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Implicit but Stable: Mental Imagery Changes Explicit but not Implicit Anxiety

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ABSTRACT

This study investigates the malleability of explicit and implicit anxiety through mental imagery. Sixty adults imagined themselves in an anxious, calm, or neutral situation. Thereafter, explicit state and trait anxiety were assessed with self-reports, and implicit anxiety was assessed with a variant of the Implicit Association Test. The results indicate that imagery manipulation changed state anxiety in the expected direction. Explicit trait anxiety and implicit anxiety, however, were found to be stable. These findings suggest that the implicit self-concept of anxiety has trait-like characteristics and is as stable against a short-term voluntary mental control strategy as an established explicit measure of trait anxiety.

Introduction

For the last 20 years, mental imagery has been considered an important factor for inducing, changing, and modulating emotions, and it has been extensively employed as a standard procedure in clinical and experimental psychology to transform dysfunctional moods (e.g., Wolpe, 1958) and to induce emotions in the laboratory (e.g., Lang, 1979). A surge of interest in this phenomenon was recently described in cognitive psychopathology as attested to by a special issue of *Memory* devoted fully to mental imagery (Holmes & Hackmann, 2004). In this context, several studies demonstrated that mental imagery is indeed an influential strategy for intentionally modulating emotions. In general, the impact of mental imagery on emotions has been assessed with explicit measures (basically self-report: e.g., Holmes & Mathews, 2005). Yet, it is worth mentioning that explicit measures have two important constraints (Greenwald et al., 2002): *introspection limits* (i.e., lack of awareness especially for the more "automatic" components of the response) and *response biases* (i.e., deliberate modification of certain aspects of the response, as with social desirability). These limitations may diminish the validity of explicit measures and, consequently, the strength of the conclusions that can be drawn from studies on mental imagery.

In an attempt to overcome these limits, scholars in cognitive psychopathology recently showed a growing interest in indirect measures of emotion information processing (e.g., De Houwer, 2002) such as nonverbal expression and implicit cognitive tasks. So far, only few studies have implemented such measures to investigate mental imagery and emotions.

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Concerning nonverbal expression, it has been shown that holding a negative self-image in mind during a conversation not only modifies self-reported anxiety, but also contaminates the quality of the interaction as judged by conversational partners (Hirsch, Meynen, & Clark, 2004) and independent judges (Hirsch, Mathews, Clark, Williams, & Morrison., 2003). Despite the fact that these findings were not replicated in a more recent study (Hirsch, Mathews, Clark, Williams, & Morrison, 2006), the abovementioned studies suggest that holding a mental image in mind can modulate the implicit aspects of the emotion process. More direct evidence for the modulation effect of mental imagery on implicit constructs has been observed using cognitive tasks.

Concerning implicit cognitive tasks, Hirsch et al. (2003) showed that nonanxious volunteers who were trained to hold a negative self-image in mind (similar to the kind spontaneously described by anxious persons) demonstrate the same lack of inferential bias commonly observed in anxious individuals during a lexical decision task. In the authors' view, this result shows that mental imagery can induce biased information processing similar to a genuine anxious state. Unfortunately, this conclusion is built upon the interpretation of a null finding, with only 14 participants, and with a substantial exclusion rate (about 30% because of difficulties in holding the negative image in mind). Furthermore, no reliability of the employed implicit measure is reported. Yet, as indicated by Bosson, Swann, and Pennebaker (2000), only a few of the currently used implicit measures show adequate internal consistency. Thus, replications of these results with empirically validated implicit measures are necessary.

A recently developed task for assessing implicit stereotypes, the Implicit Association Test (IAT: Greenwald, McGhee, & Schwartz, 1998) presents good internal consistency and has been successfully adapted to anxiety (IAT- Anxiety: Egloff & Schmukle, 2002). The IAT is a general purpose procedure for measuring the relative strengths of associations between concepts. This is done by comparing response times in two combined classification blocks during which participants are required to sort items along two semantic dimensions (i.e., ME-OTHER and anxious-calm). In a first critical block, concepts are combined and assigned together to the same response key, in agreement with a positive self-representation (ME-calm and OTHER-anxious). A reverse arrangement is used in a second critical block (ME-anxious and OTHER-calm). The basic assumption of the IAT is that the sorting task is easier (as defined by lower latencies and fewer errors) when items belonging to closely associated response categories are responded to using the same response key, as compared to conditions when less closely associated categories are used. Egloff and Schmukle (2002) demonstrated that the IAT-Anxiety can predict observer-rated anxiety during a stressful speech. Although the IAT-Anxiety effect is fairly stable over time (Egloff, Schwerdtfeger, & Schmukle, 2005), previous studies have shown that it varies as a function of gender (Egloff & Schmukle, 2004) and trait anxiety (Schmukle & Egloff, 2004). More interestingly, Egloff and Schmukle (2002) show that the IAT-Anxiety is a reliable measure for predicting behavior (e.g., anxious expressions) over and above self-reported anxiety. The IAT-Anxiety is generally unaffected by social desirability (Egloff & Schmukle, 2003) and faking instructions (Egloff & Schmukle, 2002). This suggests that the implicit component of the anxiety self-concept may be relatively immune to attempts at voluntary control through faking efforts. However, the question of its malleability through other cognitive strategies remains open. For instance, Egloff, Week, and Schmuckle (2007) showed that writing about anxiety-arousing (vs. extraversion-arousing) situations did not lead to a change in IAT- Anxiety as such, but did significantly enhance the relationship between implicit and explicit anxiety. Interestingly, this study

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suggests that cognitive manipulations might modify the rank order of participants' IAT-Anxiety scores (by enhancing explicit-implicit synchronization), while leaving mean IAT-Anxiety scores unchanged.

A review of the IAT literature in social psychology indicates that a certain number of situational cues or mental strategies readily influence implicit attitudes and stereotypes (Blair, 2002). This effect is often observed in psychopathology. Teachman, Gapinski, Brownell, Rawlins, and Jeyaram (2003) showed that evoking empathy through stories of discrimination against overweight people did not produce lower implicit anti-fat attitudes in a broad-spectrum sample. However, this manipulation led to a lower IAT bias in overweight participants. Using an IAT task, Teachman, Woody, and Magee (2006) recently showed that participants who were informed that intrusive thoughts are personally meaningful-compared to those who receive meaningless information or no information at all - implicitly reevaluated their intrusive thoughts as being more important.

Taken together, these recent findings are consistent with the hypothesis that, for certain cognitive manipulations, there is a degree of malleability in affective IAT measures. This is in line with a growing body of evidence in the domain of social psychology showing that the malleability of implicit associations can be obtained with a wide range of different cognitive strategies (for a review, see the special issue of the *Journal of Personality and Social Psychology* devoted to the topic (Vol. 81, 2001: or Blair, 2002). On the contrary, other findings indicate that implicit anxiety is fairly stable (Egloff & Schmukle, 2002, 2003). Thus, many questions remain unanswered about the specific factors that effectively shift implicit self-concepts.

Given its impact on explicit as well as implicit components of affective processing, mental imagery is a good candidate to change implicit anxiety as assessed by the IAT-Anxiety. To our knowledge, no study has yet been published on the effect of mental imagery on IAT self-concepts in the domain of psychopathology. However, in social psychology, Blair, Ma, and Lenton (2001) showed that it is possible to alter implicit gender stereotypes (measured with an IAT task) following a mental imagery procedure during which respondents are asked to hold in mind the image of a counter-stereotypical "strong woman.'' This finding suggests that implicit representations can intentionally be altered through voluntary mental strategies. However, it is not certain that this conclusion can be directly generalized to the self-concept of personality.

In sum, the current study investigates whether three mental imagery conditions (anxious, calm, and neutral) differentially modulate explicit and implicit self-representations of anxiety. In accordance with previous evidence in the domain of cognitive psychopathology and social psychology, we hypothesize that mental imagery can indeed alter explicit and implicit self-representations of anxiety in a contents-congruent direction.

Method

SAMPLE

Sixty women who were fluent French speakers were recruited from introductory psychology classes at the University of Geneva and volunteered to participate in the experiment. They were randomly assigned to one of three mental imagery conditions. The three groups did not differ with respect to age ($F(2, 57) = 1.64$, *ns;* $M = 22.07$: $SD = 1.80$), years of formal education ($F(2, 57) = .94$, *ns;* $M = 15.83$:

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SD = 1.62), or verbal (F(2, 57) = .45, *ns; M*= .59: *SD* = .22) or imaginal competencies (F(2, 57) = 1.71, *ns; M*= .78: *SD* = .15), as assessed by the Individual Differences Questionnaire (IDQ: Paivio, 1971). The IDQ consists of 86 items designed to assess verbal (e.g., "I have no difficulties expressing myself verbally") and imaginal (e.g., "I can easily picture moving objects in my mind") habits, abilities, and preferences. In our sample, the IDQ shows good reliability (a = .88 for the imaginal and *a* = .75 for the verbal subscore).

MATERIAL AND MEASURES

Manipulation Check

Affective Self-Assessment

In order to check the general impact of the mental imagery manipulation, participants were asked to retrospectively evaluate their feelings during the mental imagery task and to report them on a Self-Assessment Manikin (SAM: Bradley & Lang, 1994). The SAM is a nonverbal pictorial selfreport questionnaire, classically used in mental imagery studies that measures the three main dimensions of the emotional state: Valence (from *positive* to *negative),* Arousal (from *active* to *passive),* and Dominance (from *submissive* to *dominant).* Each dimension is reported on a 5-point scale constituted by a schematic drawing of a manikin. This quick nonverbal assessment tool has shown good convergent validity with several psychophysiological indicators of emotion, such as startle reflex, heart rate, and skin conductance (e.g., Gomez & Danuser, 2004).

Quality of Mental Imagery

Participants were asked to report the quality of the mental imagery they created on five 7-point semantic differentials *{unreal/real, fuzzy/brilliant, vague/precise, dull/vivid,* and *global/detailed).* The five scores displayed a marginally acceptable internal consistency (a = .64) and were averaged to obtain a mean "Image Quality" score per participant.

Explicit Measures

State-Trait Anxiety Inventory (STAI; Spielberger, 1993)

The STAI is a widely used self-report questionnaire that assesses state anxiety (STAI-S) and general trait anxiety (STALT). Each score is measured by 20 items. For each item, respondents are asked to report their anxiety level on a 4-point scale ranging from 1 "almost never" to 4 "almost always." The STAI has been shown to possess good psychometric properties in previous studies (Spielberger, 1993), as well as in our sample (a = .84 for STAI-T and a = .96 for STAI-S).

Explicit Anxiety State (EAS)

Participants were asked to rate their present affective state with reference to the 12 adjectives used in the IAT-Anxiety (i.e., the five *anxious* and five *calm* stimulus words, plus the two concept labels: see Appendix A) and to indicate their state on 9-point visual analog scales ranging from 1 *not at all* to 9 *very strongly.* After reversal of the calm items, an average anxiety score was calculated across the 12 ratings. The internal consistency of this anxiety scale was good (a = .96).

Implicit Measure

The implicit self-concept of anxiety was measured with the IAT-Anxiety. This task was developed and

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run using Eprime software (Schneider, Eschman, & Zuccolotto, 2002) and administered on a desktop PC. The task requires participants to sort words into four semantic categories (ME/OTHER; anxious/calm). Five words from each category (see Appendix A) were presented several times in a sequence of five blocks of trials (see Appendix B). The 10 attributes linked with the *anxious/calm* dimension were preselected from a list of 58 adjectives used in a neuroticism scale (J.P. Rolland, personal communication, September 22, 2000).

In the IAT-Anxiety, stimulus words were presented sequentially in the center of the screen and participants were required to categorize them by pressing a right or left response key previously assigned in accordance with the category labels listed at the top left- and right-hand corners of the screen. Participants completed 5 blocks. As shown in Appendix B, Blocks 3 and 5 were critical for the definition of the IAT-Anxiety effect. In Block 3, words were categorized with the left response key when they belonged to the categories *ME* or *calm* and the right response key when they belonged to the *OTHER* or *anxious* categories. In Block 5, the reverse label combinations were used. Participants' responses and associated reaction times were recorded for each trial. Participants were instructed to respond as quickly and accurately as possible. After incorrect responses, error feedback was given and a correct answer had to be given before moving on to the next trial. The IAT-Anxiety took about 10 minutes to complete.

Data Reduction

In accordance with Greenwald, Nosek, and Banaji (2003), IAT D effects were computed with the following algorithm. First, Block 3 and Block 5 latencies greater than 10,000 ms were deleted. Second, the pooled latency *SD* from Blocks 3 and 5 was computed for each participant. Third, the difference between the mean latencies of Block 3 (ME-calm) and Block 5 (ME-anxious) was divided by the pooled latency *SD.* Higher IAT scores thus indicate greater implicit anxiety. No participants showed error rates in excess of 20%, so all data were retained for analysis. The internal consistency between the two IAT-Anxiety halves was acceptable ($\alpha = .74$).

Mental Imagery

In all three mental imagery conditions, each individual was asked to take 3 minutes to recall one personal situation from the past year that had elicited an anxious, calm, or neutral feeling, depending on the condition, and to recollect this event as vividly as possible. After creating this personal image, participants were asked to describe it in a short paragraph. Then they were asked to imagine themselves in the same situation as if it were occurring in the present. This self-focused mental imagery was guided by a standard tape about 3 minutes long ("At this very moment, you are, once again, experiencing the event you just described [...] Do you hear any sounds or smell any odors? [...] What are your bodily sensations? [...]"). Then, the tape described the core bodily sensations commonly associated with the given affective state in a present self-focused way *{anxious:* "Your muscles are tense. Your heart is beating faster. You are sweating even though the weather is not particularly warm. Your face is tense. Your breathing has quickened.": *calm:* "Your muscles are relaxed. Your heart is beating slowly. You are not sweating and the weather is fine. Your face is relaxed. Your breathing is relaxed.": *neutral:* "Your muscles are neither tense nor relaxed. Your heart is beating at the normal rate. You are not sweating and the weather is like it is on any other day. Your face is not particularly expressive. Your breathing is regular."). Finally, the tape guided participants' imagery to the target feeling *{anxious:* "At this very moment, you feel stressed,

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overcome by a bad feeling."): *calm:* "At this very moment, you feel relaxed, overcome by a good feeling."): *neutral:* "At this very moment, you feel normal: you are not overcome by any particular feeling.").

Procedure

Participants were tested individually in a quiet room by two experimenters. Each participant gave written informed consent to participate in the study, was randomly assigned to one of three imagery groups and was asked to listen carefully to the tape and follow the instructions as closely as possible. The mental imagery manipulation lasted about 6 minutes during which time the participant was left alone. Afterwards, participants completed the implicit and then explicit measures of anxiety while keeping the mental imagery in mind. Finally, they filled out the manipulation check questionnaires and were then debriefed and thanked for their participation.

Results

MANIPULATION CHECK

An ANOVA with SAM score (valence, arousal, dominance) as a repeated measures factor and condition (anxious, calm, neutral) as a between-subjects factor revealed a significant multivariate condition effect on the self-reported affective state (F(56, 110) = 11.05, p< .00: partial η^2 = -29). The univariate results obtained for each SAM dimension indicated significant condition effects for valence (F(2, 57) = 15.91: p< -001, partial η^{22} = -36), arousal *{F{2,* 57) = 3.73; p< -05, partial η^2 = -12), and dominance *(F(2,* 57) = 5.05: p< *.05,* partial η^2 = -15). Scheffé posthoc tests confirmed that more negative affect was reported in the anxiety condition than in the other two conditions, and less negative affect was reported in the calm condition than in the neutral condition *(p* < .05). In addition, participants in the anxiety condition reported less dominance than those in the neutral and calm conditions. No significant post hoc group pairwise comparisons were found for the arousal and image quality measures (Table 1).

Table 1 *- Manipulation check for the anxious, calm, and neutral mental imagery groups*

	Groups					
	Anxious		Calm		Neutral	
	M	*SD*	*M*	*SD*	*M*	*SD*
SAM						
- Valence	3.50_a	0.76	1.70_b	0.73	2.25_c	1.45
- Arousal	2.05_a	0.99	2.80_a	1.24	2.90_a	0.97
- Dominance	2.05_a	0.83	3.15_b	1.04	2.60_{ab}	1.35
Image quality	5.16_a	0.92	5.26_a	0.91	5.45_a	0.94

Note. Scores that do not share the same subscript differ significantly according to posthoc comparisons with Scheffé collection accepted if p< .05.

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As shown in Table 2, the groups differed significantly in terms of explicit measures of state anxiety, namely, the EAS *{F{2,* 57) = 61.85, *p* < .01, partial η^2 = -68) and the STAI-S (F(2, 57) = 64.03, p < .01, partial η^2 = .69). Post hoc comparisons indicated that participants who were asked to imagine themselves in an anxious situation reported more intense state anxiety than participants in the calm or neutral conditions (Scheffé *p*< .05, all Cohen's *d* between 3.70 and 2.50: see Table 2). However, there were no significant differences between the three groups with respect to trait anxiety (STAI-T: F(2, 57) = 1.63, *ns,* partial η^2 = .05).

Table 2 *- Explicit and implicit anxiety for the anxious, calm, and neutral mental imagery groups*

	Groups					
	Anxious		Calm		Neutral	
	M	*SD*	*M*	*SD*	*M*	*SD*
Explicit						
EAS	6.56 $_a$	1.05	3.19 $_b$	1.35	2.73 $_b$	1.15
STAI-S	59.45 $_a$	8.17	35.15 $_b$	8.30	32.00 $_b$	8.71
STAI-T	48.05 $_a$	10.17	44.05 a	10.88	42.60 $_a$	8.48
Implicit						
IATD	-0.48 $_a$	0.24	-0.45 $_a$	0.32	-0.58 $_a$	0.27

Note. Scores that do not share the same subscript differ significantly according to posthoc comparisons with Scheffé correction accepted if p< .05.

Table 3 *- Pearson's correlations between measures*

	1	2	3	4
1. SAM-valence	-			
2. EAS	0.40**	-		
3. STAI-T	0.24*	0.22*	-	
4. STALE	0.38**	0.90**	0.24*	-
5. IAT-D	-0.05	0.01	0.09	-0.04

Note. ***p*< .01. **p*- < .05. *N*= 60.

As indicated in Table 2, all the IAT D effect scores were negative. That is, participants tended to respond faster in the "ME-calm" than in the "ME-anxious" block, implicitly endorsing calmness more than anxiety. A one-factorial ANOVA of the I AT D scores was conducted with condition (anxious, calm, neutral) as a between-subjects factor. Interestingly, no group difference emerged (F(2, 57) = 1.19, *ns;* partial η^2= .04), meaning that, in our study, mental imagery did not influence the implicit

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self-concept of anxiety. A post hoc power analysis indicated that a total sample size of 1158 individuals would have been required to increase the statistical power of this effect size to .80 (observed effect size: f= .12: critical F(2, 720) = 3.01, p < .05, λ = 9.68).

Finally, in the total sample, the IAT-Anxiety did not correlate with the explicit measures (Table 3) or with the SAM variables and the subjective quality of the mental image held in mind. In order to examine whether mental imagery moderated these implicit-explicit relationships, we conducted two stepwise regressions with explicit trait and state anxiety as the criterion variables. The IAT D scores as well as the mental imagery conditions (coded as dummy variables) were introduced in the first step. The interaction term between these variables was included in the second step of the equation. The first step model (with IAT and condition) did not predict trait-anxiety variance (= .06, F(3, 59) = 1.18, p = .38), but significantly predicted state-anxiety variance (R^2 = .70, F(3, 59) = 44.15, p< .001). However, in both cases there was no significant improvement in explained variance from step 1 to step 2 (for trait anxiety: $\triangle R^2$ = .01, $F(2,$ 54) = 0.13, p= .88: and for state anxiety: $\triangle R^2$= .01, $F(2,$ 54) = 1.21, p= .31). This indicates that the relationship between implicit and explicit anxiety is not moderated by a specific mental imagery condition.

Discussion

The results of this study showed that state anxiety, but not trait anxiety, increased when a vivid mental image of a past anxiety-provoking situation was created and held in mind. This finding is in line with prior anxiety research, which has consistently found that experimental manipulations can influence the degree of state anxiety over short periods of time (Lamb, 1973: Spielberger & Rickman, 1990). Thus, as already stated by Wolpe (1958) and reformulated in the most recent cognitive theories of psychopathology (Holmes & Hackmann, 2004), voluntarily holding a specific mental image in mind successfully influences emotional states.

Contrary to our predictions, no change was found for implicit anxiety as assessed by the IAT-Anxiety. The strength of implicit anxiety was not influenced by the mental image manipulation, nor did it correlate with any explicit measure of anxiety. The relationship between IAT and explicit anxiety was found to be almost nonexistent for the sample as a whole, as well as for specific mental imagery condition subgroups. Thus, in our study, the specific mental imagery of anxiety situations neither modified lAT-Anxiety scores nor modulated the relationship between explicit and implicit measures of anxiety. This suggests that short lasting mental imagery modifies respondents' subjective feelings while leaving more automatic emotional self-concepts unchanged. However, our study does not exclude the possibility that more long-lasting interventions based on mental imagery, for instance, the recently developed "imagery rescripting protocols'' (for more details, see the special issue of Holmes, Arntz, & Smucker, 2007), might induce greater changes in implicit and trait anxiety alike. It should be noted that a post hoc power analysis indicated that the size of our sample allows a convincing statistical observation of a large effect size (of f= .40: power = .78), but it does not allow a conclusive statistical description of a medium effect size (of f= .25 or less). We can thus rule out the possibility that mental imagery can produce a large effect on IAT, but we cannot rule out the possibility that mental imagery has a medium to small effect on implicit measures. Obviously, further studies with larger samples are recommended for replicating our preliminary data and

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shedding new light on this issue.

In the present study, in accordance with the findings of Greenwald et al. (1998), the explicit and implicit measures were not correlated, which indicates that two fairly independent emotion information processes underlie the two types of measures: One process is strongly susceptible to mental imagery, while the other is not. This is consistent with the idea that the IAT-Anxiety is predominantly a measure of implicit trait anxiety (Egloff et al., 2005: Schmukle & Egloff, 2004). In addition, our study showed that the implicit anxiety captured by the IAT-Anxiety cannot be changed by short-term mental imagery any more than it can be changed by faking instructions (Egloff & Schmukle, 2002) or social desirability (Egloff & Schmukle, 2003). Although strategies that influence long-term dispositions can be expected to change I AT-Anxiety scores, those that influence short-term affective states cannot. Accordingly, Schmukle and Egloff (2004) recently demonstrated that IAT-Anxiety scores did not change when a state of anxiety was induced by public speaking. Similarly, Glen and Banse (2004) did not find a malleability effect for a self-esteem IAT with a deficit- versus resources-focused interview designed to modulate self-esteem. Taken together, these studies suggest that short-lasting mental imagery modifies participants' subjective feelings while leaving their emotional dispositions and implicit emotional self-concepts unchanged.

This conclusion is not, however, compatible with the results of the study by Blair et al. (2001), which showed a malleability effect of a short-term mental imagery procedure - analogous to the one we used - on implicit stereotypes, or with a fairly substantive body of new findings showing malleability of implicit self-concepts through different mental manipulations (e.g., Teachman et al., 2003, 2006). The discrepancy between data from this latter line of studies and our data can be explained by differences in manipulation procedures. To our knowledge, the investigations that successfully showed a malleability effect of IAT self-concepts principally relied on strategies that may be less voluntary than mental imagery, for example, information priming and empathy suggestion through story reading (Teachman et al., 2003) and situation reappraisal via specific instructions (Teachman et al., 2006). Moreover, none of these studies described a malleability effect on the IAT- Anxiety (but rather on the IAT-Fat Attitude an implicit measure of the attitude toward fat items, and on the IAT-Thoughts Evaluation a measure of the implicit evaluation of thoughts). These methodological differences reduce the possibility of determining the source of the discrepancies with a simple explanation. Given the fact that malleability effects on IAT measures have mainly been obtained with involuntary (e.g., priming or reappraisal) rather than voluntary mental strategies (e.g., faking or mental imagery), one can argue that further studies can more easily describe malleability effects with involuntary rather than voluntary control strategies. Even if new studies varying control strategies in a coordinated way are considered necessary, the validity of the IAT task as a measure of implicit self-concepts in general and implicit anxiety in particular is now well established (e.g., de Jong, 2002; Egloff & Schmuckle, 2002, 2003, 2004; Tanner, Stopa, & De Houwer, 2006).

Several explanations can be advanced to account for the discrepancy between our results and the results of Blair et al.'s (2001) study, which also used mental imagery. First, the malleability effect they found may have been an artifact of the suboptimal IAT scoring method they used: Blair et al. (2001) used the "traditional" scoring algorithm (the difference score expressed in ms), while we used the improved scoring algorithm proposed by Greenwald et al. (2003; D score similar to an individual effect size measure). The new scoring method has been shown to be superior because the D measure is not influenced by age or cognitive skill confounds, such as response speed (Cai, Sriram,

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Greenwald, & McFarland, 2004) or task set switching effects (Mierke & Klauer, 2003).

Second, our study may have missed a substantial malleability effect because of the lack of sensitivity of the IAT- Anxiety. However, this seems improbable, because even if the validity of the IAT-Anxiety is still subject to debate, Egloff and Schmukle (2002) demonstrated that the IAT-Anxiety showed good psychometric properties including internal consistency and predictive validity for the nonverbal expression of anxiety. Replications with other versions of the IAT-Anxiety (i.e., with other anchor labels or items) might well bring to light mental imagery variations of implicit anxiety not captured in the current study.

Third, our findings may result from an inadequate imagery manipulation. Others studies showed that implicit fear associations, as measured using several snake-spider IATs, are malleable in spider phobic patients over the course of a long-lasting treatment, such as group-based exposure therapy lasting about 2 weeks (Teachman & Woody, 2003). Similarly, Dickes, Schmukle, Luka-Krausgrill, and Egloff (2004) described a reduction in the IAT-Anxiety scores of socially anxious patients after successful cognitive-behavioral therapy. The impact of these interventions may be explained by their length, which is considerably superior to the length of our mental imagery manipulation. However, the treatment effect observed in these studies cannot be isolated from a mere learning effect because of the test-retest procedure. Accordingly, a recent study conducted by Huijding and de Jong (2007), which included an adequate test-retest control group of spider phobic participants, showed that the treatment effect captured by the IAT does not exceed the test-retest effect. Unlike Teachman and Woody (2003), who used a three-session intervention, Huijding and de Jong (2007) used a single-session exposure treatment, although this may not have allowed new associations to become overlearned. In more general terms, long-lasting treatments are expected to modify not only affective states, but also more general dispositions, such as personality dimensions and affective traits. Thus, changes in implicit self-concepts, as captured by the IAT tasks and described in these latter studies, seem to be linked to modifications in the participant's personality structure rather than their affective state. These studies suggest that more long-lasting manipulations of emotional schemata, for instance, through cognitive-behavioral therapy, can change trait anxiety as well as the implicit anxiety self-concept. Recent treatment options based on mental imagery, such as mindfulness-based stress reduction (Kabat-Zinn, 1990) or imagery rescripting (e.g., special issue by Holmes, Arntz, & Smucker, 2007), clearly suggest that the long-term practice of mental imagery can indeed change not only explicit feelings but also relatively stable aspects of the emotional process such as dysfunctional appraisal tendencies. The use of implicit measures can therefore shed new light on our understanding of these imagery-based long-term treatments. Long-lasting mental imagery practice might be expected to change both explicit and implicit components of the emotion process and therefore induce long-lasting benefits in a clinical setting.

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Appendix A

IAT-Anxiety: The 4 French labels and their 5 related items [English translations]

MOI [ME]	**AUTRUI** [OTHER]	**Anxieuse** [anxious]	**Sereine** [calm]
je [I]	ils [they]	tendue [tense]	optimiste [optimistic]
ma [my]	les autres [others]	angoissée [anguished]	confiante [confident]
mienne [mine]	eux [them]	stressée [stressed]	rassurée [reassured]
mon [my]	leurs [their]	netveuse [nervous]	équilibrée [balanced]
moi-même [myself]	lui [him]	tourmentée [worried]	détendue [relaxed]

Appendix B

IAT-Anxiety: Block sequence

			Category	
Block	Trials (No)	Task	Left key	Right key
1	40	Initial target categorization	ME	OTHER
2	40	Initial attribution categorization	Calm	Anxious
3	*80*	*Initial combined categorization*	*ME-Calm*	*OTHER-Anxious*
4	40	Reverse target categorization	OTHER	ME
5	*80*	*Reverse combined categorization*	*OTHER- Calm*	*ME-Anxious*