

Attenuating social affective learning effects with Memory Suppression manipulations



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ABSTRACT

People can form opinions of other individuals based on information about their good or bad behavior. The present study investigated whether this affective learning might depend on memory links formed between initially neutral people and valenced information. First, participants viewed neutral faces paired with sentences describing prosocial or antisocial behaviors. Second, memory suppression manipulations with the potential to aid in the forgetting of valenced information were administered. Using the Think/No think paradigm, the effectiveness of four different suppression instructions was compared: Unguided Suppression, Guided Suppression, Distraction, and Thought Substitution. Overall, all the tasks appreciably reduced affective learning based on prosocial information, but only the Guided Suppression and Thought Substitution tasks reduced affective learning based on antisocial information. These results suggest that weakening the putative memory link between initially neutral people and valenced information can decrease the effect of learned associations on the evaluation of other people. We interpreted this as indicative that social affective learning may rely on declarative memories.

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1. Introduction

In laboratory settings, people come to attribute affective value of other people when these people's faces are associated with affectively charged stimuli through pairings or explicit instructions. To illustrate this, let us consider the following examples. Hermans, Vansteenwegen, Crombez, Baeyens, and Eelen (2002) found a decrease in liking for the pictures of faces paired with an aversive electrocutaneous stimulus. Baeyens, Eelen, Van den Bergh, and Crombez (1992) showed that neutral faces underwent a reevaluation when paired with pleasant and unpleasant face pictures. Bliss-Moreau, Barrett, and Wright (2008) reported changes in liking and disliking of people when participants were shown initially neutral faces of these people and asked to imagine the pictured person performing prosocial or antisocial behaviors.

A large body of literature on impression formation and evaluative learning has been amassed over the past fifty years (e.g., Anderson, 1965, 1981; Asch, 1946; Bohner & Wänke, 2002; Chaiken & Stangor, 1987; Eagly & Chaiken, 1993; Hovland, 1951; Hovland, Janis, & Kelley, 1953; Olson & Zanna, 1993; Petty & Cacioppo, 1986; Petty, Fabrigar, & Wegner, 2003). Recently, Bliss-Moreau et al. (2008) developed a minimalist impression formation paradigm that has proven to have both

practical and theoretical values. At the practical level, it represents the way people might learn about the value of others based on information about their good or bad behavior in everyday situations. At the theoretical level, studying the mechanisms underlying this type of social affective learning is fundamental to our understanding how people form opinions about others, which presumably help people to navigate their social world. However, more work clearly needs to be done to better understand the mechanisms of this social affective learning. Although suggestive, the data reported by Bliss-Moreau et al. (2008) do not answer an important theoretical question: Does the picture of a person come to elicit an affective response because a memory link was formed between it and emotional information? One way to address this question would be to manipulate the [effective] strength of the memory link by experimentally suppressing the memory of the emotional information that was previously paired with the neutral faces. Because this is a problem of learning and memory, studies of memory control examining the potential of various instructions to suppress subsequent retrieval of emotional memories attracted our attention. We reasoned that this sort of social affective learning may rely on declarative memories, which consist of storing and retrieving emotional information about others. We then asked whether a reduction of [expressed] affective learning could be achieved by experimentally suppressing the memory of the emotional information about others that previously accompanied the neutral faces. In this case, it is useful to consider each of the two possible outcomes and their respective interpretations. First, if suppressing emotional memories of others attenuates affective

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learning effects, it would provide support for the view that declarative memories have a causal role in such learning. Second, if affective learning effects were not modulated by memory suppression, then it would imply that the memory link between the neutral faces and the emotional information is not a major contributing factor for such learning effects to occur.

In the literature on memory control, variants of the Think/No think paradigm have been used to examine whether suppressive mechanisms can operate on memory representations (e.g. Anderson & Green, 2001; Depue, Banich, & Curran, 2006; Marx, Marshall, & Castro, 2008). For example, in Marx et al. (2008), participants were exposed during the training phase to cue word-target word pairs on a computer screen. In an initial test phase, the cues were presented and the participants were asked to recall the associated target. Then, during the treatment phase, participants were shown only the cues. For some cues, participants were instructed to try to suppress thoughts of the associated target (No think condition), whereas for other cues, they were instructed to think of the associated target (Think condition). Cues that were presented in green indicated the Think condition, whereas cues presented in red indicated the No think condition. These manipulations did not involve additional presentations of the associated targets, so cognitive control had to be applied to internal memory representations. In the final phase of the experiment, recall of each target item in response to its cue was assessed. Relevant to our present study, the results of Marx et al. (2008) indicated that recall of target words in the No think condition was inferior to recall of words in the Think condition; and importantly, they also found that unpleasant targets were less forgotten (i.e., they were better recalled) than pleasant targets. Later in the paper, we discuss the possible reasons for the moderating effect of stimulus valence on memory suppression.

The training phase of a prototypical Think/No think paradigm is highly similar to the conditioning phase of the impression formation paradigm developed by Bliss-Moreau et al. (2008); in both paradigms, participants are instructed to learn associations between many neutral cues and emotional target stimuli under minimal learning conditions (i.e., a small number of presentations per pair). To test for the role of contingency memory between neutral faces and emotional information in learning the affective value of faces using Bliss-Moreau et al.'s paradigm, the strategy of the present experiment was to add a subsequent treatment phase involving Think/No think manipulations and then to assess the influence of memory suppression produced by the various No think manipulations on the affective ratings of the conditioned faces. We here use the term 'conditioned' in the sense that at test a conditioned face presumably activates the emotional information that is now associated with it.

It is possible that suppressing negative memories is more difficult than suppressing positive memories because natural selection has, for functional reasons, favored the retention of information concerning aversive events (e.g., Seligman, 1971). Therefore, stronger memory suppression techniques might be needed to weaken negative memories. In addition to the commonly used Think/No think procedure described above (e.g. Anderson & Green, 2001; Depue et al., 2006; Marx et al., 2008) in which participants are only instructed to suppress the original targets (without guided instructions), we employed two other related techniques that have proven effective elsewhere in suppressing negative memories: Guided Suppression and Thought Substitution. In the guided version of the Think/No think procedure, participants receive direct suppression instructions (borrowed and adapted from Schie, Geraerts, & Anderson, 2013). Schie et al. (2013) found that very detailed instructions for memory control facilitated suppression of negative memories. In Thought Substitution, participants are instructed to think of new information of neutral valence to keep from remembering (i.e., interfering with) the original emotional targets (borrowed and adapted from Joormann, Hertel, Brozovich, & Gotlib, 2005). Joormann et al. (2005) found that participants were able to suppress both negative and positive memories by using a Thought Substitution technique.

Additionally, we designed a Distraction procedure (adapted from Loftus, 1972) that consisted of instructing the participants to count backwards by threes to prevent them from rehearsing the original targets. Loftus (1972) found that such a Distraction task during acquisition decreased memory performance for neutral pictures. However, it should be noted that this technique has not been used within the paradigm of suppressing previously established memories as far as we know. Therefore, using this technique on established memories may or may not be obtained, especially with negative memories because it is possible that to suppress negative memories only strong memory suppression strategies, such as Guided Suppression and Thought Substitution, will be effective.

In our procedure, after the pretraining rating phase of 40 'neutral' faces, participants viewed neutral faces paired with sentences describing prosocial or antisocial behaviors. During this learning phase, they were asked to imagine a person with the presented face performing the behavior described. This was followed by a phase of post-training affective ratings of the 40 faces. Next, participants were asked to covertly perform one of four memory suppression tasks (presented above) along with a 'remember' task during which the 40 faces were sequentially presented and for half of the faces they were asked not to think about the related social behaviors, whereas for the other half of the faces participants were asked to think about the related behaviors. Subsequently, there was a phase of post-treatment affective ratings of the 40 faces. Finally, as a manipulation check for memory suppression, there was a recall test of the social behaviors cued by each of the 40 faces.

First, we predicted that a conventional effect of affective learning would be observed after the learning phase that consisted of pairing neutral faces with sentences describing negative and positive behaviors. That is, we expected to observe high affective ratings for Faces_{Pos} (faces paired with positive behaviors) and low ratings for Faces_{Neg} (faces paired with negative behaviors). Second, in the event that we obtained any effect of memory suppression within our paradigm of social affective learning, we anticipated that affective ratings of Faces_{Pos} in the No think conditions would decrease in the four memory suppression groups. Moreover, in light of the expected greater difficulty in reducing negative affective ratings, we expected that attenuated ratings of Faces_{Neg} might be obtained only with the Guided Suppression and Thought Substitution procedures because these strategies are most strongly oriented toward retrieval suppression. More generally, one potential benefit of research is to shed light on the role of contingency memory between faces and emotional information on [expression of] social affective learning.

2. Method

2.1. Participants and design

A total of 148 undergraduate students (approximately 65% females and 35% males; ages 18–23 years; 37 participants per group) at the State University of New York at Binghamton participated in this study for partial fulfillment of a course requirement. All of them gave their informed consent to participate in the experiment. A 2 (Behavior: Negative, Positive) × 2 (Instruction: Think, No think) × 3 (Phase: Pre-test, Conditioning, Treatment) × 4 (Memory Suppression: Unguided Suppression, Guided Suppression, Distraction, Thought Substitution) mixed design analysis of variance (ANOVA) was employed, with the first three factors being within-subject variables and the fourth factor being a between-subject variable. The participants were randomly assigned to one of the four memory suppression groups with the constraint that the groups were balanced as closely as possible with respect to gender. The data from 30 participants were not used in the analyses because either these participants did not correctly provide sufficient input to all the dependant variables, defined as failing ($n = 23$) (i.e., the datasets of participants who had to respond at all on more than 50% of the trials' missing responses were excluded ($n = 23$), or

their data files were not saved due to procedural errors such as computer malfunctions ($n = 7$) (e.g., computer malfunction). The final group sizes were as follows: Unguided ($n = 27$), Guided ($n = 31$), Distraction ($n = 28$), and Thought Substitution ($n = 32$), with each group having approximately the same gender ratio.

2.2. Materials and procedure

Participants performed the experiment using personal computers located in small rooms. The task was programmed using Python 2.7 computer language. We used 40 faces (half male and half female) each of which portrayed a neutral affective state (Minear & Park, 2004). The information associated with the faces consisted of sentences describing prosocial and antisocial and neutral behaviors were borrowed and adapted from Bliss-Moreau et al. (2008), and all previously assessed for valence in a pilot study. A 9-point rating scale for valence ranging from 1 (very negative feelings) to 9 (very positive feelings) was used for affective ratings. Participants were instructed to read the instructions with which they were presented and to reread them if they were not clear; otherwise they were to press the spacebar to start the task.

2.2.1. Pre-test ratings

Participants sequentially viewed the 40 faces. A given face (13×13 cm) was presented in the center of the screen and a question (Helvetica, font size 16) appeared beneath the face. Participants were asked to express their 'global feelings' toward the faces (the presentation order of which was randomized) on a 9-point scale ranging from 1 (very negative feelings) to 9 (very positive feelings). Each face was displayed until the participant gave his/her response. After a 1-s inter-trial interval, the screen advanced to the next face.

2.2.1.1. Pre-test instructions.

In this experiment, you will participate in a decision making task. Initially, you will see faces, and you will be asked to give your immediate emotional reaction to each one. Make your choice with a click on the left mouse button on the scale below each face.

2.2.2. Conditioning

Participants next viewed face-sentence pairs and were told to imagine each person performing the behavior described in by the corresponding sentence. The 40 faces were each paired with a unique descriptive sentence that was positive or negative (counterbalanced for gender) in affective tone (see the Appendix). The face-sentence pairs were each displayed on the computer screen for 5 s with a 1-s inter-trial interval (Helvetica, font size 16). Each face-sentence pair was presented twice in random order (one full cycle before the second full cycle).

2.2.2.1. Conditioning instructions.

You will now see pairs of faces and sentences. Your objective is to remember the pairings by imagining each person performing the behavior described in by the corresponding sentence.

Next, affective ratings of the faces were collected exactly as before.

2.2.2.2. Affective rating instructions.

Now you will see only the faces, and you will be asked to give your immediate emotional reaction to each one. Make your choice with a click on the left mouse button on the scale below each face.

2.2.3. Treatment

Following this, we asked the participants to use cognitive strategies that could aid forgetting of learned information. Four different memory

suppression treatments were used: Unguided, Guided, Distraction, and Thought Substitution. In the Unguided group, the participants were only instructed to suppress the original targets and they did not receive any guidance concerning how to do it. In the Guided group, they received explicit suppression instructions with very detailed guidance concerning how to do it. In the Distraction group, they were instructed to count backwards by threes, which was intended to prevent them from covertly rehearsing and hence remembering the original targets. Finally, in the Thought Substitution group, they were instructed to imagine new behaviors of neutral valence to keep from remembering the original target behaviors.

For all four groups, each face was randomly assigned to one of two subsets: a Think subset (5 male and 5 female faces associated with positive behaviors; 5 male and 5 female faces associated with negative behaviors) and a No think subset (the remainder of the faces). In both the Think and No think conditions, a trial consisted of a face being presented (without the sentence describing the behavior previously associated with the face) for 5 s, followed by a 1-s inter-trial interval. The word "Remember" was presented in green above the face in the Think condition and the word "Forget" was presented in red above the face in the No think condition. The difference between the Unguided and Guided conditions was the specific suppression instructions provided to participants at the beginning of this phase. Additionally, for the Distraction group, in the No think condition: a random number between 500 and 1000 appeared on the screen for 5 s. Participants were told to count backward by threes from the number as quickly as possible and to be careful to be as accurate as possible. At the end of each trial, they were asked to enter their final number using the keyboard. For the Thought Substitution group, in the No think condition, a trial is consisted of a face with a new phrase describing an affectively neutral behavior (see the list in Appendix) for 5 s, and a 1-inter-trial interval. This neutral behavior might be viewed as a source of retroactive interference with the original behavior. The word "Forget" was presented in red above the face in the No think condition. Participants were instructed to suppress the memory of behavior previously paired with the face when the word "Forget" appeared and to replace it with the new behavior described on their monitor immediately below the face. In the Think condition, all four groups were similarly instructed to remember the behaviors previously paired with the faces. Thus, each group was differently instructed on how to suppress the behavior previously associated with the face when the word "Forget" appeared and treated similarly when the word "Remember" appeared. Each face-memory instruction was presented twice in random order (one full cycle before the second full cycle).

2.2.3.1. Unguided Suppression instructions.

Now, you will only see the faces for the remainder of the experiment. It is really important that if the instruction "REMEMBER" is displayed on the screen, you should try to remember the behavior previously paired with the face because we will ask you later to recall it. If the instruction "FORGET" is displayed on screen, you need not remember it as we will not ask you to recall it. In this latter case, you can do whatever you want but don't look away from the screen or close your eyes.

2.2.3.2. Guided Suppression instructions.

Now, you will only see the faces for the remainder of the experiment. It is really important that if the instruction "REMEMBER" is displayed on the screen, you should try to remember the behavior previously paired with the face because we will ask you later to recall it. If the instruction "FORGET" is displayed on screen, you need not remember it as we will not ask you to recall it. Because this task is very important, we will take a moment to describe exactly what we want you to do when the word "FORGET" appears. It is CRUCIAL that you

PREVENT the paired behavior from coming to mind **at all**. You should accomplish this by blocking out all thoughts of the behavior. Although this may be challenging at first, please try hard to not think about the behavior at all, **not even for a second**, and not even after the face is gone from the screen. If the behavior does happen to pop into your mind, please actively push the behavior out of mind and keep it out of mind. It is very important that you accomplish this WITHOUT replacing the unwanted thought with something else, like another word, image, or idea. Your goal should be to never think of the behavior when the word “FORGET” is presented above a face. Please note that while you are trying to block out the paired behavior, it is essential that you **pay full attention to the face**. Please continue to look directly at the face until it disappears. That is, you should **never** move your eyes or attention away from the face. In fact, it is attentional ability that we are studying, that is, your ability to remain diligently focused on the face, while consistently and effectively ignoring the distracting behavior.

2.2.3.3. Distraction instructions.

Now, you will only see the faces for the remainder of the experiment. It is really important that if the instruction “REMEMBER” is displayed on the screen, you should try to remember the behavior previously paired with the face because we will ask you later to recall it. If the instruction “FORGET” is displayed on screen, you need not remember it as we will not ask you to recall it, but do not look away from the screen. In order to help you forget, we will ask you to count backwards by threes as quickly as possible starting from the number appearing on the face. Please be as accurate as possible because afterwards we will ask you to type your final number on the keyboard.

2.2.3.4. Thought Substitution instructions.

Now, you will only see the faces for the remainder of the experiment. It is really important that if the instruction “REMEMBER” is displayed on the screen, you should try to remember the behavior previously paired with the face because we will ask you later to recall it. If the instruction “FORGET” is displayed on screen, you need not remember it as we will not ask you to recall it, but do not look away from the screen. In order to help you forget, we will give you a substitute behavior to learn that we will ask you to recall later.

Afterwards, affective ratings of all the faces were collected exactly as before.

2.2.4. Recall Test

Finally, participants were shown the 40 faces and asked to recall the original associated behavior.

2.2.4.1. Recall test instructions.

Now you will see the faces one more time. Using the keyboard, I need you to type the behavior that was paired with the face. Please, try just as hard to recover the behaviors we told you to forget as the behaviors we told you to remember. If you do not remember the behavior, type “forgot”. After you have recorded your answer, press ENTER to move onto the next face.

After the participants completed the experiment, they were debriefed about the purpose of the study, thanked, and dismissed.

3. Results

3.1. Evaluative ratings

The mean affective ratings of the Faces as a function of the Behavior valence, instructions, phases, and suppression techniques are depicted on the left side of each panel in Fig. 1. For ANOVAs, when necessary, probability values have been adjusted using the Greenhouse–Geisser correction. All simple effect tests used error terms appropriately derived from the overall analysis. Effect sizes are reported as partial-eta squared (η^2_p) for ANOVAs, and Cohen's *d* for simple effects.

Considering the complex statistical design, for the sake of clarity only the statistical analyses of interest are presented. A 2 (Behavior: Negative, Positive) \times 2 (Instruction: Think, No think) \times 3 (Phase: Pre-test, Conditioning, Treatment) \times 4 (Memory Suppression: Unguided, Guided, Distraction, Thought Substitution) mixed design ANOVA reached statistical significance for the 4-way interaction, $F(6, 228) = 2.17, p = .047, \eta^2_p = .05$. First, we focused on Pre-test and Conditioning to verify (1) the absence of differences between the faces before their pairings with Negative and Positive information, and (2) the affective learning effects by comparing the changes in ratings for both Faces_{Neg} and Faces_{Pos} between Pre-test and Conditioning. To do so we used a 2 (Behavior: Negative, Positive) \times 2 (Instruction: Think, No think) \times 2 (Phase: Pre-test, Conditioning) \times 4 (Memory Suppression: Unguided, Guided, Distraction, Thought Substitution) mixed ANOVA. Of main interest, the interaction between Behavior (Negative, Positive) and Phase (Pre-Test, Conditioning) was statistically significant, $F(1, 114) = 250.92, p < .0001, \eta^2_p = .69$. No other interaction involving Instruction and/or type of Memory Suppression as factors was significant, largest $F(1, 114) = 1.22, p = .27, \eta^2_p = .01$, suggesting the lack of pre-existing differences between the ‘to-be-forgotten’ and ‘to-be-remembered’ Face-information pairs in the four Memory Suppression groups. This allowed us to safely conclude that the changes in the ratings of the faces subsequently observed between Conditioning and Treatment were due to the differential effect of Think/No think instructions used in the four Memory Suppression groups. No main effect or interaction was significant for the 2 (Behavior: Negative, Positive) \times 2 (Instruction: Think, No think) \times 4 (Memory Suppression: Unguided, Guided, Distraction, Thought Substitution) ANOVA conducted during Pre-test, largest $F(1, 114) = 1.30, p = .25, \eta^2_p = .01$, confirming the visual impression from Fig. 1 that the ratings of the faces were similar before Conditioning for all four Memory Suppression groups. Further analyses with simple-effect tests confirmed the visual impression that the ratings of the faces associated with the Negative Behaviors during Conditioning were lower than the ratings of these faces when they had been presented alone during Pre-test for all four Memory Suppression groups, $F(1, 114) = 170.83, p < .0001, d = .60$, and conversely that the ratings of the faces associated with the Positive Behaviors during Conditioning were higher than the ratings of these faces when they had been presented alone during Pre-test for all four Memory Suppression groups, $F(1, 114) = 127.94, p < .0001, d = .53$. Taken together, these results evidenced affective learning effects.

Follow-up analyses focused on Conditioning and Treatment to investigate the changes in the ratings of the faces occurring between Conditioning and Treatment due to the differential effect of different Think/No think instructions used in the four Memory Suppression groups. The analysis yielded a significant 2 (Behavior: Negative, Positive) \times 2 (Instruction: Think, No think) \times 2 (Conditioning, Treatment) \times 4 (Memory Suppression: Unguided, Guided, Distraction, Thought Substitution) 4-way interaction, $F(3, 114) = 3.42, p = .02, \eta^2_p = .08$. Subsequent analyses conducted to explore the interaction examined the interactions between Behavior, Instruction, and Phase separately for each Memory Suppression condition.

In the Unguided condition, there was a significant 3-way interaction between Behavior, Instruction, and Phase, $F(1, 26) = 7.42, p = .01, \eta^2_p = .22$. Subsequent analyses conducted to explore this three-way

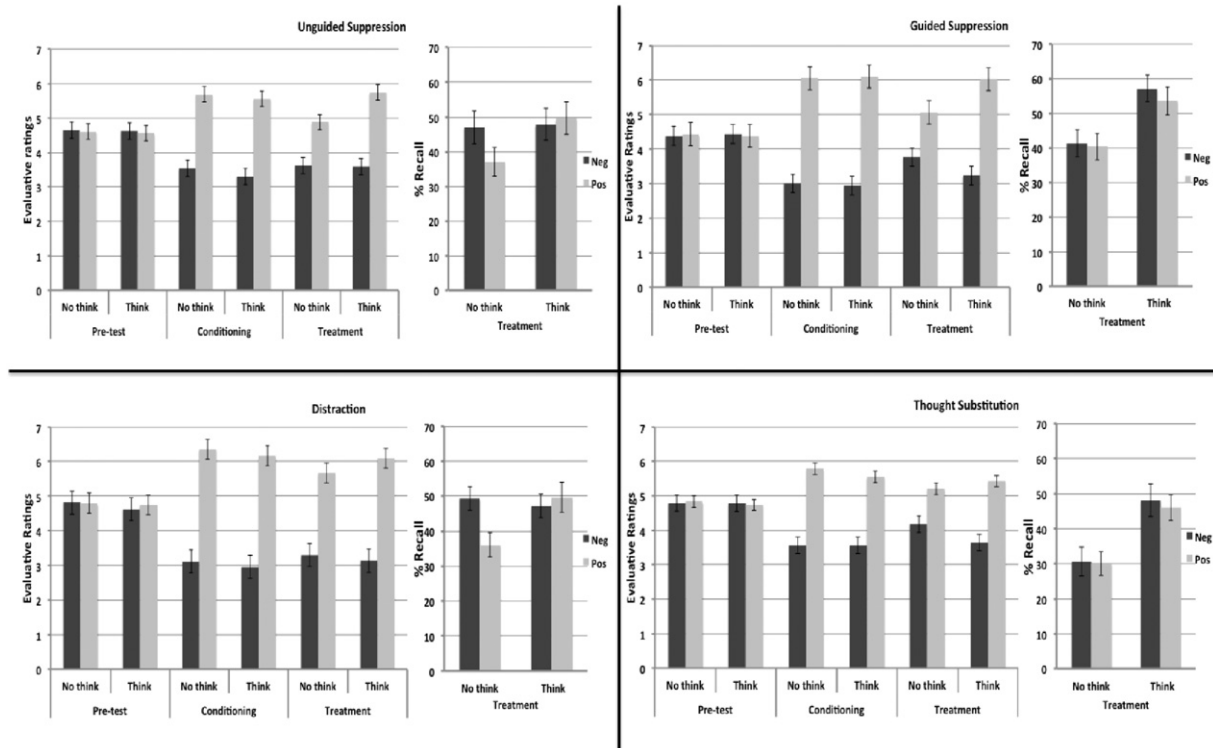


Fig. 1. The left side of each panel presents Pre-test, post Conditioning, and post Treatment evaluative ratings of faces as a function of the positive (prosocial) and negative (antisocial) information within the Think/No think instructions, displayed for the Unguided Suppression, Guided Suppression, Distraction and Thought Substitution groups. The right side of each panel presents percentages of both positive and negative information correctly recalled following presentations of the conditioned faces within the Think/No think conditions, displayed for the four groups on the recall test after treatment. Error bars represent standard errors of the mean.

interaction examined the interaction between Behavior and Phase separately for each Instruction (Think/No think). For the No think instruction, the interaction between Behavior and Phase was significant, $F(1, 26) = 12.175, p = .002, \eta^2_p = .32$. Simple effect tests exploring the 2-way Behavior \times Phase interaction revealed no change in the ratings of the Faces_{Neg} between Conditioning and Treatment, $F < 1, d = .11$, confirming the visual impression that the 'Forget' instruction did not attenuate the ratings of the Faces_{Neg}. However, the ratings of the Faces_{Pos} after Treatment were lower than the ratings of these Faces_{Pos} after Conditioning, $F(1, 26) = 14.96, p = .001, d = .66$, suggesting that the No think instruction attenuated the affective ratings of the Faces_{Pos}. For the Think instruction, only the main effect of Behavior was significant, $F(1, 26) = 79.62, p < .0001, \eta^2_p = .75$, whereas the main effect of Phase and the two-way interaction were not statistically significant, $F_s(1, 26) = 1.84$ and $.17, p_s = .19$ and $.69, \eta^2_p = .06$ and $.006$, respectively. Taken together, these results reflected no appreciable change in the ratings of either Faces_{Neg} or Faces_{Pos} between Conditioning and Treatment, suggesting that the Think instruction did not modulate the affective ratings.

In the Guided condition, there was also a significant 3-way interaction between Behavior and Instruction and Phase, $F(1, 30) = 18.74, p < .0001, \eta^2_p = .38$. The same set of statistical analyses conducted in the Unguided condition was conducted here. For the No think instruction, the interaction between Behavior and Phase was significant, $F(1, 30) = 28.71, p < .0001, \eta^2_p = .49$. Unlike the Unguided condition, the No think instruction in the Guided condition attenuated the ratings of the Faces_{Neg}, $F(1, 30) = 12.55, p = .001, d = .59$, confirming the visual impression that the ratings of the Faces_{Neg} after Treatment were higher than the ratings of these Faces_{Neg} after Conditioning; like the Unguided condition, the ratings of the Faces_{Pos} after Treatment were lower than the ratings of these Faces_{Pos} after Conditioning, $F(1, 30) = 36.37, p < .0001, d = .80$, suggesting that the No think instruction attenuated the ratings of the Faces_{Pos}. For the Think instruction, only the main effect

of Behavior was significant, $F(1, 30) = 62.20, p < .0001, \eta^2_p = .67$, whereas the main effect of Phase and the two-way interaction were not statistically significant, $F_s(1, 30) = 2$ and $2.6, p_s = .17$ and $.12, \eta^2_p = .06$ and $.08$, respectively. Here, too, the Think instruction did not have any significant effect on the ratings.

For the Distraction condition, the same set of statistical analyses was conducted. The conclusions were similar to those drawn from the Unguided condition. A 3-way interaction between Behavior, Instruction, and Phase was found, $F(1, 27) = 8.55, p = .007, \eta^2_p = .24$. For the No think instruction, the interaction between Behavior and Phase was significant, $F(1, 27) = 12.58, p = .001, \eta^2_p = .32$. Simple-effect tests exploring the two-way Behavior \times Phase interaction revealed no change for the Faces_{Neg} between Conditioning and Treatment, $F(1, 27) = 2.23, p = .15, d = .16$; whereas the affective ratings of the Faces_{Pos} after Treatment were lower than the ratings of these Faces_{Pos} after Conditioning, $F(1, 27) = 14.98, p = .001, d = .50$. For the Think instruction, only the main effect of Behavior was significant, $F(1, 27) = 65.04, p < .0001, \eta^2_p = .71$, whereas the main effect of Phase and the two-way interaction of Behavior and Phase were not statistically significant, $F_s(1, 27) = .6$ and $1.48, p_s = .45$ and $.23, \eta^2_p = .02$ and $.05$ respectively.

The Thought Substitution instructions, like the Guided Suppression instructions, attenuated the affective ratings of both Faces_{Neg} and Faces_{Pos}. Using the same type of statistical analysis as before, we found a significant three-way interaction between Behavior, Instruction, and Phase, $F(1, 31) = 28.14, p < .0001, \eta^2_p = .48$. For the No think instruction, the interaction between Behavior and Phase was significant, $F(1, 31) = 42.58, p < .0001, \eta^2_p = .58$. Here, the No think instruction attenuated the ratings of both Faces_{Neg} and Faces_{Pos}, $F_s(1, 31) = 17.30$ and $21.86, p_s < .001, d_s = .62$ and $.58$, respectively. For the Think instruction, only the main effect of Behavior was significant, $F(1, 31) = 44.38, p < .0001, \eta^2_p = .59$, whereas the main effect of Phase and the two-way interaction were not statistically significant, $F_s(1, 31) = .22$ and $1.54, p_s = .64$ and $.22, \eta^2_p = .01$ and $.05$, respectively.

In sum, all four of the No think conditions appreciably reduced affective learning effects based on prosocial information, and we found that only Guided Suppression and Thought Substitution reduced affective learning effects based on antisocial information.

3.2. Recall data

The mean percentages of both positive and negative behaviors correctly recalled following presentations of faces within the Think/No think instructions, displayed for the four groups on the recall test are depicted on the right side of each panel in Fig. 1. Two coders blinded to the Think/No think conditions scored recall performance. Sentences were scored according to 'close meaning' so that, if a participant reasonably recalled the information but not in the exact terms used during Conditioning, it was still counted as correct. If the coder could not clearly discern the intended answer then it was scored as incorrect. The overall interrater correlation was .98. When there was a discrepancy between the two raters, the response was scored as incorrect.

The recall data served as a manipulation check to confirm the effects of our experimental manipulations on the memory links between the faces and the valenced behavior. A 2 (Behavior: Negative, Positive) \times 2 (Instruction: Think, No think) \times 4 (Memory Suppression: Unguided, Guided, Distraction, Thought Substitution) mixed design ANOVA detected a significant 3-way interaction, $F(3, 114) = 2.70, p = .049, \eta^2_p = .07$. Subsequent analyses conducted to explore this interaction examined the interaction between Behavior and Instruction separately for each Memory Suppression condition.

In the Unguided condition, we found a main effect of Instruction, $F(1, 26) = 4.96, p = .03, \eta^2_p = .16$, which confirms the visual impression that the recall of information following presentations of faces was smaller with the No think instruction than with the Think instruction (upper left panel in Fig. 1). Importantly, there was a significant interaction between Behavior and Instruction, $F(1, 26) = 4.80, p = .04, \eta^2_p = .16$. We conducted simple effect tests to explore the two-way Behavior \times Instruction interaction. For the No think instruction, we found that the performance recall was lower for the Faces_{Pos} than for the Faces_{Neg}, $F(1, 26) = 8.89, p = .006, d = .44$, a result that is consistent with the No think instruction better attenuating the affective ratings of the Faces_{Pos} than the Faces_{Neg}. We did not find any difference between the two Behavior conditions (i.e., Positive and Negative) for the Think instruction, $F < 1, d = .07$, which is consistent with the failure of the Think instruction to significantly alter affective ratings.

With the Guided Suppression instructions, we found a main effect of Instruction, $F(1, 30) = 31.52, p < .0001, \eta^2_p = .51$, suggesting that the recall of information following presentations of faces was weaker in the No think instruction than in the Think instruction. Contrary to Unguided Suppression, the main effect of Behavior and the two-way interaction of Behavior and Instruction were not statistically significant, with both $F_s < 1, \eta^2_p = .02$ and $.01$. As can be seen in the upper right panel from Fig. 1, both recall of positive and negative information similarly decreased in the No think condition in comparison to the Think condition. Taken together, these results were consistent with the affect learning results showing that No think instruction influenced both positive and negative affective learning.

In the Distraction condition, we found a marginal effect of Instruction, $F(1, 27) = 3.75, p = .06, \eta^2_p = .12$. But more critically, there was a significant interaction between Behavior and Instruction, $F(1, 27) = 5.85, p = .023, \eta^2_p = .18$. For the No think instruction, we found that recall was lower for the Faces_{Pos} than for the Faces_{Neg} (as can be seen in the lower left panel from Fig. 1), $F(1, 27) = 11.57, p = .002, d = .74$, which is consistent with the finding that the No think instruction attenuated only the affective ratings of the Faces_{Pos}. We did not find any difference for the Think instruction, $F < 1, d = .12$, which is concordant with the lack of change in ratings of Faces_{Neg} between Conditioning and Treatment as a result of the Think instruction.

In the Thought Substitution condition, we found a main effect of Instruction, $F(1, 31) = 23.64, p < .0001, \eta^2_p = .43$, reflecting that the recall of information following presentations of faces was smaller with the No think instruction than with the Think instruction. The main effect of Behavior and the two-way interaction of Behavior and Instruction were not statistically significant, with both $F_s < 1, \eta^2_p = .01$ and $.002$. As can be seen in the lower right panel from Fig. 1, the results for Thought Substitution mirrored the results of Guided Suppression. This is consistent with the observation that the No think instruction attenuated both positive and negative affective ratings.

In summary, we observed that (1) the recall of positive information following presentations of faces was weaker using the No think instruction than the Think instruction across all four memory suppression techniques, and (2) only the Guided Suppression and Thought Substitution instructions reduced recall for negative information in the No think condition relative to the Think condition. Thus, all four memory suppression instructions appreciably reduced expression of affective learning based on prosocial information, and only the Guided Suppression and Thought Substitution instructions reduced expression of affective learning based on antisocial information.

4. Discussion

First, we found that the valence of a given face was changed in accord with the valence of information (i.e., behavior) that was paired with it. Second, we found that the acquired valence of these faces could be differentially modified by different Think/No think instructions. More specifically, we experimentally manipulated affective memory with four variants of Think/No Think instructions to determine whether affective learning effects could be attenuated, while distinguishing between their effects on positive and negative affective learning. We found that in all conditions the No think instructions appreciably reduced affective learning that was based on prosocial information. Notably, the No think instructions in the Guided and Thought Substitution conditions influenced both positive and negative affective learning, with the effect being larger for positive affective learning but still significant for negative affective learning. No other treatment instructions reduced negative affective learning. Additionally, our results suggest there is a causal relation between declarative memories and affective learning effects. We reasoned that suppressing emotional memories would attenuate expression of affective learning because it should prevent the faces from activating recollections of affective attributes of the associated behaviors.

An important contribution of our observations concerning the role of declarative memories is that we found that Memory Suppression instructions differentially attenuated affective learning effects as a function of the valence of the 'to-be-forgotten' information. This is consistent with prior reports in the memory control literature showing that negative emotional information is less readily suppressed than positive emotional information (e.g. Kensinger & Corkin, 2003; Marx et al., 2008) unless highly effective strategies of memory control are used (e.g., Thought Substitution: Joormann et al., 2005; Guided Suppression: Schie et al., 2013). Notably, we here provide the first direct comparison between different memory suppression techniques in a single experiment to support the claim that negative memories can be forgotten with strong memory suppression techniques (i.e., Guided Suppression and Thought Substitution) as opposed to more basic techniques (i.e., Unguided Suppression, Distraction). There are many possible reasons for the differential effects of valence across the four memory suppression instructions that we used. Three of these are, all other things being equal: (1) the vividness of negative memories is higher than that of positive memories (e.g., Ochsner, 2000); (2) negative memories are more cognitively elaborated than the positive memories (e.g., Kensinger & Corkin, 2003); (3) negative information is prioritized over positive information because of its greater adaptive value (e.g., Libkuman, Stabler, & Otani, 2004). Thus, negative memories are expected to be more difficult to suppress than positive memories. The present results extend the literature by demonstrating

that negative affective learning seems to be more difficult to attenuate than positive affective learning.

Of course, no research is without its potential shortcomings. One might think that *mere exposure effects* would shift all faces to a more positive rating between phases. However, it is doubtful that the positive affective learning that we observed was solely caused by a mere exposure effect. The reasons for this are twofold: First, Bliss-Moreau et al. (2008) found that participants' propensity to make positive judgments about faces that had been paired with prosocial sentences during learning was higher in comparison with their judgments of faces that had been paired with neutral sentences. Therefore, we can be reasonably confident that the positive affective learning effect that we observed cannot be centrally explained as mere exposure effect because we used both materials and procedure for pairing faces with prosocial behaviors identical to Bliss-Moreau et al. Second, the ratings of faces associated with prosocial behaviors did not increase after the treatment phase during which they were presented alone (akin to a mere exposure procedure); rather they decreased, which is the opposite of the mere exposure effect.

Might different levels of arousal between positive and negative information account for our pattern of results? This is unlikely; Marx et al. (2008) conducted a similar study on memory suppression manipulating arousal (different levels), valence (positive and negative), and instruction (Think/No think), and they did not find an interaction between those three factors ($F < 1$) when they analyzed their cued recall data (similar to our procedure). This lends support, albeit indirect support, for the view that arousal did not modulate the interaction between valence and instruction in the present research.

Admittedly, comparisons of Conditioning data with Treatment data are confounded by testing having occurred at different times because both the passage of time and the Conditioning test itself could have possibly influenced the Treatment test data. But if either of these factors were appreciable, they should have been evidenced equally in all four instructional groups and in both Think/No think conditions, which they were not.

An additional weakness of the present experiment is the absence of a No-Treatment condition paralleling the Think/No think conditions for both US conditions. Comparisons of the [post] Conditioning data with the [post] Treatment data might be viewed as evidence of differential effects of the No think instructions from those of the Think instructions during Treatment. One could argue that such comparisons cannot tell us whether the observed differences in affective ratings were due to the effectiveness of Think, No think, or both. However, in the Think condition for Faces_{Neg}, the two treatment conditions in which the No think instructions proved ineffective with respect to the negative information (i.e., Unguided Suppression and Distraction) serve as functional 'controls' for the two treatment conditions in which the No think instructions were effective (i.e. Guided Suppression and Thought Substitution). Critically, the two groups in which the No think instructions had no effect serve as controls that are not confounded by potential order effects. Also, it is notable that each manipulation's effect on affective ratings was mirrored by its effect on recall. Each memory suppression group appreciably reduced [expression of] affective learning based on prosocial information; this was paralleled in each group by the recall of positive information following presentations of faces being weaker with the No think instructions than with the Think instructions. In contrast, only Guided Suppression and Thought Substitution instructions reduced affective learning based on antisocial information; correspondingly, only these two strategies reduced recall of negative information. No other treatment instruction affected negative affective learning or recall of negative information. Thus, we have grounds for differentiating between the effects of the present Think and No think instructions. Still, it would be illuminating to have direct measures of affective learning and recall of behaviors in a control condition without any of treatment instructions. Thus, in future pursuits of this new avenue of research, one critical refinement of our procedure would be to include such a control.

We should also acknowledge that the memory suppression effects reported here were obtained using an explicit self-report measure of affective value. It would be worth examining whether the current effects could be replicated using a less direct measure (e.g., affective priming or the Implicit Association Test). However, it would be most likely difficult to implement such an assessment considering that the memory suppression paradigm ordinarily involves a large number of paired items. Also of interest for future research might be whether the present effects would extend to situations in which cues (faces) rather than targets (valenced information) were suppressed. Finally, one might ask whether affective social learning is related to memory of links with specific emotional information or with general evaluation. The effects demonstrated here have theoretical value in that they add to our knowledge about social affective learning and declarative memories, and practical importance in that they speak to social-cognitive issues.

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Appendix A.

A.1. 20 prosocial behavioral acts

- Celebrated a child's birthday
- Helped little brother build a sand castle
- Gave a backrub to a loved one
- Complimented a coworker
- Helped an elderly woman with her groceries
- Gave up seat on the bus to a pregnant lady
- Took a niece to the playground
- Held the door open for a boy on crutches
- Celebrated a holiday with grandparents
- Warmly hugged a sibling
- Threw a surprise birthday party for a parent
- Cooked a fabulous dinner for significant other
- Tutored a struggling classmate for free
- Volunteered to clean up litter at the park
- Gave a well deserved award to an employee
- Bought ice cream for a young child on a sunny day
- Helped a blind man pick out items in the grocery store
- Read a book out loud to residents of a nursing home
- Surprised significant other with flowers
- Picked up friend at the airport after a long trip

A.2. 20 antisocial behavioral acts

- Provoked a person into a fist fight
- Passionately kissed best friend's spouse
- Made a racist comment
- Was arrested by police officer
- Threw a chair at a classmate
- Cut in line at the bank
- Hit a small child
- Fired an employee before Christmas
- Stole from a blind person
- Abandoned significant other at the altar
- Kicked a puppy

Vomited in a friend's new car
 Made fun of an overweight child
 Yelled at a bus driver
 Cursed at the flight attendant
 Slammed the door in the face of a girl scout selling cookies
 Carelessly spilled boiling water on a friend
 Drunkenly crashed a friend's car
 Lost all of the company's money gambling
 Lied to an investigator about a crime

A.3. 20 neutral behavioral acts

Rode the elevator
 Paid the driver for a bus ticket
 Asked the instructor for a pencil
 Bought shampoo from the clerk
 Read a story about the mayor
 Mailed a letter to someone
 Answered the ringing phone
 Passed a man on the street
 Told the cabdriver the destination
 Saw a person across the room
 Washed the laundry at the laundromat
 Drove to the store
 Walked around the neighborhood
 Was handed mail by the mail carrier
 Printed a document
 Sat next to a woman on the train
 Asked the store owner about a product on the shelf
 Asked the gas station attendant to pump gas
 Asked the doorman for directions
 Stopped at the bank's drive thru

References

- Anderson, M.C., & Green, C. (2001). Suppressing unwanted memories by executive control. *Nature*, *410*, 366–369.
- Anderson, N.H. (1965). Averaging versus adding as a stimulus-combination rule in impression formation. *Journal of Experimental Psychology*, *70*, 394–400.
- Anderson, N.H. (1981). *Foundations of information integration theory*. New York: Academic Press.
- Asch, S.E. (1946). Forming impressions of personality. *Journal of Abnormal and Social Psychology*, *41*, 258–290.
- Baeyens, F., Eelen, P., Van den Bergh, O., & Crombez, G. (1992). The content of learning in human evaluative conditioning: Acquired valence is sensitive to US-revaluation. *Learning and Motivation*, *23*, 200–224.
- Bliss-Moreau, E., Barrett, L.F., & Wright, C. (2008). Individual differences in learning the affective value of others under minimal conditions. *Emotion*, *8*, 479–493.
- Bohner, G., & Wänke, M. (2002). *Attitudes and attitude change*. Hove, UK: Psychology Press.
- Chaiken, S., & Stangor, C. (1987). Attitudes and attitude change. *Annual Review of Psychology*, *38*, 575–630.
- Depue, B.E., Banich, M.T., & Curran, T. (2006). Suppression of emotional and nonemotional content in memory effects of repetition on cognitive control. *Psychological Science*, *17*, 441–447.
- Eagly, A., & Chaiken, S. (1993). *The psychology of attitudes*. Fort Worth, TX: Harcourt, Brace, Jovanovich.
- Hermans, D., Vansteenwegen, D., Crombez, G., Baeyens, F., & Eelen, P. (2002). Expectancy-learning and evaluative learning in human classical conditioning: Affective priming as an indirect and unobtrusive measure of conditioned stimulus valence. *Behaviour Research and Therapy*, *40*, 217–234.
- Hovland, C.I. (1951). Human learning and retention. In S.S. Stevens (Ed.), *Handbook of experimental psychology* (pp. 613–689). New York: Wiley.
- Hovland, C.I., Janis, I.L., & Kelley, H.H. (1953). *Communication and persuasion*. New Haven, Conn.: Yale University Press.
- Joormann, J., Hertel, P.T., Brozovich, F., & Gotlib, I.H. (2005). Remembering the good, forgetting the bad: Intentional forgetting of emotional material in depression. *Journal of Abnormal Psychology*, *114*, 640.
- Kensinger, E.A., & Corkin, S. (2003). Memory enhancement for emotional words: Are emotional words more vividly remembered than neutral words? *Memory & Cognition*, *31*, 1169–1180.
- Libkuman, T., Stabler, C., & Otani, H. (2004). Arousal, valence, and memory for detail. *Memory*, *12*, 237–247.
- Loftus, G.R. (1972). Eye fixations and recognition memory for pictures. *Cognitive Psychology*, *3*, 525–551.
- Marx, B.P., Marshall, P.J., & Castro, F. (2008). The moderating effects of stimulus valence and arousal on memory suppression. *Emotion*, *8*, 199.
- Minear, M., & Park, D.C. (2004). A lifespan database of adult facial stimuli. *Behavior Research Methods, Instruments, & Computers*, *36*, 630–633.
- Ochsner, K.N. (2000). Are affective events richly recollected or simply familiar? The experience and process of recognizing feelings past. *Journal of Experimental Psychology: General*, *129*, 242.
- Olson, J.M., & Zanna, M.P. (1993). Attitudes and attitude change. *Annual Review of Psychology*, *44*, 117–154.
- Petty, R.E., & Cacioppo, J.T. (1986). *Communication and persuasion: Central and peripheral routes to attitude change*. New York: Springer-Verlag.
- Petty, R.E., Fabrigar, L.R., & Wegner, D.T. (2003). Emotional factors in attitudes and persuasion. In R.J. Davidson, K.R. Scherer, & H.H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 752–772). Oxford: Oxford University Press.
- Schie, K., Geraerts, E., & Anderson, M.C. (2013). Emotional and non-emotional memories are suppressible under direct suppression instructions. *Cognition & Emotion*, *27*, 1122–1131.
- Seligman, M.E. (1971). Phobias and preparedness. *Behavior Therapy*, *2*, 307–320.