Happy but overconfident: Positive affect leads to inaccurate metacomprehension

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Happy but overconfident: Positive affect leads to inaccurate metacomprehension

When learning from text, it is important that learners not only comprehend the information provided but also accurately monitor and judge their comprehension, which is known as metacomprehension accuracy. To investigate the role of a learner’s affective state for text comprehension and metacomprehension accuracy, we conducted an experiment with N = 103 university students in whom we induced positive, negative, or neutral affect. Positive affect resulted in poorer text comprehension than neutral affect. Positive affect also led to overconfident predictions, whereas negative and neutral affect were both associated with quite accurate predictions. Independent of affect, postdictions were rather underconfident. The results suggest that positive affect bears processing disadvantages for achieving deep comprehension and adequate prediction accuracy. Given that postdictions were more accurate, practice tests might represent an effective instructional method to help learners in a positive affective state to more accurately judge their text comprehension.

Keywords: affect; metacomprehension accuracy; reading; text comprehension

From the perspective of evolutionary theories, affective states have a signaling function in the way that they inform people how to adapt to a situation. Thus, they influence how people process information (e.g., Forgas, 2017). Positive affect conveys that a situation is safe. Therefore, it triggers assimilative, top-down processing that relies upon pre-existing knowledge and heuristics. Negative affect, in contrast, indicates that a situation is problematic. Thus, it fosters accommodative, bottom-up processing that focuses attention on external information (for an overview, see also Bless & Fiedler, 2006).

Despite the fact that learning is often accomplished by reading texts and emotions are omnipresent in learning situations (e.g., Pekrun, Frenzel, Götz, & Perry, 2007), however, research has given surprisingly little attention to the role of a learner’s affective state for learning from reading. For learning from reading to be effective, it is necessary that learners not only comprehend the information provided in a text but also accurately monitor and judge
their comprehension, which is known as metacomprehension accuracy (e.g., Thiede, Griffin, Wiley, & Redford, 2009). Whether positive, negative, and neutral affect influence text comprehension and metacomprehension accuracy differently is in the focus of the study presented in this article.

**Affect and text comprehension**

Given that different affective states lead to different styles of information processing (e.g., Forgas, 2017), it seems plausible that they also result in different outcomes when comprehending a text. Little research, however, has been dedicated to testing this assumption empirically. Bohn-Gettler and Rapp (2011) showed that learners in whom positive or negative affect was induced recalled more information of a text than learners in whom neutral affect was induced. Baumeister, Alquist, and Vohs (2015) found that performance on factual-knowledge questions and free recall after reading a text did not vary as a function of a learner’s affective state (e.g., induced neutral, excited, relaxed, and depressed emotions). Scrimin and Mason (2015) revealed that learners in a positive-induced affective state acquired more factual knowledge from reading a text than learners in a negative-induced affective state. Learners in a neutral-induced affective state scored in between the other two affect groups and did not statistically differ from them. When learners had to apply their knowledge to new situations, however, the affective state that they were in made no difference. Finally, Mills, Wu, and D’Mello (2017) showed that learners in positive- and negative-induced affective states performed equally well when answering factual-knowledge questions about a text. However, learners in a negative-induced affective state were more successful than learners in a positive-induced affective state in answering deep-reasoning questions that assessed the ability to draw inferences and apply the acquired knowledge.
Overall, the results of the reported studies (Baumeister et al., 2015; Bohn-Gettler & Rapp, 2011; Mills et al., 2017; Scrimin & Mason, 2015) suggest that affect-induced comprehension differences do not occur in any case. However, it seems that the comprehension differences that were observed in the studies can be explained by specific styles of information processing triggered by distinct affective states. More concretely, when shallow processing was sufficient for comprehension (i.e., remembering factual information), learners in a positive affective state performed better than learners in a negative affective state, with learners in a neutral affective state not differing from the others (Scrimin & Mason, 2015). In contrast, when deep processing was required for comprehension (i.e., drawing inferences and applying knowledge), the opposite appeared to be the case and learners in a negative affective state achieved better performance than learners in a positive affective state (Mills et al., 2017). To what extent a neutral affective state influences deep comprehension is rather unclear. Scrimin and Mason (2015) found no difference in deep comprehension between learners in positive, negative, and neutral affective states. To conclude, depending on the level of processing required for successful comprehension, the different affective states each seem to have processing advantages (cf. Forgas, 2017).

Affect and metacomprehension accuracy

Research has given little attention not only to the role of affect for text comprehension but also to the role of affect for metacomprehension accuracy. Metacomprehension accuracy is important when learning from text because it influences whether learners effectively self-regulate their learning (e.g., Thiede, Anderson, & Therriault, 2003). For example, when learners underestimate their text comprehension, they might overlearn material that is already understood while neglecting other material. In contrast, when learners overestimate their text comprehension, they might prematurely terminate the study of material that is in fact not well
understood (e.g., Dunlosky & Rawson, 2012). Research shows that learners often overestimate their comprehension of texts (e.g., Miesner & Maki, 2007). This is particularly true for learners’ predictions, that is, when they judge their comprehension after reading but before taking a comprehension test. In contrast, learners’ postdictions, that is, when they judge their comprehension after taking a comprehension test, are typically more accurate (e.g., Pierce & Smith, 2001).

To understand how a learner’s affective state might influence prediction accuracy, the affect infusion model is informative (Forgas, 1995). According to this model, when making judgments about an object, people ask themselves how they feel about the object. In doing so, they mistake their pre-existing feelings as a reaction to the object of judgment. As a consequence, positive affect results in a positive judgment about the object, whereas negative affect leads to a negative judgment about the object. Following this model, when their own text comprehension is the object of judgment, learners in a positive affective state should tend to make optimistic predictions of their comprehension, whereas learners in a negative affective state should tend to make pessimistic predictions of their comprehension. Given that heuristic processing is likely to occur when being in a positive affective state (e.g., Forgas, 2017), learners in this affective state might be particularly prone to rely on their affect when providing their predictions. In contrast, when being in a negative affective state, learners usually engage in analytical processing (e.g., Forgas, 2017). Thus, for these learners, the tendency to base their predictions on their affect might be mitigated. Hence, concerning prediction accuracy, it can be conjectured that learners in a positive affective state would be inclined to overestimate their comprehension, whereas learners in a negative affective state would rather accurately judge their comprehension. How learners in a neutral affective state would judge their comprehension, however, is an open question.
As supported by the postdiction-superiority effect (Pierce & Smith, 2001), postdictions are typically more accurate than predictions. This is because, when providing postdictions, learners primarily rely on feedback generated from completing a comprehension test, such as the frequency of guessing the correct answer, to make their judgments. Accordingly, a learner’s affective state, irrespective of whether it is positive, negative, or neutral, should not play an important role for postdiction accuracy.

Whether the distinct affective states differently influence prediction accuracy and lose their impact on postdiction accuracy, however, has not yet been investigated. Baumeister et al. (2015) found that learners in whom positive or negative affect was induced erroneously predicted to have learned more from reading a text than learners in whom neutral affect was induced. Yet, Baumeister et al. (2015) focused on judgments per se but did not analyze metacomprehension accuracy by comparing judgments with actual comprehension performance. However, it is important to examine whether judgments are accurate or reflect over- or underconfidence because this determines the effectiveness of regulatory decisions (e.g., terminating the study of material that is perceived to be well understood; cf. Thiede et al., 2003). A study that looked at affect and metacomprehension accuracy was conducted by Miesner and Maki (2007). They revealed that, independent of whether test anxiety was high or low, learners overestimated their comprehension in their predictions and accurately judged their comprehension in their postdictions. However, Miesner and Maki (2007) focused on naturally occurring test anxiety that differs from experimentally induced affect that is not directly connected to the learning task. Moreover, they investigated the intensity (i.e., arousal) of one specific negative emotion, namely, test anxiety. Thus, there is a lack of research on the influence of positive versus negative affect (i.e., valence) on the accuracy with which learners predict and postdict their comprehension of a text.
A study that looked at judgment accuracy as a function of the valence of an affective state was conducted by Sidi, Ackerman, and Erez (2017). They found that people in a positive-induced affective state showed larger overconfidence than people in a neutral-induced affective state. However, they did not examine the role of negative affect and focused on people’s confidence in general-knowledge questions rather than on judgments in the context of learning.

The present study

In this study, we examined whether positive, negative, and neutral affect would influence comprehension and metacomprehension accuracy differently when learners read an expository text. We focused on deep comprehension of this text by asking learners to answer application questions.

The findings obtained by Mills et al. (2017) suggest that negative affect, compared with positive affect, has processing advantages for achieving deep comprehension. However, the effects observed by Mills et al. (2017) were quite small, and the study by Scrimin and Mason (2015) revealed no significant difference in deep comprehension depending on affective state. Therefore, we predicted that negative affect would result in somewhat better text comprehension than positive affect, whereas we formulated no prediction concerning the impact of neutral affect because there is no prior research that would warrant a definite assumption (comprehension hypothesis).

Following the affect infusion model (Forgas, 1995) and research on affect-dependent processing styles (e.g., Forgas, 2017), positive affect seduces learners to provide overoptimistic judgments and negative affect renders it more likely that learners do not rely on their affect when providing judgments. Accordingly, concerning prediction accuracy, we assumed that learners in a positive affective state would overestimate their text
comprehension, whereas learners in a negative affective state would rather accurately judge their text comprehension. Due to missing prior research, we formulated no specific assumption regarding how learners in a neutral affective state would judge their text comprehension (prediction hypothesis).

Postdictions are generally more accurate than predictions because feedback from completing a comprehension test becomes available and can be used for judging comprehension (e.g., Pierce & Smith, 2001). Hence, concerning postdiction accuracy, we expected that learners would judge their text comprehension quite accurately irrespective of their affective state (postdiction hypothesis).

**Method**

**Sample and design**

A total of $N = 103$ university students of the social sciences participated in this experiment. Their mean age was 23.21 ($SD = 3.82$) years. The experiment had a one-factorial between-subjects design with affective state as the independent variable. Participants were randomly assigned to the positive ($n = 35$), negative ($n = 34$), or neutral ($n = 34$) affect condition. Text comprehension and metacomprehension accuracy with regard to predictions and postdictions constituted the dependent variables.

**Materials and measures**

**Affect induction and assessment**

Affect was induced through a combination of the autobiographical recollection method (e.g., Abele, 1990) and the musical mood induction procedure (e.g., Västfjäll, 2001). The combination of these two affect induction techniques is usually more effective than the use of a single one (e.g., Siemer, 2001). Therefore, to induce positive, negative, or neutral affect,
participants were asked to recall a happy, sad, or neutral autobiographical event while listening to appropriate music (positive: “Kleine Nachtmusik Allegro” by Mozart; negative: “Adagio pour Cordes” by Barber; neutral: “Symphony No 40 in G minor” by Mozart; see Västfjäll, 2001).

The success of the affect induction was measured multiple times during the experiment by means of the affect grid (Russel, Weiss, & Mendelsohn, 1989) that assesses current affect on the dimensions of valence (1 = extremely negative to 9 = extremely positive) and arousal (1 = extremely low to 9 = extremely high).

**Text**

The text used in this study was an expository science text that dealt with population dynamics. The text was constructed on the basis of different articles about this topic found on the internet and in textbooks. Predominantly, the text dealt with the Lotka-Volterra model that is composed of different equations that describe predator-prey dynamics. The text also provided two graphs to illustrate equations about predator-prey dynamics. The text included 579 words and had a Flesch-Reading-Ease score (Flesch, 1948) of 33, indicating that the text was rather difficult to read.

**Text comprehension**

Text comprehension was assessed by five application questions in a single-choice format with three response options. Participants received 1 point for each correct answer. To facilitate the interpretation of text comprehension, we converted the number of correctly answered questions into percentage of correctly answered questions.

**Metacomprehension accuracy**
We assessed metacomprehension accuracy for predictions and postdictions. When predicting their text comprehension, participants judged the number of comprehension questions they would presumably answer correctly before they completed the questions. When postdicting their text comprehension, participants judged the number of comprehension questions they presumably answered correctly after they had completed the questions. Metacomprehension accuracy in terms of bias was calculated by taking the signed difference between a participant’s judged number of correct questions (in %) and actual number of correct questions (in %; see Schraw, 2009). Hence, a positive value indicated overestimation, a negative value indicated underestimation, and a value of zero indicated a perfectly accurate judgment.

**Prior knowledge**

We assessed prior knowledge about population dynamics with one open-ended question that asked participants to write down everything they know about this topic. Participants received 1 point for providing a rough definition of what population dynamics are and 2 points for additionally providing a more detailed explanation of predator-prey relationships. Two raters independently scored participants’ answers with high inter-rater agreement, Cohen’s κ = .93, 95% CI [0.85, 1.00].

**Procedure**

The experiment was divided into three phases. In the pre-experimental phase, participants first completed the prior knowledge test within a time limit of 5 minutes. Then, they were instructed on how to rate their current affect with the 9 x 9 affect grid by marking the square that best exemplified the valence (extremely negative on the left to extremely positive on the right) and arousal (extremely low at the bottom to extremely high at the top) of their affect. After this instruction, they rated their affect for the first time (pre-experimental affect).
In the induction phase, depending on the affect condition, participants listened to a happy, sad, or neutral music piece via headphones at a preset volume for approximately 6 minutes. While listening to the music, participants were instructed to recall a happy, sad, or neutral autobiographical event. Participants were encouraged to remember the event vividly and in detail to feel the emotions that were present in the original situation. They were asked to do so for as long as the music was playing. After the induction, participants rated their affect for the second time (pre-reading affect).

In the learning phase, participants read the text about population dynamics within 8 minutes. They were told that their comprehension of the text would be tested. After reading, the text was removed and participants again indicated their affect (post-reading affect). Then, participants made the prediction of their text comprehension. To do so, they were informed about the kind, format, number, and processing time of the upcoming comprehension questions. Next, participants answered the questions within a time limit of 10 minutes. After completion, they rated their affect for the last time (post-test affect) and made the postdiction of their text comprehension. Finally, they answered demographic questions.

**Results**

*Affect manipulation check*

A MANOVA with the four valence ratings as the dependent variables and affective state as the fixed factor revealed a statistically significant difference in valence based on affect, \( F(8, 194) = 33.55, p < .001, \eta^2 = .58 \) (large effect). We predicted that positive affect would result in the highest, negative affect in the lowest, and neutral affect in the intermediate valence ratings. This prediction was represented by the following contrast weights: positive affect condition: +1, negative affect condition: -1, neutral affect condition: 0. Table 1 displays the results of the contrast analysis for each dependent variable. With respect to the pre-
experimental valence rating, the affect groups did not significantly differ from each other. Importantly, after the affect induction, however, our prediction was confirmed across all three valence ratings.

Another MANOVA with the four arousal ratings as the dependent variables and affective state as the fixed factor showed no statistically significant effect of affect, $F(8, 194) = 1.82, p = .075, \eta^2 = .07$ (medium effect). We conducted simple contrasts with the neutral affect condition as the reference category to check whether it significantly differed from the positive and negative affect conditions. As displayed in Table 1, after the affect induction (pre-reading arousal rating), the neutral affect group indicated significantly lower arousal than the other two affect groups. This is not surprising given that neutral affect is typically associated with feeling calmer and more relaxed (cf., e.g., Scrimin & Mason, 2015). With respect to the other three arousal ratings, the neutral affect group did not significantly differ from the positive and negative affect groups. Moreover, further analyses that contrasted the positive affect group with the negative affect group revealed no significant difference in arousal on all four ratings (all $ps \geq .297$). Thus, we manipulated affect with respect to valence as intended while keeping arousal, particularly for the positive and negative affect groups, at an equal level.

--- Please insert Table 1 about here ---

**Comparability of affect groups**

On average, the three affect groups did not significantly differ from each other with respect to last school grade in biology ($1 = best, 6 = worst$), $M_{positive} = 2.13, SD = 0.72; M_{negative} = 2.00, SD = 0.61; M_{neutral} = 2.30, SD = 0.86; F(2, 98) = 1.40, p = .251, \eta^2 = .03$ (small effect), and prior knowledge about population dynamics, $M_{positive} = 0.34, SD = 0.54; M_{negative} = 0.35, SD = 0.54; M_{neutral} = 0.21, SD = 0.41; F(2, 100) = 0.91, p = .404, \eta^2 = .02$ (small effect).
**Text comprehension**

An ANOVA showed that comprehension performance significantly differed between the affect groups, $F(2, 100) = 3.33$, $p = .040$, $\eta^2 = .06$ (medium effect). Pairwise comparisons with the Tukey test, which controls for the familywise error rate, revealed that the neutral affect group ($M = 75\%$, $SD = 18\%$) scored significantly higher than the positive affect group ($M = 62\%$, $SD = 25\%$; $p = .031$). The negative affect group ($M = 69\%$, $SD = 19\%$) scored in between the other two affect groups but did not significantly differ from them ($ps \geq .340$).

Thus, partly in line with the comprehension hypothesis, negative affect descriptively resulted in somewhat better text comprehension than positive affect. Moreover, the results showed that neutral affect lead to significantly better text comprehension than positive affect.

**Judgment magnitude**

Although our hypotheses were not directly related to the magnitude of participants’ judgments, we first analyzed the effects of affective state on predictions and postdictions per se before we examined accuracy. An ANOVA showed that there was no significant difference in prediction magnitude between the affect groups, $F(2, 100) = 1.50$, $p = .229$, $\eta^2 = .03$ (small effect). Descriptively, however, the positive affect group ($M = 76\%$, $SD = 17\%$) made the highest predictions, followed by the neutral affect group ($M = 71\%$, $SD = 17\%$), with the negative affect group ($M = 69\%$, $SD = 18\%$) providing the lowest predictions (all $ps$ from pairwise comparisons with the Tukey test $\geq .254$).

Another ANOVA showed that postdiction magnitude did also not significantly differ between the affect groups, $F(2, 100) = 0.57$, $p = .569$, $\eta^2 = .01$ (small effect). Descriptively, the neutral affect group ($M = 64\%$, $SD = 20\%$) provided the highest postdictions, followed by the positive affect group ($M = 60\%$, $SD = 21\%$) and the negative affect group ($M = 60\%$, $SD = 20\%$; all $ps$ from pairwise comparisons with the Tukey test $\geq .608$).
We further examined whether judgment magnitude changed from predictions to postdictions depending on affective state. To do so, we performed a mixed ANOVA with affective state (positive vs. negative vs. neutral) as the between-subjects variable and judgment magnitude (prediction vs. postdiction) as the within-subjects variable. The analysis revealed a significant interaction effect between affective state and judgment magnitude, $F(2, 100) = 3.69, p = .028, \eta^2 = .07$ (medium effect). A simple effects analysis demonstrated that participants significantly decreased their judgments from prediction to postdiction in all affect groups, positive affect group: $F(1, 100) = 38.06, p < .001, \eta^2 = .28$ (large effect); negative affect group: $F(1, 100) = 13.01, p < .001, \eta^2 = .12$ (medium effect); neutral affect group: $F(1, 100) = 5.45, p = .022, \eta^2 = .05$ (small effect). As displayed in Figure 1, this reduction in judgment magnitude was greatest in the positive affect group. The result suggests that completing comprehension questions particularly promoted learners in a positive affective state in adapting their judgments.

--- Please insert Figure 1 about here ---

Metacomprehension accuracy

An ANOVA showed that there was a significant difference in prediction accuracy between the affect groups, $F(2, 100) = 6.07, p = .003, \eta^2 = .11$ (medium effect). The positive affect group overestimated comprehension by 15% ($SD = 29\%$), which was significantly greater than zero, $t(34) = 3.01, p = .005, d = 0.51$ (medium effect). In contrast, the negative and neutral affect groups provided rather accurate predictions. In the negative affect group, prediction accuracy was 0% ($SD = 20\%$) and did not significantly differ from zero, $t(33) = 0.25, p = .802, d = 0.04$ (small effect). In the neutral affect group, there was a slight underestimation of -3% ($SD = 19\%$) that did not significantly differ from zero, $t(33) = -1.23, p = .241, d = -0.19$ (small effect). Pairwise comparisons with the Tukey test showed that the
positive affect group more strongly overestimated comprehension than the neutral affect group \((p = .003)\) and the negative affect group \((p = .041)\). The latter two groups did not significantly differ from each other \((p = .646)\). Thus, the prediction hypothesis was confirmed in that positive affect resulted in overconfident predictions, whereas negative affect was associated with rather accurate predictions. In addition, the results revealed that neutral affect also lead to quite accurate predictions.

Postdiction accuracy did not significantly differ between the affect groups, \(F(2, 100) = 1.44, p = .241, \eta^2 = .03\) (small effect). The positive affect group provided accurate judgments with a minor underestimation of -2% \((SD = 23\%)\) that did not significantly differ from zero, \(t(34) = -0.58, p = .563, d = -0.10\) (small effect). The negative affect group underestimated comprehension by -9% \((SD = 21\%)\), which was significantly different from zero, \(t(33) = -2.49, p = .018, d = -0.43\) (medium effect). Likewise, underestimation in the neutral affect group was -10% \((SD = 20\%)\) and significantly different from zero, \(t(33) = -3.02, p = .005, d = -0.51\) (medium effect). Pairwise comparisons with the Tukey test confirmed that the three affect groups did not significantly differ from each other with respect to postdiction accuracy \((all \ ps \geq .255)\). Hence, in accordance with the postdiction hypothesis, the affective states did not influence postdiction accuracy differently.

**Discussion**

In this study, we examined whether positive, negative, and neutral affect would influence text comprehension and metacomprehension accuracy differently. Concerning text comprehension, negative affect was descriptively more effective in supporting deep comprehension than positive affect. Thus, it is plausible to assume that learners in a negative affective state actually engaged in a different style of processing, namely, in more analytical processing, compared with learners in a positive affective state (e.g., Forgas, 2017).
However, this difference in processing style had a rather small effect on achieving deep comprehension in this study as was the case in the experiments of Mills et al. (2017). Furthermore, neutral affect was significantly more beneficial for obtaining deep comprehension than positive affect. Previous research revealed that affectively charged states induce extra-task processing, requiring attentional and cognitive resources, whereas a neutral affective state leaves more capacity that can be allocated to a given task (e.g., Seibert & Ellis, 1991; see also Ellis & Ashbrook, 1988). Hence, it can be conjectured that neutral affect in the present study posed little extra-task demands, thereby leaving cognitive capacity for achieving deep comprehension.

With regard to prediction accuracy, positive affect resulted in significantly greater overconfidence compared with negative and neutral affect that both promoted rather accurate judgments. Apparently, the affective state influenced which information or cues learners used for making their predictions. To explain how the affective state might influence cue use and, therefore, metacomprehension accuracy, the cue-utilization framework (Griffin, Jee, & Wiley, 2009; cf. Koriat, 1997) represents a useful theoretical basis. According to this framework, when making predictions, learners can base their judgments on heuristic or representation-based cues (Griffin et al., 2009; cf. Koriat, 1997). Heuristic cues, such as topic interest (e.g., Lin, Zabrucky, & Moore, 1997), are available whether or not a text has been read. Therefore, they are usually not valid indicators of text comprehension and yield rather inaccurate predictions. In contrast, representation-based cues, such as accessibility of textual information (e.g., Baker & Dunlosky, 2006), are associated with the mental representation constructed from reading a particular text. Thus, they are typically valid indicators of text comprehension and yield quite accurate predictions. In the present study, due to heuristic processing when being in a positive affective state (e.g., Forgas, 2017), their affect might have presented a salient heuristic cue for the learners. In this case, positive affect might have
signaled that the object of judgment, that is, text comprehension, is favourable, resulting in overly optimistic predictions (cf. Forgas, 1995). In fact, 63% of the learners in a positive affective state overestimated their comprehension in their predictions (compared with only 26% and 21% of the learners in negative and neutral affective states, respectively). In contrast, when being in a negative affective state, due to analytic processing (e.g., Forgas, 2017), learners’ tendency to use their affect as a heuristic cue might have been reduced. Instead, the learners might have been more inclined to use cues tied to their mental representation of the text. In this case, learners’ judgments and actual comprehension performance were both determined by the mental text representation they constructed from reading, yielding more accurate predictions. Likewise, when being in a neutral affective state, the learners might have attended to cues related to their mental text representation when predicting their comprehension. Specifically, by requiring little off-task processing, neutral affect leaves attentional and cognitive resources (e.g., Ellis & Ashbrook, 1988) that the learners might have devoted to monitoring their mental text representation, resulting in rather accurate predictions (the precise ways in which the distinct affective states might have influenced prediction accuracy are displayed in Figure 2).

With regard to postdiction accuracy, learners in positive, negative, and neutral affective states did not significantly differ from each other and provided rather underconfident judgments. That learners in a positive affective state judged their comprehension quite accurately – with only a slight tendency towards underestimation – is in line with the postdiction-superiority effect (Pierce & Smith, 2001). Apparently, learners in a positive affective state primarily used cues that resulted from completing comprehension questions, such as the frequency of guessing, to make their postdictions (see Figure 2). Using these cues might have compensated for the overestimation bias observed in their predictions. Learners in negative and neutral affective states might also have attended to cues that resulted
from completing comprehension questions when making their postdictions (see Figure 2). However, that they were inclined to provide underconfident judgments might reflect the finding that when learners indicate the retrospective confidence in their answers to forced-choice questions, easy items are associated with a certain degree of underconfidence (easy-hard effect; e.g., Lichtenstein & Fischhoff, 1977). In the present study, comprehension performance of learners in negative and neutral affective states was quite good. Thus, it seems likely that the test questions had a rather moderate degree of difficulty for them, leading to underconfident postdictions.

--- Please insert Figure 2 about here ---

Although this study provides important findings, we did not examine the mechanisms supposedly underlying the observed effects in more detail. Therefore, future research should combine offline measures, such as metacognitive judgments, with online measures, such as think-aloud protocols or eye-tracking techniques, to provide further insights into the processes (e.g., cue utilization) that account for the affective influences on metacomprehension accuracy. Moreover, process data in terms of response times would help to examine efficiency (dis)advantages (e.g., number of correct answers/time) of the different affective states (cf. Sidi et al., 2017). Whether the obtained results are generalizable to situations where affect is not experimentally induced but occurs naturally is another open question for future research. In this case, affect might be even more persistent and, for example, influence learning across multiple texts.

In conclusion, the present study extends research on the role of affect for learning in several crucial ways. First, the study adds to the scant evidence concerning affective influences on text comprehension (Baumeister et al., 2015; Bohn-Gettler & Rapp, 2011; Mills et al., 2017; Scrimin & Mason, 2015). Second, it is the first study to demonstrate that affect has an impact on metacomprehension accuracy. Third, by focusing on positive,
negative, and neutral affect, the study yields comprehensive insights into the effects of affective valence on learning from text. Specifically, the results obtained in this study suggest that positive affect bears processing disadvantages for achieving deep comprehension and, particularly, accurate metacomprehension (cf. Forgas, 2017). In other words, learners in a positive affective state not only have difficulties with deeply comprehending a text but also overestimate their comprehension when providing predictions. As a consequence, their self-regulated learning might be seriously hampered. In contrast, negative and neutral affect appear to be more beneficial in this regard. However, advocating the elimination of positive affect or even the induction of negative affect in learning environments would be an inappropriate conclusion. Although negative affect seems to have beneficial effects on the accuracy with which learners predict their comprehension, it can have detrimental effects on other aspects of learning such as attention, motivation, and learning strategy use (e.g., Pekrun et al., 2007). Therefore, more practicable solutions to foster accurate predictions would be to make learners aware of their affect and its possible consequences for judgment accuracy or to provide them with the opportunity to take practice tests so that they can use cues from completing the questions to more accurately judge their comprehension.
References


Figure 1. Comprehension performance and judgment magnitude for predictions and postdictions in the affect conditions. Error bars represent 95% confidence intervals.
Figure 2. Presumed ways in which (a) positive affect, (b) negative affect, and (c) neutral affect might have influenced prediction accuracy and postdiction accuracy. Adapted from “The Effects of Domain Knowledge on Metacomprehension Accuracy,” by T. D. Griffin, B. D. Jee, and J. Wiley, 2009, Memory & Cognition, 37(7), p. 1002. Copyright 2009 by Springer. Adapted with permission.
Table 1. Results of the planned contrasts across the affect conditions with the affect ratings during the experiment as the dependent variables.

<table>
<thead>
<tr>
<th>Affect rating</th>
<th>Positive affect (n = 35)</th>
<th>Negative affect (n = 34)</th>
<th>Neutral affect (n = 34)</th>
<th>F(1, 100)</th>
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