

## Illusions of Learning: Irrelevant Emotions Inflate Judgments of Learning

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### ABSTRACT

People use assessments of how much they have learned to choose and recommend instructors, seminars, and weekend trips. How do people assess how much they have learned? Recent theorizing has depicted emotion as a cue for learning, and so people may be misled by recent emotional states to infer that they have learned more than they actually have. Four studies showed that people associated emotion with learning and believed, often falsely, that they learned more when in an emotional than unemotional state. Factual lessons were coupled with manipulations of arbitrary, irrelevant emotional states. Participants rated that they learned more after an emotion had been induced than in emotionally neutral control conditions. These differences remained significant after controlling for actual learning as measured by objective tests, which was unaffected by emotion. This illusion of learning caused by emotion was robust with respect to changes of procedure and sample, including whether the emotion came before or after the information to be learned. Alternative explanations were ruled out, including that emotion would intensify ratings generally, that emotion would make incoming information seem particularly personally relevant, that emotion increased engagement in the research, and that illusory learning would depend on retrospective exaggeration of one's prior ignorance. Because irrelevant emotions can increase people's judgments that they have learned something, incidental emotional experiences could increase a person's likelihood of deciding to take another class with a particular instructor, to sign up for another leadership seminar, or to engage in a risky (but emotion-filled) excursion. Copyright © 2014 John Wiley & Sons, Ltd.

KEY WORDS emotion; learning; perceived learning

### EMOTION AND THE ILLUSION OF LEARNING

Broad, vague claims that “I learned a lot” can be heard in diverse contexts, including course evaluations, romantic breakup conversations, team-building exercises, and interviews with reality television stars. It is tempting to accept them at face value, but a skeptic might note that unsupported claims of learning could be distorted easily. For example, many persons claim after a highly involving romantic disappointment to have learned much, but when they seek to articulate these lessons, the results are often painfully vacuous and trite (Baumeister & Wotman, 1992). Likewise, students who take a study skills improvement course often report that they have acquired much improved skills, but their subsequent academic records fail to show much benefit (Conway & Ross, 1984).

The present research tested one hypothesis about how people might succumb to *illusions of learning*, defined as mistaken or exaggerated perceptions of how much one has learned. The hypothesis was that emotional states can create the false impression of learning. When asked to assess how much they have learned, people may judge on the basis of the emotions they have felt rather than by surveying any actual increase in knowledge.

Illusions of learning could influence and potentially distort decision processes. Most obviously, many training programs

and college courses are evaluated in part by having people rate how much they learned, and insofar as these ratings are susceptible to bias, decisions about their value and whether to retain, revise, or discontinue them could be swayed inappropriately. More broadly, many people wish to learn, and many difficult or unpleasant experiences can be justified on the basis of what one learns. However, if such assessments are inflated by illusion, then people may needlessly suffer through such events without any real payoff. A complementary idea is that people might not have any emotional reactions to events that confer benefits more so if repeated (such as medical tests, paying taxes, or teeth cleanings). Inserting even (or especially) task-irrelevant emotion into the experience might up the odds of people agreeing to do it again. Making decisions also appears to deplete a limited resource (Vohs et al., 2008), and the depleted state intensifies emotional reactions (Vohs et al., 2014), so making decisions may increase susceptibility to thinking one has learned much when one has learned little or nothing. A more troublesome potential consequence would arise if people overestimate their expertise and become overconfident about making decisions because they have illusions of having learned much more than they did.

### EMOTIONS AND JUDGMENTS

When individuals make judgments about the world around them, they often use their emotions as one source of information (Schwarz & Clore, 1983). For example, participants reported being less satisfied with their lives if they had just written about a sad event than if they had just written about a happy event. Participants were more likely to say that an

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action was immoral if they had recently been induced to feel disgust through the presence of a dirty trash can or unpleasant spell in the room (Schnall, Haidt, Clore, & Jordan, 2008). Participants standing at the bottom of a hill viewed the hill as steeper if they were listening to sad music at the time they made their judgment than if they were listening to happy music (Riener, Stefanucci, Proffitt, & Clore, 2011). When making many different kinds of judgments, people use their (task-irrelevant) mood as a source of information in determining their judgments.

We propose that learning is another domain in which individuals may use their (sometimes irrelevant) emotions to make judgments. A review by Baumeister, Vohs, DeWall, and Zhang (2007) concluded that a main function of conscious emotion (as distinguished from automatic affective reactions) is to stimulate cognitive processing after the fact so as to facilitate learning. In particular, emotion is often a sign that there is something worth learning. This is because emotion indicates both high relevance to one's motivations (people do not have much emotion when they do not care) and that something new or unexpected has happened (emotion reacts to novelty). Because emotions may be taken as a sign that there is something worth learning, individuals may assume they learned more when they are in emotional rather than more neutral states. We propose that people often assess their learning by asking themselves, "Did I feel anything?" If the answer is yes, they conclude that they learned significantly more than if the answer is no.

#### EMOTIONS AND LEARNING

Emotion does sometimes contribute to genuine learning. People who lack normal emotionality, such as owing to brain damage, sometimes fail to learn from negative outcomes (e.g., Bechara, Damasio, Tranel, & Damasio, 1997). Events and stimuli that evoke emotion are remembered better than others (McGaugh, 2002), even a year afterward (Bradley, Greenwald, Petry, & Lang, 1992). Emotions improve attention to relevant information (Christianson, 1986; Christianson & Loftus, 1991). Editors for a special issue in the *Journal of Behavioral Decision Making* noted several processes by which emotion affects decision making (Peters, Västfjäll, Gärling, & Slovic, 2006). One was akin to emotion acting as a spotlight or highlighting pen that focuses people on incoming information. Emotions might provide sufficient focus on new material so as to give it more impact or elaboration, leading to greater learning compared with an unemotional state.

A related pattern is that emotions often seem to serve as cues that can increase learning by increasing cognitive processing. Emotions stimulate counterfactual thinking (Roese, 1997), and regret is felt most intensely when there is something worth learning, in that some particular changes would likely have produced a better outcome (Kahneman & Tversky, 1982; Medvec, Madey, & Gilovich, 1995). Novel behaviors are associated with emotion far more than habitual behaviors, for which learning has largely ceased (Wood & Neal, 2007; Wood, Quinn, & Kashy, 2002). Unexplained outcomes often generate strong emotions, which are significantly reduced when the

person is able to explain what happened (Kurtz, Wilson, & Gilbert, 2007; Wilson, Centerbar, Kermer, & Gilbert, 2005; see Wilson & Gilbert, 2008, for a review).

All these findings suggest that emotion often does arise at times when learning may occur, that it contributes to the learning process, and that it dissipates as the learning is completed. The association of emotion with learning means that emotion may serve as a subjective sign that the person is learning. Like many cued associations, it can at times lead people to an incorrect conclusion.

#### ILLUSION OF LEARNING

Although emotion does genuinely improve learning in many cases, some benefits may be more apparent than real. Research with flashbulb memories has suggested that people can come to falsely believe they remember emotional events more than neutral ones (Talarico & Rubin, 2003). Evidence in eyewitness testimony research shows that people often profess certainty about recollecting the details of a scene but in actuality their memories are inaccurate, partly owing to the experience of salient emotional states. In one study, participants watched a video of either a violent (mugging) or non-violent (direction-seeking) scene and were then asked to identify the actors in the scene (Clifford & Hollin, 1981). Although confidence was significantly (positively) correlated with accuracy for participants in the non-violent scene condition, there was no correlation between confidence and accuracy in the violent condition. Assuming the violent scene evoked more emotion than the non-violent one, the implication is that emotion interfered with assessing how much the participant knew (thus learned). Overviews of research on the weapon focusing effect (e.g., Kramer, Buckhout, & Eugenio, 1990) suggest that the intense focus on the weapon and attendant emotional reactions render witnesses unable later to remember much more than the weapon itself (Christianson, 1992). In that case, then, emotion may have altered attentional processes, causing the emotional person to learn some things better and others worse.

Emotions may serve the purpose of facilitating the encoding of a salient lesson into memory, such as by drawing attention, stimulating reflection, and highlighting importance of what is happening (Baumeister et al., 2007). Emotion and learning will often be correlated. When people try to judge how much they learned, therefore, they may turn to their recent emotions rather than attempting to remember what they knew in the past and compare what they knew in the past to what they currently know. It is presumably easier to look back and recall having had a salient emotion than to appraise changes in one's knowledge. This strategy of relying on emotion to gauge learning would often yield a correct answer but would also be vulnerable to illusions of learning, especially in cases in which the emotion occurred without actual learning.

It is not difficult to generate plausible hypotheses about how various specific emotions might cause an illusion of

learning. Feeling sad could cause a woman to doubt that she can trust a friend. Feelings of excitement and mastery might prompt a man to think he has learned about his tastes (“Maybe I do actually like math!”). Feeling guilty might cause people to reflect on what they did wrong and to infer they have learned profound lessons. However, the original impetus for the present research went beyond these specific hypotheses to propose that a broad variety of emotions, indeed emotions per se, could foster an illusion of learning. That was based on the view that emotions in general function to stimulate learning (Baumeister et al., 2007)—thus creating the possibility that what is often a genuine cause of learning would at other times be mistaken for a reliable sign of it.

To summarize: Emotion may often occur in connection with important, novel events and may increase learning by stimulating cognitive processing. Because of this genuine connection and because of the difficulty of assessing one’s actual learning, people may rely on emotion as a salient signal that learning has happened. As a result, salient emotion may cause people to overestimate how much they learned.

The present research sought to show that emotions might produce just such illusions of learning. The pilot study simply tested the hypothesis that people associate experiences of great learning with more emotion than experiences of little learning. Studies 1–3 tested the hypothesis that participants who are induced to feel any one of a variety of emotions will report having learned more from a reading assignment unrelated to the emotion, as compared with participants in a neutral control condition. Because the emotion was irrelevant to the material being learned, we hypothesized that there would be no actual differences between the emotion and neutral control conditions on actual learning. (That would establish that the reported increase in learning was in fact illusory.) Study 4 also tested some alternative explanations. These included the hypothesis that the increase in perceived learning is simply part of a broader pattern of holding more intense opinions or giving more extreme ratings generally. Another possibility was that the increase in perceived learning reflected a retroactive distortion, as has been shown by Conway and Ross (1984), by which people create an illusory impression of learning by underestimating how much they knew about the topic prior to the study.

#### STUDY 1 (PILOT): LEARNING AND EMOTION IN AUTOBIOGRAPHICAL RECOLLECTIONS

Study 1 provided background for our primary hypothesis. It sought to establish that people associate the experience of emotion with learning, which is an important basis for the main hypothesis that emotion can cause an illusion of having learned. We tested the hypothesis that participants would write about significantly more intense emotional experiences when they were asked to write about a time when they learned much than when they were asked to write about a time when they did not learn much.

#### Method

Fifty-eight participants (38 women) were recruited through Amazon’s Mechanical Turk. Participants were randomly assigned to write about either a situation where they learned very little or a situation where they learned much. Participants were instructed as follows:

I would like you to write about a situation in your life where you learned a lot [a little]. Describe it in as much detail as you can. Please write at least five sentences.

#### Results

##### *Coding emotional intensity and perceived learning*

Two independent coders who were blind to condition and hypotheses rated the essays. They were asked to judge the emotional intensity of the essays on a scale of 1 (*not at all emotionally intense*) to 5 (*extremely emotionally intense*). As a manipulation check, coders were also asked to judge how much the participant thought he or she learned on a scale of 1 (*learned nothing*) to 5 (*learned an extreme amount*). The intraclass correlation between the raters was significant for emotional intensity,  $r(55) = .75$ ,  $p < .001$ , and amount learned,  $r(55) = .85$ ,  $p < .001$ . Because the two coders had a relatively high level of agreement, the ratings of the first coder were used in the initial submission of this paper. At the suggestion of reviewers, all essays were re-coded by two additional undergraduate research assistants who conferred to resolve disagreements. The results with both sets of codings were quite similar, and we report results here on the basis of the reviewer-requested coding.

##### *Learning*

As predicted, analysis of variance (ANOVA) showed that participants assigned to write about a time when they learned much wrote about significantly more emotionally intense situations ( $M = 2.41$ ,  $SD = 1.31$ ) than participants who were assigned to write about a time when they learned a little ( $M = 1.55$ ,  $SD = .72$ ),  $F(1, 56) = 9.91$ ,  $p = .003$ . The manipulation check confirmed that participants who were instructed to write about a time when they learned much were judged by independent coders to have believed they learned more ( $M = 3.85$ ,  $SD = 1.13$ ) than participants who were instructed to write about a time when they learned a little ( $M = 1.84$ ,  $SD = .97$ ),  $F(1, 56) = 53.17$ ,  $p < .001$ . Coders’ perceptions of participants’ learning mediated the relationship between learning condition and emotional intensity. Coder-judged learning was significantly and substantially correlated with emotional intensity,  $r(56) = .60$ ,  $p < .001$ . An analysis of covariance (ANCOVA) using condition assignment as the predictor and coder-judged learning as the covariate showed that condition no longer significantly predicted emotional intensity when controlling for coder-judged learning,  $F(1, 55) = .16$ ,  $p = .69$ . However, coder-judged learning remained a significant predictor of emotional intensity,  $F(1, 55) = 14.97$ ,  $p < .001$ .

### Examples

There was a wide variety of stories. Stories about not having learned including watching much television for several years, doing a pointless and tedious job, fighting and then agreeing to share despite already having known that sharing is appropriate, cleaning up one's room and learning not to let the mess recur but then letting it recur, and several stories about terrible classes (e.g., statistics, chemistry). Stories about learning much included several family deaths, romantic breakups, good college courses, and a drunk-driving infraction that inspired the writer to abstain from alcohol for the past decade.

### Discussion

Participants reported having felt considerably more emotion in experiences from which they believed they had learned a great deal than in experiences from which they thought they learned little or nothing. The more intense their emotion, the more learning they reported. These were actual experiences from their lives, rather than laboratory sessions (as will be used in the following studies). The findings are consistent with the view that one function of emotion is to stimulate learning: We infer that the high emotion felt during these past experiences contributed to the presumptive learning, such as by stimulating extensive cognitive processing.

Moreover, insofar as people experience more emotion when they learn much than when they learn a little, they may come to associate most emotions with learning and therefore could use their amount of (recalled) emotion as a heuristic guide for estimating how much they learned. That is, high perceived learning often comes with high emotion, so people may estimate that high emotion is a reliable sign of high learning. That was the hypothesis for the remaining studies.

To be sure, these findings provide no proof that actual learning occurred. This was however established in prior work reviewed in the Introduction (e.g., McGaugh, 2002). For present purposes, the important thing is that people's personal recollections have a strong association between substantial emotion and having learned a great deal.

## STUDY 2: INDUCED EMOTION ENHANCES FEELING OF SUBSEQUENT LEARNING

Study 2 tested the hypothesis that people rely on the experience of emotion (erroneously) to judge the amount that they have learned. Participants were assigned to complete an autobiographical emotion induction essay task (Brewer, Doughtie, & Lubin, 1980; Schwarz & Clore, 1983; Wright & Mischel, 1982), after which they were told to read an informational article. Participants were then asked to report how much they thought they learned from the article. To assess actual learning, we then gave participants a brief multiple-choice quiz on the content of the article. The main prediction was that the emotions would increase the estimates of learning, independent of actual learning.

We tested an assortment of emotional states. The six emotions (angry, fearful, embarrassed, excited, proud, or guilty) were selected to provide a range of emotions including good and bad, self-focused and other-focused. This enabled us not only to look for a general pattern across the six emotions but also to be alert to differential effects of different emotions.

Study 2 also examined some potential mediators of the link between felt emotion and illusory learning. It tested the hypotheses that emotion might make the article seem personally relevant to the reader or might make the reader feel extra glad to have read the article.

### Method

#### Participants

Two hundred sixty-nine adults (84 female; 5 unreported; ages 19–62  $M = 31.8$ , 203 White, 51 Asian, the rest various other minorities) participated online in exchange for \$10. They reported their ethnicity as largely Caucasian ( $n = 203$ ), with 51 reporting Asian ethnicity, six reporting Pacific Islander ethnicity, four reporting African-American ethnicity, and five not reporting.

#### Procedure

A computer program first randomly assigned participants to condition. Participants assigned to any one of the six *emotion conditions* wrote about a time in which they felt angry, fearful, embarrassed, excited, proud, or guilty. *Neutral control condition* participants wrote about the path they take from their house to a favorite grocery store.

Subsequently, participants read a one-page story, at their own pace, about the surprisingly sophisticated biology of jellyfish, adapted from the *New York Times*. After indicating that they had finished the article, it disappeared from the computer screen and participants were unable to return to it. Participants then rated how much they had learned on 1 (*none*) to 7 (*an extreme amount*) scales: “How much did you learn from this article?” “How much more do you know now than you did before reading this article?” and “To what extent did reading this article contribute to your knowledge of the topic?” ( $\alpha = .81$ ). These were summed to create a perceived learning index. Participants were also asked to rate “To what extent was the information you learned relevant for your life” and “How glad are you that you read this article” on a scale of 1 (*not at all*) to 9 (*extremely*). Participants' final task was to take a seven-item, multiple-choice quiz on the jellyfish story. Six items asked for facts about the essay and one the gist.

### Results and discussion

We tested our hypothesis that condition would predict perceived learning by using a one-way ANOVA on the perceived learning index. Across the seven conditions, there was significant variation in perceptions of learning,  $F(6, 262) = 6.07, p < .001$ . A planned comparison confirmed that participants who had been assigned to the six emotion conditions felt that they learned more than did neutral control condition participants,  $t(262) = 5.27, p < .001$  (Figure 1). A second one-way ANOVA



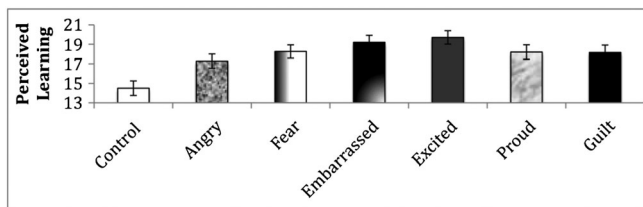


Figure 1. Perceived learning as a function of condition (actual learning was held constant statistically); Study 2. Perceived learning was measured by combining the items “How much did you learn from this article?” “How much more do you know now than you did before reading this article?” and “To what extent did reading this article contribute to your knowledge of the topic?” Participants used 1 (*none*) to 9 (*an extreme amount*) scales

dropped the control condition in order to investigate possible variation among the emotion conditions. Participants in the various emotion conditions showed nonsignificant variation in how much they said that they learned,  $F < 1.95$ , *ns*. Thus, contrary to several pet hypotheses, the illusion of learning was mostly the same regardless of which specific emotion was felt. In other words, the perception of learning differed as a function of whether there was emotion or no emotion, and not as a function of which emotion was involved.

Crucially, objective learning did not vary systematically across the different emotion and control conditions: An ANOVA with condition on test scores showed no differences as a function of condition,  $F < 1$ . Furthermore, an omnibus ANCOVA showed reliable variation in perceived learning even after statistically controlling for objective learning,  $F(6, 253) = 5.44$ ,  $p < .01$ , and planned comparisons on the residual measure showed that the combined perceived learning ratings from participants in the emotion conditions were greater than perceived learning ratings from participants in the neutral control condition,  $t(253) = 4.97$ ,  $p < .001$ . Hence, it seems appropriate to speak of illusion of learning, because differences in perceived learning were not accompanied by difference in actual learning.

Last, the effect seemed specific to the perception of learning. ANOVAs found no significant variation among conditions in ratings of being glad to have read the article, nor in ratings of finding the material personally relevant,  $F_s < 1.3$ . Thus, emotion made participants think they had learned a relatively high amount about jellyfish—but there was no sign that this boost in perceived learning was due to actual learning, perceived personal relevance, or satisfaction at having read the article.

### STUDY 3: INDUCED EMOTION ENHANCES ILLUSION OF PREVIOUS LEARNING

Because the emotion induction was given at the beginning of the experiment in Study 2, it is possible that participants in the emotion conditions actually experienced the article itself differently than participants in the neutral control conditions in ways that were not reflected in our measures of personal relevance, factual learning, or joy over having read it. One way to rule this out would be to induce the emotion after participants read the article. Study 3 did this.

Study 3 also broadened the scope of our hypothesis testing in a few other ways. First, Study 3 included two low-arousal (depressed and relaxed) and two high-arousal (excited and angry) emotions. On the basis of research showing that false memories are more likely under high arousal than low arousal (Corson & Verrier, 2007), we predicted that participants might think they learned more when feeling high-arousal emotions than when feeling low-arousal emotions. The four emotions were therefore actually chosen to represent the four quadrants of the emotional circumplex (good and bad, and high and low arousal; Russell, 1980; Russell & Carroll, 1999).

Second, Study 3 used a different neutral control condition than in Study 2. Because the primary test of our hypothesis pits the neutral control condition against the emotion conditions, it was important for us to ensure that the results of Study 2 were not due to anything particular about its neutral control condition. Third, we also changed the learning material, in case the article of Study 2 on jellyfish was somehow idiosyncratic. Our predictions, however, remained the same: that participants in the emotion conditions would perceive that they learned more than participants in the neutral control condition—in the absence of any real differences in learning.

### Method

#### Participants

Eighty-six participants (74 women) took part in exchange for partial course credit.

#### Procedure

Participants were told the study involved reading comprehension and writing ability. Upon arrival at the lab, participants were given a brief passage about the life of George Bernard Shaw (Jones & Wilson, 2006). Participants were instructed to learn as much as possible and were given 5 minutes to read, but they were not allowed to take notes or use a handheld device (e.g., cell phone and laptop) while reading. After the 5 minutes were over, the experimenter removed the article so that the participant could not reference it for the rest of the study.

Next, participants in the four *emotion conditions* wrote about a memory that they thought would make them feel excited (positive, high arousal), relaxed (positive, low arousal), angry (negative, high arousal), or sad (negative, low arousal). Participants were encouraged to remember the scene vividly and feel the emotions that were present in the original situation. Participants in the *neutral control condition* were asked to write a vivid, detailed description of what they did today before entering the lab, and they were not asked to relive any emotions.

Participants were then asked what they felt that they had learned from reading the article in three questions: “How much information did you learn from this article?” “How much more do you know now than you did before reading this article?” and “To what extent did reading this article contribute to your knowledge of the topic?” on a scale from 1 (*none*) to 9 (*an extreme amount*) ( $\alpha = .80$ ).

Two questions assessed how personally relevant participants perceived the information to be: “To what extent was the information you learned relevant for your life?” and “To what extent could you apply the information you learned from this article?” (1 = *not at all*; 9 = *extremely*;  $\alpha = .79$ ). Another question assessed “How glad are you that you read this article?”

Next, participants’ objective learning was assessed with a free writing recall task. For 5 minutes, participants listed everything they could remember from the article.

## Results

### *Coding objective learning*

Two coders listed the information contained in the article. The coders’ lists agreed on 89% of the material. One coder’s list was used as the master list to which participants’ recollections of the essay were compared (range 0–9,  $M = 5.0$ ). A second coder judged a portion of participants’ recollections, and the intraclass correlation was high,  $r(13) = .94$ ,  $p < .001$ . Thus, it appears that the codings yielded a reliable measure of how well each participant’s recollection of the article matched the material in the article itself.

### *Main results*

We predicted that condition assignment would predict perceived learning beyond how much was actually learned. A one-way ANCOVA, with objective learning scores as covariate, indicated that there was significant variation among conditions in perceived learning when controlling for actual learning,  $F(4, 79) = 2.52$ ,  $p < .05$ . The central hypothesis was tested by comparing perceived learning scores in the four emotion conditions against the neutral control condition. This test revealed that, as predicted, being assigned to relive an emotion boosted the perception of learning as compared with the neutral control condition,  $t(80) = 2.66$ ,  $p = .006$  (Figure 2).

As in the preceding studies, the perception of learning was about the same for all the different emotions. A one-way ANCOVA on the four emotion conditions (dropping the control condition) found no evidence that they differed from each other in perceived learning,  $F < 1$ , *ns*. The learning was also again apparently illusory. A one-way ANOVA on number of

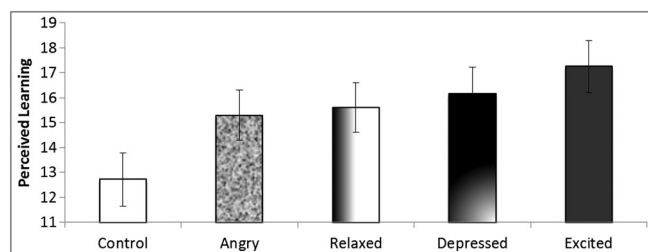


Figure 2. Perceived learning as a function of condition (actual learning held constant statistically); Study 3. Perceived learning was measured by combining the items “How much information did you learn from this article?” “How much more do you know now than you did before reading this article?” and “To what extent did reading this article contribute to your knowledge of the topic?” on scales from 1 (*none*) to 9 (*an extreme amount*)

facts correctly recalled from the article indicated no difference among conditions in amount of actual learning,  $F < 1$ , *ns*.

We tested whether two alternate explanations could account for the results. As in Study 2, condition assignment did not predict participants’ perception of the personal relevance of the information they learned, nor how glad participants were that they read the article,  $F_s < 1.2$ , *ns*. This suggests that emotions changed how much people believed they learned from the material, but this effect was not working through changes in perceptions of the article’s content.

## Discussion

Participants’ perceptions of how much they learned from an article about George Bernard Shaw were higher after an emotional state had been induced than if participants had been instructed to write about a neutral event. There was no evidence of any differences in actual learning, even using a painstaking measure that compared freely recalled synopses of the article with the original article. By putting the emotion manipulation after the reading passage, we were able to ensure that emotion condition and neutral control condition participants read the Shaw article while in roughly the same subjective state. The emotion was induced after the article was read and was irrelevant to the article, so it would not plausibly have contributed to learning, an assumption that was confirmed by the objective measures of learning. Also again, the different emotional conditions produced roughly equal increments in perceived learning. Thus, emotions representing the four quadrants of the emotional circumplex all caused participants to increase their ratings of how much they learned, and by about the same amount, independent of any actual increase in learning.

## MANIPULATION VALIDATION STUDY

The studies reported earlier sought to manipulate emotion but did not administer manipulation checks. Checks were omitted partly to avoid calling attention to emotion as the focus of the study. Hence, it was desirable to conduct a separate study to confirm that our manipulation of recalled emotional events did in fact rekindle the requisite emotions.

An additional issue with the preceding studies was the possibility that recalling an emotional event engaged participants more in the study than recounting minor daily activities (in the neutral control condition). Being more engaged in the study could have contributed to the perception of having learned more. Hence, this study also included a measure of feelings of engagement.

## Method

### *Participants*

Eighty-eight participants (68 women, 83% White, 20.5% Hispanic or Latino, 4.5% Asian, and 6.8% African-American) completed the study in exchange for partial course credit. Five participants were excluded for not following instructions.

### Procedure

Participants were randomly assigned to either a control condition or one of four emotion conditions. Participants in the control condition were asked to write about what they did before entering the lab. Participants in the four emotion conditions were asked to write about a time when they felt excited, angry, depressed, or relaxed.

After completing the writing task, participants were asked to rate the extent to which they felt excited (excited, enthusiastic, stoked, and pumped), angry (angry, infuriated, mad, and furious), depressed (depressed, gloomy, miserable, and sad), and relaxed (content, relaxed, easygoing, and peaceful) on a scale of 1 (*not at all*) to 9 (*extremely*),  $as > .85$ .

Participants rated the writing task on the degree to which they found it engaging and interesting, as well as their motivation during it on a scale of 1 (*not at all*) to 5 (*extremely*). Participants last rated how much effort they put into the writing task on a scale of 1 (*none*) to 5 (*an extreme amount*).

### Results

Planned comparisons confirmed the effectiveness of the manipulations, which was the purpose of the study. Table 1 presents the full results. Participants in the excited condition reported feeling significantly more excited than participants in the control,  $t(78) = 4.84, p < .001$ . Participants in the angry condition reported feeling significantly angrier than participants in the control condition,  $t(78) = 2.84, p < .01$ . Participants in the depressed condition reported feeling significantly more depressed than participants in the control,  $t(78) = 3.59, p < .01$ .

The only apparent failure was the inducement of the relaxed state. Although the means were in the right direction, there was no significant difference in how relaxed participants felt between participants in the relaxed and participants in the control condition,  $t(77) = 1.39, p = .17$ .

There were no differences between conditions in participants' ratings of engagement, interest, or motivation,  $F_s < 1.30, ns$ . There was also no significant difference in the effort participants reported putting into the writing task,  $F(4, 77) = .68, p = ns$ .

### Discussion

This validation study provided evidence that the emotion manipulations increased how angry, excited, and depressed

Table 1. Means and standard deviations of self-rated emotions as a function of condition; validation study

Condition	Reported emotion			
	Excited	Angry	Depressed	Relaxed
Excited	6.33 (2.13)	1.09 (.20)	1.20 (.33)	5.73 (1.64)
Angry	3.39 (2.13)	2.78 (1.58)	2.88 (1.58)	4.38 (2.11)
Depressed	2.62 (1.64)	2.60 (2.26)	3.62 (1.92)	4.66 (1.65)
Relaxed	3.78 (1.72)	1.19 (.55)	1.50 (.82)	6.74 (1.32)
Control	3.36 (1.81)	1.46 (.66)	2.10 (1.04)	5.99 (1.42)

After completing the writing task, participants rated the extent to which they felt excited (excited, enthusiastic, stoked, and pumped), angry (angry, infuriated, mad, and furious), depressed (depressed, gloomy, miserable, and sad), and relaxed (content, relaxed, easygoing, and peaceful) on a scale of 1 (*not at all*) to 9 (*extremely*),  $as > .85$ .

participants felt, as compared with the control condition. The relaxation manipulation did not successfully increase participants' feeling of relaxation as compared with the control condition. Although the manipulation did yield relatively high reported relaxation, the comparison was hampered because control participants reported much more relaxation (5.99 on a 10-point scale) than any of the other emotions (1.46, 2.10, and 3.36). Thus, baseline levels of relaxation were high, creating a possible ceiling effect. In any case, it seems that our manipulations generally achieved the desired effect of increasing the target emotion.

There were no significant differences between conditions in interest, engagement, motivation, or effort. Thus, any effects of our manipulations do not appear to be mediated by those factors.

### STUDY 4: SPECIFICITY OF ILLUSION AND RETROACTIVE DISTORTION

Study 4 sought to replicate the illusion of learning in a non-U.S. sample in order to increase generality further. Replication is highly valued, and to obtain replication in samples that differ on any major characteristic—such as native language and continent, as in this case—adds confidence in the overall conclusions.

Study 4 also tested two alternate explanations for the effects of Studies 2 and 3. One alternate hypothesis is that when people are in an emotional state, they experience stronger feelings than normal about everything and attach these feelings to whatever confronts them. If so, then emotional participants may not only claim to have learned more but might also say they like eating potato chips and dislike traffic jams more than participants in an unemotional state. There were suggestions in prior studies that this would not be the case, as people in the emotion conditions did not state that they felt gladder, for instance, after reading text. Nonetheless, a cleaner test of this hypothesis would use concepts independent from the learning material, which is what we did in Study 4.

A second alternate hypothesis was that some of emotion's effects on perceived learning operate through decreasing people's perceptions of their prior knowledge. This would be in line with the "getting what you want by revising what you had" eponymous hypothesis of Conway and Ross (1984), who showed that in the absence of actual learning, people exaggerated their retrospective impression of their own prior ignorance. Rather than influencing perceptions of learning directly, emotions could influence perceptions of learning by decreasing the amount that participants thought they knew before they experienced the emotion. This would still reflect a relationship between learning and emotion but would suggest a different mechanism for the effect.

Participants were randomly assigned to a neutral condition, or to one of five emotion conditions: angry, fearful, embarrassed, excited, or proud. These were chosen to represent an assortment self-conscious and ordinary emotions.



## Method

### Participants

One hundred eighty-one undergraduates at a large Dutch university participated. All but four were women, all but one were of Dutch nationality, and nearly all were between ages of 18 and 25 years. They were randomly assigned across six conditions.

### Procedure

Participants in the emotion condition were asked to write about a time in which they felt angry, fearful, embarrassed, excited, or proud. Participants in the neutral control condition wrote about the path they would take from the classroom back to their home. All participants were told to imagine the scenario vividly, as if they were there. They were allowed to write in Dutch.

Subsequently, participants read a four-paragraph passage about the history of U.S. Route 66 (adapted from Wikipedia). This essay was chosen in part because we presumed that Dutch young adults would have little prior knowledge of Route 66.

Then participants turned past five blank pages<sup>1</sup> to a page that asked about how much they felt they had learned. Three items asked, “Thinking about what you know now, how much do you know about Route 66?”; “How much did reading this article add to your current knowledge of the topic?” (1 = *nothing*; 7 = *quite a lot*); and, “If you were to answer questions now about Route 66, how well would you do compared to others in your class?” (1 = *much worse than others*; 7 = *much better than others*). We summed these items ( $\alpha = .75$ ) to create a perceived learning index.

Participants thought back to before they read the essay and rated how much they had known then about Route 66 (1 = *nothing*; 7 = *quite a lot*) and how well they would have performed, compared with others, on a quiz about Route 66 (1 = *much worse than others*; 7 = *much better than others*). We summed these items ( $\alpha = .63$ ) to create a perceived prior knowledge index.

Then participants turned the page and took a five-item, multiple-choice quiz. Four items asked about facts in the essay and one about the gist. Then to investigate possible changes in attitudes toward a broad assortment of phenomena, participants reported how much they liked green apples, Ikea furniture, dark chocolate, swimming, and winter (1 = *not at all*; 5 = *very much*).

## Results and discussion

There was significant variation among conditions in perceptions of how much one had supposedly learned,  $F(5, 176) = 4.76$ ,  $p < .001$ . A planned contrast showed that participants who were in the five emotion conditions reported learning more than participants in the neutral control condition,  $t(176) = 4.42$ ,  $p < .001$ . The means are displayed in

<sup>1</sup>Several design features were in place to discourage participants from looking back at the essay for answers. One was the insertion of the blank pages, which created space between the essay and quiz so as to make it difficult—and obvious—if participants wanted to turn back to look at the answers. The attention of the course instructor and six research assistants also discouraged returning to the essay page, which consequently was not done.

Figure 3. There was no difference in perceived learning among emotion conditions,  $F < 1.1$ .

Participants’ objective learning as measured by their quiz scores did not vary by condition,  $F(5, 172) < 1.6$ , *ns*. Predicting perceived learning after controlling for actual learning confirmed the omnibus effect,  $F(5, 172) = 5.50$ ,  $p < .01$ , and planned comparisons using the residualized measure also showed that emotion condition participants reported having learned more than neutral control condition participants even when controlling for participants’ quiz scores,  $t(172) = 4.88$ ,  $p < .001$ .

Participants’ judgments of their knowledge before reading the Route 66 essay were tested (Conway & Ross, 1984). An ANOVA showed no effect of condition on perceptions of one’s prior knowledge,  $F < 1$ . The ratings of prior knowledge were quite low in general.

Individual one-way ANOVAs tested whether participants’ reports of their feelings about non-learning concepts, such as dark chocolate, Ikea furniture, and winter, were affected by condition. There was no effect of condition on any of the opinion items,  $F_s < 1.64$ ,  $p_s > .15$ . Thus, emotion did not intensify evaluative reactions generally. Its effects were specific to how much people think they have learned.

## GENERAL DISCUSSION

Four experiments indicated that people associate emotion with learning and that emotion can cause an illusion of learning. That is, persons who experienced an emotional state reported that they learned more than neutral control condition participants, even though the emotion was irrelevant to the learning task, and, more important, objective tests of the lesson material found no sign whatsoever of better learning. The differences in perceived learning remained intact when we controlled for the test score evidence of actual learning.

The link between emotion and illusory learning was quite robust across changes of procedure. We found the effect with American and European samples, with both student and non-student samples, with three different lessons having considerably different content, with male-majority and female-majority samples, and with three

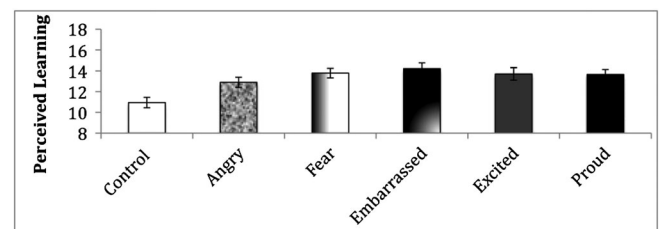


Figure 3. Perceived learning as a function of condition (actual learning held constant statistically); Study 4. Perceived learning was measured by combining the items, “Thinking about what you know now, how much do you know about Route 66?”; “How much did reading this article add to your current knowledge of the topic?” (1 = *nothing*; 7 = *quite a lot*); and “If you were to answer questions now about Route 66, how well would you do compared to others in your class?” (1 = *much worse than others*; 7 = *much better than others*) ( $\alpha = .75$ )



different data collection settings (individual laboratory session, classroom study, and online study). We found the effect regardless of whether the emotion came before or after the lesson.

The studies also undertook to rule out a variety of potential confounds and alternate explanations. The illusion did not operate by making people find the lesson material especially relevant to their own lives, nor by making them especially glad they had read the lesson (Studies 2–3). It did not operate by making people retrospectively revise their estimates of how ignorant they had been prior to the lesson (Study 4). The illusion seemed specific to learning, insofar as the emotion manipulations only affected ratings of learning and did not produce differences in subjective ratings of various other things, such as dark chocolates, Ikea furniture, or winter (Study 4). The manipulations appear to have generated requisite increases in the target emotions but not in feeling engaged with the study materials, nor in interest, motivation, or effort.

The effect was not specific to one or two emotional states because we used quite an assortment across the various studies. Studies 2 and 4 used angry, fearful, embarrassed, excited, proud, and guilty, in order to include both positive and negative versions of ordinary and self-conscious emotions (Miller, 1996; Tangney & Fischer, 1995). Study 3 used excited, relaxed, angry, and sad, in order to cover all four quadrants of the emotional circumplex that is created by the two dimensions of valence and arousal (Russell, 1980). Despite our theory that emotion per se, rather than any specific emotion, could cause an illusion of learning, we confess to having favored assorted hypotheses about which emotions would be best or worst at producing the illusion of learning—but none panned out. There was no evidence of systematic variation across different emotions in the illusion of learning.

Moreover, the illusion may well be based on the fact that people genuinely associate emotion with learning. Evidence for that association was found when people were prompted to write about situations in which they learned much or a little (Study 1). Writing about a time in which people learned much, relative to a time in which people learned only a little, aroused recollections that were filled with highly emotional details. Thus, even asking people to recall times when they learned a big life lesson leads them to conjure up situations steeped in emotion.

We also reviewed other evidence that emotion does sometimes facilitate actual learning. This pattern is consistent with the general theory that improving learning is one basic purpose and function of emotion. Sometimes, emotion really is connected with superior learning. Because people associate emotion with learning, they may infer from emotion that learning is happening, perhaps especially when it is difficult to obtain a direct assessment of how much they learned. Relying on emotion to gauge learning leaves them susceptible to the illusion of learning, in which the fact of emotion encourages them to think they learned plenty even though they did not.

To be sure, it remains possible that there may be exceptions and counterexamples, although we found none. In particular, it is plausible that sometimes an emotion

might be a cue that one has failed to learn, such as when one suffers dismay over recognizing that one has made the same mistake or fallen for the same ploy again. Future research may explore such possibilities, as well as other possible boundary conditions. For example, when learning is vitally important and/or externally mandated, perhaps people would be less prone to illusion than in the relatively casual situations we used (although evidence from eyewitness testimony and other situations that place high value on accurate judgment has not been encouraging with regard to people's ability to sweep distorting biases aside when necessary). Nonetheless, our contribution has documented that a wide assortment of emotions can produce an illusion of learning of a variety of facts.

The fact that people associate learning with emotion likely plays a role in the illusion of learning, but it remains unclear exactly why emotions increase people's perceptions of learning. Are people using emotion as information, and would their learning judgments no longer be affected by their emotions if they attributed their emotions elsewhere (Schwarz & Clore, 1983)? Is this a heuristic process that could be overridden by motivation<sup>2</sup>? It is also even possible that the mechanism could be different for different kinds of emotions (e.g., positive and negative emotions). These questions could provide fruitful avenues for future research. People's estimates of how much they learned are subject to distortion and inflation on the basis of emotion. Emotional states, even ones fully and obviously irrelevant to the lesson content, cause people to raise their estimates of how much they learned. When people claim to have learned a substantial amount, they may be misled by their emotions.

Estimates of learning are far from trivial, especially in decision contexts. As one example, the salaries of college instructors at many institutions depend in part on students' reports of how much they learned. Anecdotal evidence, at least, suggests that students favor classes with plenty of emotional theatricality, possibly more than courses that dispassionately convey large amounts of information. As another example, decisions about whether to embark on a risky adventure may be swayed by advice from others who claim to have learned a great deal from similar adventures, but that advice may be misguided insofar as the episode may have yielded emotion rather than genuine learning. (For example, seeing euphoric lottery winners on television may inspire people to buy lottery tickets, despite the fact that dispassionate statistical calculations suggest that such purchases are a waste of possibly precious money.) More broadly, believing one has learned a great deal may encourage self or others to have faith in a person's judgment and confidence in that person's decisions.

Our own interest in these phenomena was inspired less by practical applications than by its potential implications for emotion theory. The view that a central purpose of emotion is to stimulate retrospective cognitive processing

<sup>2</sup>Thank you to reviewer 1 for this idea for future research.

so as to facilitate learning fits well with the present findings. We assume that many emotional experiences do induce learning, which is why people may have come to rely on surveying their recent emotions as an easy way of estimating how much they learned. As with many heuristics, mistakes and illusions can reveal the process by which mostly correct decisions are made (Funder, 1987). The amount of emotion experienced may often be a serviceable guide to how much learning took place, even if it is sometimes inaccurate. In any case, it may be useful to know that when people say they learned much, what they mean is that they felt much.

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