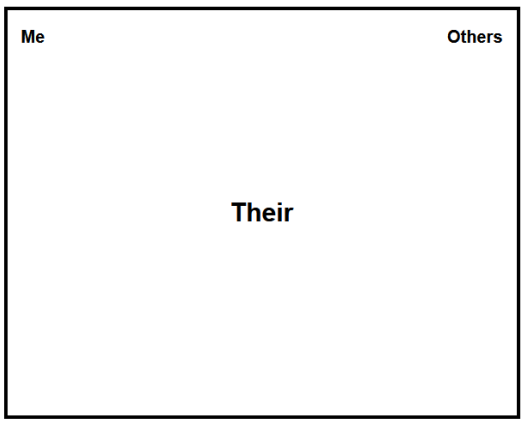
good psychometric qualities with a reported Cronbach's alpha of .94 and good test-retest reliability (Smith & Betz, 2000).

***Implicit Association Test (IAT)***

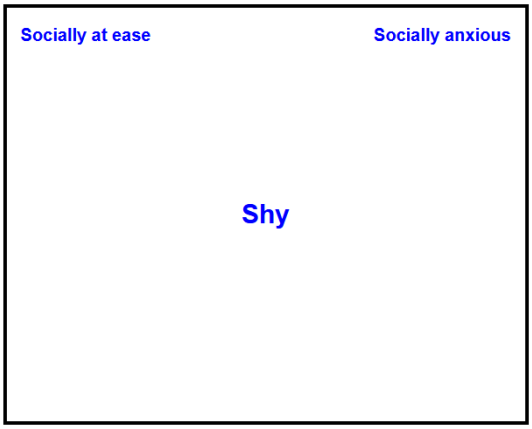
An IAT was employed to assess the level of implicit SA bias. Participants were asked to complete 7 blocks of a discrimination task as fast as possible. In each block they had to sort words from the following categories: "Me " versus "Others ", "socially at ease " versus "socially anxious ". The stimuli words (Appendix C) appeared on the middle of the screen and had to be sorted to the categories on the left or right side of the screen (Figure 5). The first three blocks were training blocks. Followed by a congruent test block where "Me " and "socially at ease " were presented together on one side and opposed by "Others " and "socially anxious ". Then two training blocks and an incongruent test block were completed. For the incongruent block, the configuration of concepts was switched. "Me " and "socially anxious " were opposed by "Others " and "socially at ease " (Figure 5). Based on the reaction times it could be established how strong the associations between stimuli and categories and the different configurations of categories were, and therefore the level of SA bias was established.

**Figure 5**

*Procedure of IAT*

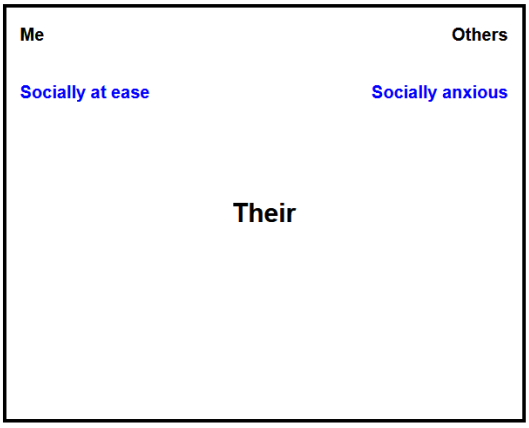
| **Block** | **Stimuli** |
|---|---|
| Block 1 – Training |  |
| | 20 discrimination tasks: "Me" vs. "Others" |

Block 2 - Training



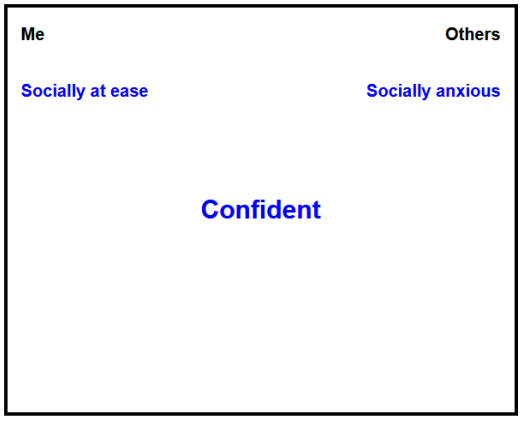

20 discrimination tasks: “socially at ease” vs. “socially anxious”

Block 3 - Training



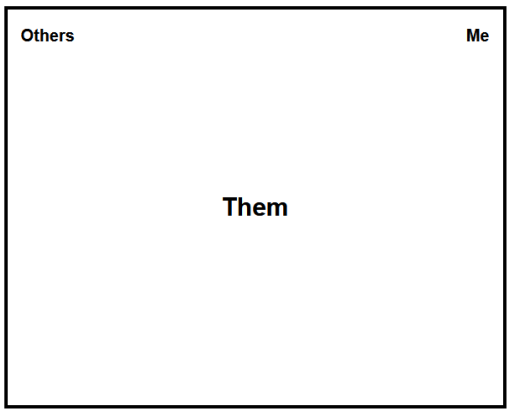

20 discrimination tasks: “Me/socially at ease” vs. “Others/socially anxious”

Block 4 – Test with congruent categories



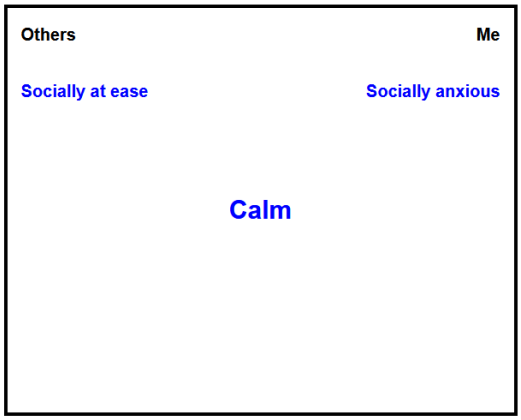

40 discrimination tasks: “Me/socially at ease” vs. “Others/socially anxious”

Block 5 – Training with switched sides



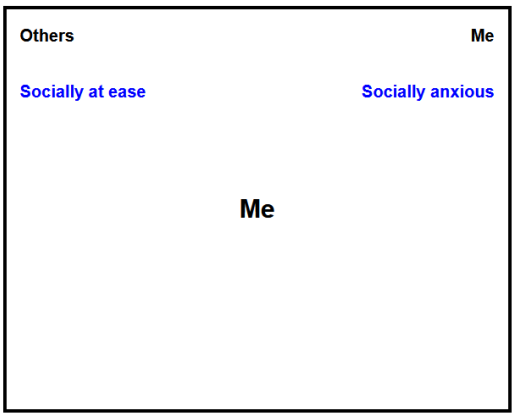

20 discrimination tasks: “Others” vs. “Me”

Block 6 – Training with switched sides and incongruent categories




20 discrimination tasks: “Others/socially at ease” vs. “Me/socially anxious”

Block 7 – Test with switched sides and incongruent categories



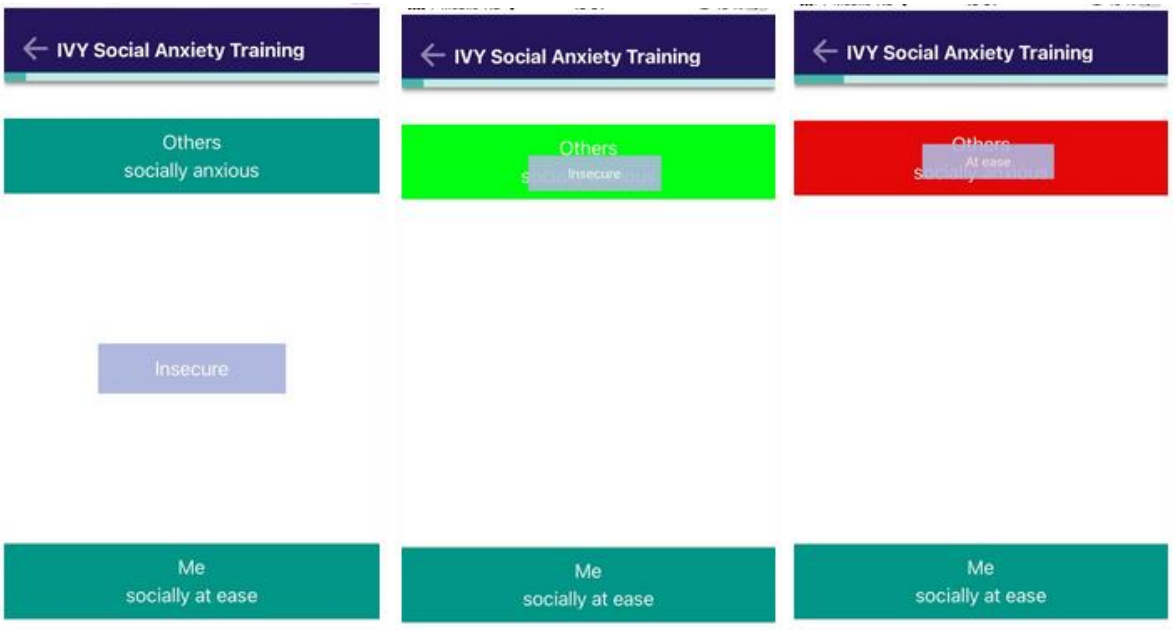

40 discrimination tasks: “Others/socially at ease” vs. “Me/socially anxious”

### *Social Anxiety Bias App (SAB app)*

Finally, the CBM training was conducted through the SAB app. The SAB app is part of the TIIM app maintained by the BMS lab of the University of Twente. It was available for free in the iTunes App Store for IOS or the Play store for Android devices. Within the app participants were able complete daily CBM training. Modules were made available that consisted of 120 discrimination tasks each. The same stimuli as in the IAT were used (Appendix C) and each presented five times in a randomized order. Participants were instructed to swipe word stimuli from the middle of the screen up or down towards the associated category "Others/socially anxious" or "Me/socially at ease" (Figure 6). Correct allocations were acknowledged with a sound and the category label turned green (Figure 6). In case of incorrect allocations, the category label turned red, and the task had to be repeated (Figure 6). Apart from providing participants with the training sessions, the application also offered reminders in the form of push notifications. Despite the fact that the SAB app was still being tested and improved, a previous study looking into its influence on explicit and implicit vitality found promising results (Wächtler, 2019). After 14 days of using the app, a significant increase in implicit vitality and in explicit vitality for consciously fatigued students was found (Wächtler, 2019).

**Figure 6**

*Screenshots from SAB App*




Start Screen Correct Response Incorrect Response

**Design**

A quasi-experimental within-subject design was employed in this study, with participants completing a pretest on day 1, completing the SAB training twice a day for four days, and subsequently completing a posttest on day 6. This timeline was chosen as a result of the substantiation between the number of sessions needed to find effects and the expectation that drop-out rates increase, and adherence decreases over time. The effect of the SAB training on the dependent variables "implicit SA bias" and "explicit SA" was tested by comparing the pre- and posttest measures. Furthermore, the "change in PSSE" was included as a possible mediator and the "pre-existing level of PSSE" as a moderator.

**Procedure**

Participants either signed up for the study via "SONA" or were provided directly with an access link by the researchers. Following the link, participants were redirected to soSci where they had to complete a pretest. In the pretest participants were asked to sign an informed consent first and indicate information about their demographics. Afterwards, they completed the LSAS, PSSE and two other scales that are not relevant for the scope of this paper. The survey was followed by the IAT for SA bias. Subsequently, they received instructions on how to download and create a profile in the TIIM app for continuing the study. On the following four days participants completed a CBM training twice a day in the app. Lastly, they were asked for their e-mail address to be able to link the data from soSci and the SAB app. After completion of all SAB app modules, participants received an e-mail including the link for the posttest in soSci and their personal ID that had to be entered in the posttest to enable researchers to link pre- and posttest. The posttest included a repetition of the LSAS and PSSE as well as the IAT for SA bias. Finally, participants were thanked for their participation and, if recruited via SONA, received their credits.

**Data analysis**

SPSS was used to conduct statistical analyses. Before conducting analyses, the dataset needed to be prepared. Participants with missing posttests were excluded. Overall scores for the LSAS and PSSE were computed. As a first step, descriptive statistics were conducted in order to gain a general overview of the dataset. Afterwards, the data was checked for normality by performing a Shapiro-Wilk test, to check the suitability for the subsequent analyses (Rani Das, 2016).

The improved D-scores (Greenwald et al., 2003) were used to compare the strengths of the associations between categories in pre- and post-test scores of the IAT. Therefore, the average response times for blocks three, four, six and seven were calculated. In the next step,

the response time latencies for each configuration (block three and four vs. block six and seven) were contrasted. Results should range between -2 and +2 (Nosek et al., 2013). A positive value indicates a stronger association between words related to being socially at ease and self-concept words. A more negative value indicates a stronger association between SA words and self-concept words, and hence an implicit SA bias (*Implicit Association Test (IAT)*, 2022). The mean differences between pre- and post-test d-scores allowed to conclude on the changes in implicit SA bias. A paired t-test was used. Results with $p < .05$ were accepted as significant and results with $p < .10$ were accepted as marginally significant.

The change in explicit SA was established by comparing the mean difference in the pre- and post-test scores of the LSAS. A paired t-test was performed.

To establish whether the level of PSSE is a predictor for implicit SA bias (RQ2.1, RQ2.2) or explicit SA (RQ2.3, RQ2.4) bivariate correlation analyses were conducted, and a Pearson's correlation coefficient determined.

A repeated measures ANOVA was conducted in order to test whether change in PSSE is a mediator for the effect of SAB training on implicit SA bias (RQ3.1) and explicit SA (RQ3.2). Using a repeated measures ANOVA the significance of a change in mean-scores can be established. For RQ3.1 pre- and posttest d-scores were included as within-subject variables and the change in PSSE as a covariate. The same analysis with pre- and posttest LSAS scores and change in PSSE as a covariate was conducted in order to answer RQ3.2.

A repeated measures ANOVA was also performed to establish whether PSSE has a moderating effect. Here, the baseline PSSE was included as a covariate and pre- and posttest d-scores (RQ4.1) and LSAS scores (RQ4.2) as within-subject variables.

## Results

### Assumptions

In a first step, it was tested whether the data was suitable for the planned analyses. A Shapiro-Wilk test was used to check the assumption of normality (Rani Das, 2016). The d-scores in the present sample were normally distributed (pretest $p = .682$; posttest $p = .078$). Therefore, parametric tests were conducted. The pretest data of the LSAS scores, measuring explicit SA, were also tested for normality. The pre-test LSAS scores were normally distributed ($p = .224$), however the posttest data was found to be not normally distributed ($p = .043$). Nevertheless, after consideration of non-parametric alternatives and due to the fact that the pretest data, the baseline measure in the sample, was normally distributed, it was decided to still conduct parametric tests while acknowledging the limitations.

**Effects of CBM on implicit SA bias and explicit SA (RQ1)**

After confirming the normal distribution of the data, a paired samples t-test was conducted to determine the effect of SAB training on implicit SA. It showed a marginally significant difference between the d-score before training (M=.33, SD=.48) and the d-score score after training (M=.54, SD=.39), t(24) = -2.02, $p$ = .055. The d-scores increased, which indicates shorter reaction times to associate one's self-concept with being socially at ease. Concluding, hypothesis 1.1 can partly be accepted, a marginally significant reduction in implicit SA bias between pre- and posttest was found.

Then the effectiveness of SAB training on explicit SA was tested using a paired t-test. It showed that SAB training did not elicit a statistically significant change in explicit SA as measured with the LSAS (t(24) = 1.14, $p$ = .265). Concluding, hypothesis 1.2 was rejected as no significant difference between the explicit SA in pre- and posttest was found. The non-parametric alternative, a Wilcoxon signed-ranked test, came to the same conclusion, a non-significant change ($Z$ = -1.12, $p$ = .265) in explicit SA was found.

**Correlation between PSSE and implicit SA bias and explicit SA (RQ2.1, 2.2, 2.3 and 2.4)**

A Pearson correlation coefficient was computed to assess the linear relationship between pretest level of PSSE and the pretest level of implicit SA bias. There was a negative correlation between the two variables, r(23) = -.09, $p$ = .659, however it was not significant. The longitudinal effect of the pretest level of PSSE was assessed by establishing the correlation with the posttest level of implicit SA bias. There was a negative correlation between the two variables, r(23) = -.19, $p$ = .376, however it was not significant. As the found correlation was not significant, the hypothesis must be rejected. PSSE was no predictor for the level of implicit SA bias in the pre- or posttest. The same analyses were repeated for explicit SA. A Pearson correlation coefficient was computed to assess the linear relationship between pretest level of PSSE and the pretest level of explicit SA. There was a significant negative correlation between the two variables, r(23) = -.59, $p$ = .002. Thus, the hypothesis was accepted. A longitudinal correlation between pretest level of PSSE and posttest level of explicit SA was found. There was a significant negative correlation between the two variables, r(23) = -.62, $p$ = <.001. Concluding, the hypothesis was accepted.

**PSSE as a Mediator (RQ3.1 and 3.2)**

Repeated measures ANOVAS were conducted to ascertain whether the change in PSSE was a mediator for the effect of SAB training on implicit SA bias (RQ3.1) and explicit SA (RQ3.2). A repeated measures ANOVA was conducted in order to ascertain whether there is a significant difference between pre- and posttest d-scores, measuring implicit SA

bias, mediated by the change in PSSE. The within-subject effect of time for implicit SA bias was again found to be marginally significant, $F(1, 23)= 4.06$, $p = .056$. The mediator "change in PSSE" did not significantly interact with the change in d-scores, $F(1, 23) = .13$, $p = .718$. Thus, the hypothesis that the change of PSSE is predicting the effect of SAB training on implicit SA bias, has to be rejected. The same analysis was repeated for explicit SA. The within-subjects effect of time for explicit SA was determined and found to be non-significant, $F(1,23)= 1.28$, $p = .269$. The repeated measures ANOVA including the change in PSSE, was non-significant, $F(1,23)= .04$, $p = .854$. Therefore, the hypothesis has to be rejected. The change in PSSE is no predictor for the effect of SAB training on explicit SA.

**PSSE as a Moderator (RQ 4.1 and 4.2)**

A repeated measures ANOVA was performed to test whether PSSE is more likely to function as a moderator. The within-subjects effect of time on implicit SA bias was non-significant, $F(1,23)= .37$. This is unexpectly contrary to the results established using a t-test and the mediation analysis. Furthermore, including the pretest level of PSSE as a moderator a non-significant effect was found, $F(1,23) = .07$, $p = .798$. Consequently, the hypothesis that the baseline level of PSSE is a moderator for effect of SAB training implicit SA bias has to be rejected. Another repeated measures ANOVA was performed to assess whether the pretest level of PSSE is a moderator for the effect of SAB training on explicit SA. The effect of time on the LSAS score, was found to be non-significant, $F(1,23)= .50$, $p = .486$. Also the moderation effect of the pre-existing level of PSSE was non-significant, $F(1,23) = .86$, $p = .364$. Thus, the hypothesis, that PSSE is a moderator for the effect of SAB training on explicit SA, has to be rejected.

**Summary**

To summarize the main findings, a marginally significant effect of SAB training on implicit SA bias but not explicit SA was found. PSSE had neither a mediating nor a moderating function on the effect of SAB training on implicit SA bias or explicit SA. However, in both pre- and posttest the level of PSSE was a significant predictor for the level of explicit SA. This effect was not found for implicit SA bias.

## Discussion

The aim of this study was to test the effectiveness of cognitive bias modification (CBM) as a novel treatment option for social anxiety (SA). Specifically, the effect of training in the Social Anxiety Bias app (SAB app) on explicit and implicit SA bias was tested.

Additionally, it was explored whether Perceived Social Self-Efficacy (PSSE) interacts with the effects.

The results showed that the SAB training had a marginally significant effect on implicit SA bias. After completing up to eight training sessions, participants were slightly faster to associate themselves with words describing being socially at ease and less likely to associate themselves with words related to being socially anxious. It has to be noted, that an effect was found even though the sample was rather small and complete adherence to all trainings could not be assured. No a-priori power analysis was conducted, but post-hoc it is recommended to include a larger sample to increase the achieved statistical power when replicating the study. Doing this, the probability of a type 2 error, rejecting a hypothesis even though it is probable, can be decreased (Jones, 2003). This is of importance as the effect of SAB training on implicit SA bias was only marginally significant, and all other analyses on the effect of SAB training found non-significant results. Thus, an even stronger effect is possibly expected within a larger and more adherent sample. Nevertheless, the findings of this study are an extension of existing evidence for the effectiveness of CBM for interpretation and attentional biases regarding anxiety (Beard et al., 2012; Hakamata et al., 2010; Hirsch et al., 2018; Liu et al., 2017). However, it has to be kept in mind that this study used novel stimuli words and addressed a SA self-concept bias which has not been in the focus of CBM research. Therefore, the results may only provide preliminary support for the effect of CBM on SA but still build a foundation for future studies investigating the validity of the results.

Regarding explicit SA, a decrease in self-reported SA in the LSAS was found, but the effect was not significant. The larger reduction in implicit SA bias compared to explicit SA appears to be logical, as CBM targets implicit cognitions and is hypothesized to consequently affect explicit cognitions and symptoms. Hertel and Mathews (2011) likewise conclude that the change in implicit biases is not immediately recognized by participants. Hallion and Ruscio (2011) found that explicit effects only become relevant in stressful situations. For example, participants of a study by Dandeneau et al. (2007) reported lower levels of anxiety during exams after attending CBM training. Therefore, the rather short timeframe of the intervention and the absence of a stressor during the posttest might be able to explain that the effects found in explicit SA were weaker or not yet perceived by participants. The short time frame of four days of training was initially chosen to increase the adherence of participants. However, the adherence in the study remained low. Less than half of the participants who completed the pretest (25 out of 54) continued to register in the SAB app and completed the

posttest. Feedback from participants revealed that most dropped out of the study due to technical issues. For example, the app kept getting stuck during training or the reminders were sent out late or not at all. Thus, the SAB app requires improvement before further testing. These issues might also have influenced the results, as participants needed own motivation to keep up with trainings and their representativeness might be limited. This has to be kept in mind, when determining a suitable target group of CBM, for example in a clinical setting. It is hypothesized that stronger effects could have been found with higher adherence and a longer training period to consolidate the learned associations. However, research on the optimal number of training sessions is still inconclusive (Eberl et al., 2013; Hallion & Ruscio, 2011; Jones & Sharpe, 2017). Moreover, several participants experienced delays between training sessions and between training and the posttest. Immediate effects of the intervention could not be established for all participants. Therefore, it cannot be accounted for the effect of time on the results and on differences between subjects. A delay before the posttest might have led to an increase or decrease in the found effects. Additionally, it has to be kept in mind that the sample was created by convenience sampling, and therefore there were not necessarily clinical indications for SA or SA symptoms present from the beginning. A pretest mean score of the LSAS of 49.64 was found, whereas a cut-off score of 60 is indicating a classification as SA (Rytwinski et al., 2009). This ceiling effect limits the potential for improvement, as the baseline level of SA was relatively low. Nonetheless, there was a considerable variance found in the SA scores of participants (see Appendix D). Therefore, the decrease in implicit SA bias remains a promising antecedent of further effects encompassing explicit SA.

The observed effect on implicit SA bias and explicit SA could not be explained by including PSSE in the analyses. PSSE did not increase significantly and did not have a mediating or moderating role on the effect of SAB training on implicit SA bias or explicit SA. It has to be noted for future studies, that to confidently establish whether a mediation is present the measure of the mediator, PSSE, would have needed to precede the posttest measure of SA and should not be included in the posttest (Kazdin, 2007). Previously it was expected that CBM training increases the level of PSSE and with feeling more capable to manage social situations SA was hypothesized to decrease. However, it can be concluded that CBM does not seem to work by increasing the level of PSSE. A possible explanation for these results might be that PSSE is an explicit construct measured by a self-report and the SAB training aims at implicit cognitions. This is further supported by the findings of the correlation analyses. The correlation analysis showed that there was significant negative

correlation between the pre-existing level of PSSE and explicit SA but not implicit SA bias. Thus, it can be concluded that after eight sessions, the effects of SAB training remained implicit and therefore, PSSE, as an explicit construct, was not affected, nor has it affected the effects of SAB training. SAB training showed a marginally significant effect on implicit SA bias, but the effects were not recognized by participants in the explicit SA measure. This finding further supports the idea that CBM attains its effects by affecting implicit constructs and extending effects to explicit SA might take longer. Further research is needed to investigate other explanatory factors.

One more conspicuity that should be mentioned, was found in the moderation analysis (RQ4.1). The ANOVA established in a first step that the effect of SAB training on implicit SA bias was non-significant. This is contrary to the results of the t-test (RQ1) and the first step in the mediation analysis (RQ3.1). No possible explanation for this was found. Furthermore, the significance of the results of this study needs to be apprehended with caution because no control-group was included. Therefore, the found effects cannot be attributed to SAB training with complete confidence. However, the conclusions on the effectiveness of SAB training are based on existing literature that suggests the likelihood of such effects being caused by CBM. Nevertheless, a possible placebo-effect cannot be eliminated nor other influences during the study. A variety of influences from the environment is imaginable, for example a positive or negative experience in a real-life social situation could have influenced the posttest level of SA. Lastly, a fundamental debate underlies the measurement of implicit cognitions. It remains questionable whether it is possible to truly measure implicit biases using d-scores or any other measure. It is controversial if a measure of reaction times is able reflect existing biases (Singal, 2018). Researchers should be aware that results of the IAT should be cautiously used for conclusions about real-life biases.

**Implications for future research**

The results of this study propose a promising indication that CBM training can be effective to improve at least implicit SA and presumably explicit SA in the long term. Future studies using an improved version of the SAB app are recommended. Replicating the experimental design with more participants and including a control group of sufficient size is suggested to validate the found effects and to exclude the possibility of a placebo-effect or underestimation of effects. A longer study duration is recommended to examine whether the marginal effect on implicit SA bias is able to extend to explicit SA. However, it is not yet known what the optimal duration of CBM training is. A replication with a clinical sample of

SA patients is proposed to give further insight into the effectiveness of CBM training on explicit SA symptoms. Furthermore, including not only a posttest immediately after completing the training sessions but a delayed posttest might allow researchers to draw conclusions on the prolonged effects of CBM training. Lastly, it remains unclear whether there are mediating or moderating factors that are able to explain the underlying mechanisms of CBM training and its effects on implicit and consequently explicit SA.

**Conclusion**

The present study can be considered an indicator that CBM as a novel treatment option for SA is promising. Initial reductions of implicit SA bias were found after up to eight training sessions in a non-clinical sample. Future research is recommended to validate these preliminary results and to determine whether effects on implicit SA bias can extent to explicit SA. Validating CBM as a treatment option offers the potential to develop an augmentation to therapy since many disorders or attitudes are based on or reinforced by implicit cognitions. For example, reducing anxiety, reducing drug abuse, or even generally reinterpreting experiences, or inducing more positive thinking, seems possible (Hertel & Mathews, 2011). As it is highly personalizable and can be done with relatively small effort, it is appealing to a wide range of people and might provide a response to current high barriers for treatment.

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## Appendix A

## Liebowitz Social Anxiety Scale

How much fear or anxiety do you feel in the following situations?

| | None | Mild | Moderate | Severe |
|---|---|---|---|---|
| 1. Using a telephone in public | | | | |
| 2. Participating in a small group activity | | | | |
| 3. Eating in public | | | | |
| 4. Drinking with others | | | | |
| 5. Talking to someone in authority | | | | |
| 6. Acting, performing, or speaking 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 face to face with someone 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 of your ability, skill, or knowledge | | | | |
| 18. Expressing disagreement or disapproval to someone you don't know very well | | | | |
| 19. Looking someone who you don't know very well straight in the eyes | | | | |
| 20. Giving a prepared oral talk to a group | | | | |

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| 21. Trying to make someone's acquaintance for the purpose of a romantic relationship |
| 22. Returning goods to a store for a refund |
| 23. Giving a party |
| 24. Resisting a high pressure sales person |

How often do you avoid the following situations?

| | None | Mild | Moderate | Severe |
|---|---|---|---|---|
| 1. Using a telephone in public | | | | |
| 2. Participating in a small group activity | | | | |
| 3. Eating in public | | | | |
| 4. Drinking with others | | | | |
| 5. Talking to someone in authority | | | | |
| 6. Acting, performing, or speaking 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 face to face with someone 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 of your ability, skill, or knowledge | | | | |
| 18. Expressing disagreement or disapproval to someone you don't know very well | | | | |
| 19. Looking someone who you don't know | | | | |

| |
|---|
| very well straight in the eyes |
| 20. Giving a prepared oral talk to a group |
| 21. Trying to make someone's acquaintance for the purpose of a romantic relationship |
| 22. Returning goods to a store for a refund |
| 23. Giving a party |
| 24. Resisting a high pressure sales person |

## Appendix B

## Perceived Social Self-Efficacy Scale

Please rate how confident you feel on the following statements. There are no right or wrong answers.

| | No confidence | Little confidence | Moderate confidence | Much confidence | Complete confidence |
|---|---|---|---|---|---|
| 1. Start a conversation with someone you don't know very well. | | | | | |
| 2. Express your opinion to a group of people discussing a subject that is of interest to you. | | | | | |
| 3. Work on a school, work, community or other project with people you don't know very well. | | | | | |
| 4. Help to make someone you've recently met feel comfortable with your group of friends. | | | | | |
| 5. Share with a group of people an interesting experience you once had. | | | | | |
| 6. Put yourself in a new and different social situation. | | | | | |
| 7. Volunteer to help organize an event. | | | | | |

| |
|---|
| 8. Ask a group of people who are planning to engage in a social activity (e.g., go to a movie) if you can join them. |
| 9. Get invited to a party that is being given by a prominent or popular individual. |
| 10. Volunteer to help lead a group or organization. |
| 11. Keep your side of the conversation. |
| 12. Be involved in group activities. |
| 13. Find someone to spend a weekend afternoon with. |
| 14. Express your feelings to another person. |
| 15. Find someone to go to lunch with. |
| 16. Ask someone out on a date. |
| 17. Go to a party or social function where you probably won't know anyone. |
| 18. Ask someone for help when you need it. |

| |
|---|
| 19. Make friends with a member of your peer group. |
| 20. Join a lunch or dinner table where people are already sitting and talking. |
| 21. Make friends in a group where everyone else knows each other. |
| 22. Ask someone out after s/he was busy the first time you asked. |
| 23. Get a date to a dance that your friends are going to. |
| 24. Call someone you've met and would like to know better. |
| 25. Ask a potential friend out for coffee. |

## Appendix C

## Stimuli words IAT

| Category | Stimuli |
|---|---|
| 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 |

## Appendix D

## Graphical Representation of Variance in Implicit and Explicit SA Scores