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Reinhard Pekrun

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# Emotions in Reading and Learning from Texts: Progress and Open Problems

Reinhard Pekrun <sup>a,b,c</sup>

<sup>a</sup>Department of Psychology, University of Essex, Colchester, UK; <sup>b</sup>Institute for Positive Psychology and Education, Australian Catholic University, Sydney, Australia; <sup>c</sup>Department of Psychology, University of Munich, Munich, Germany

## ABSTRACT

Reading texts can prompt intense emotions, and these emotions profoundly influence learning from texts. I first discuss the findings from the eight studies reported in this special issue. The studies represent pivotal advances in research on reading. Focusing on learning from science texts, they show that different emotions and different types of text influence reading in different ways. Furthermore, they document how the interplay of emotions, text features, and reading processes impacts knowledge acquisition, conceptual change, and attitude change. I then outline core directions for future research. We need to (a) expand current theories to adequately explain the multiple links between emotions, cognitive processes, and motivational processes during reading; (b) use causal designs to disentangle the cause-effect relations linking these processes to antecedents and outcomes, including reciprocal causation; (c) complement between-person designs with intra-individual analysis; (d) use dynamic measurement and multichannel indicators to capture emotional processes; and (e) investigate the generalizability of current findings across diverse groups of learners and sociocultural contexts.

## Introduction

Emotions can profoundly influence reading and any outcomes resulting from reading, such as knowledge acquisition, conceptual change, and attitude change (Bohn-Gettler, 2019; Bohn-Gettler & Rapp, 2014; Muis et al., 2015). However, traditionally theories and studies of reading focused on “cold” cognition and did not consider readers’ affective state. By targeting the influence of various different emotions on reading and its outcomes, the eight studies reported in the articles of this special issue represent critically important advances over traditional approaches. Using different study designs, types of texts, constructs of emotion, and indicators for performance, the studies targeted a broad range of emotions as well as processes and outcomes of reading. In this contribution, I will first discuss the advances made by these studies. I will then outline five important lines of development that may be core to future progress in the field.

## Evidence from eight studies: Emotions are pivotal for learning from texts

All eight studies reported in this special issue focused on learning from science texts. Dever et al. (2021) used Chrystal Island, a virtual science problem-solving game, to investigate the effects of emotions on recall of information immediately after reading (in-game assessments) and on more comprehensive understanding integrating various sources as assessed after the task (posttest). Four

emotions were considered, including joy, anger, confusion, and frustration. Data on these emotions were derived from automatic coding of facial expression using FACET (iMotions, 2016) and were integrated across instances of reading or performing the in-game assessments. The findings show, first, that both reading and assessment generated all four emotions and that combinations of all four were observed in most instances. Second, participants who displayed combinations of all four emotions during reading showed lower in-game performance than participants who displayed only one or two emotions. A similar, though not significant, trend emerged for posttest performance. One plausible explanation put forward by the authors is that processing multiple emotions during learning increases cognitive load, thus negatively impacting learning. According to the findings, this may be true both for reproductive learning as assessed in the in-game assessments and for constructive learning integrating various sources as assessed in the posttest.

Mensink (2021) presents an in-depth analysis of the role of emotions in learning from two different types of science texts—texts including attractive but irrelevant sections (“seductive details”) and texts purely focusing on their science topic. In line with previous research, participants rated the seductive details as more interesting but less important than the science content, and they recalled less scientific content from the texts including seductive details. For these texts, recall was higher for the seductive details than for the science content, suggesting that memory encoding of seductive details may have hindered encoding of the target content. Emotions during reading and during recall were assessed with the Epistemic Emotions Scales (EES; Pekrun et al., 2017). Regardless of type of text, and regardless of time of emotion (during reading or recall), positive emotions negatively predicted recall of science content, whereas negative emotions positively predicted recall. However, a more detailed analysis showed that different emotions within these categories differentially predicted recall. Specifically, happiness was a negative predictor, in line with reasoning that happiness can lead to superficial processing (as argued early on, e.g., by Aspinwall, 1998). In contrast, curiosity positively predicted recall, suggesting that curiosity promotes learning from texts.

The studies by Trevors (2021) and Jacobson et al. (2021) went one step further by considering texts on controversial topics. By covering such topics, the texts themselves were likely to trigger intense emotions, especially when conflicting with participants’ own values and beliefs. Trevors (2021) sampled participants who were likely to hold strong beliefs about either of two controversial topics, immigration or vaccination. The authors first assessed prior misconceptions and attitudes about these topics and then let participants read refutation texts describing the misconception, refuting it, and providing correct information. Subsequently, participants rated the amount of identity conflict and personal threat generated by the texts. In addition, using an expanded version of the EES, participants rated 14 emotions they recalled having experienced during reading. Identity conflict related positively to summary scores for three epistemic emotions (surprise, curiosity, and confusion) and seven negative emotions. Especially negative emotions, in turn, related positively to perceived threat, and threat was a negative predictor of belief change generated by the refutation texts. This sequence of correlations suggests a causal chain from identity conflict to threat and negative emotions that can reduce willingness to change one’s beliefs when reading texts.

Jacobson et al. (2021) used three versions of arefutional text targeting misconceptions about genetically modified food. The versions included a relatively short standard refutional text, an expanded text including additional explanations, and an expanded text including a historical example (instead of explanations) that served to control for effects of word length. Emotions after reading were assessed with the EES, and misconceptions as well as attitude about genetically modified food were measured both before and after reading. All three text versions led to a significant reduction in misconceptions and a positive change in attitudes. However, in some participants, reversed change was observed (increased misconception scores, reduced attitude scores), suggesting backfire effects of the texts. Regression to the mean may have played a role in these effects; however, the backfire effects were weaker when scores in both prior knowledge and prior attitude were high, suggesting that they were at least not due to regression to the mean alone. In different path analytic models, surprise was a positive predictor of change in conceptions and attitudes, and confusion was a negative predictor, thus attesting to the important role of epistemic emotions in both knowledge acquisition and attitude change.

Further expanding research on beliefs, emotions, and reading, Bohn-Gettler and McCrudden (2021) examined relations between positive affect, cognitive strategies when reading belief-consistent and belief-inconsistent text, and resulting memory performance. Participants rated their positive affect using the PANAS-X (Watson & Clark, 1994), reported their beliefs about whether intelligent design should be taught in science classrooms, and then read a dual-position text that contained arguments both in favor of and counter to doing so. In participants who held strong beliefs (either positive or negative), positive affect related to less use of backward inferences but more use of elaboration, with elaboration especially frequently used when reading belief-consistent arguments. Positive affect also related positively to use of rehearsal with belief-inconsistent text. For participants not holding clear beliefs, a different pattern of findings emerged. Even if these relations did not translate into effects on memory performance, they indicate that affect can interact with prior beliefs and text features in shaping cognitive processes during reading. As suggested by the authors, the results may be due to the joint influences of affect and motivation to protect one's belief on reading. One caveat is that the items of the PANAS-X positive affect scale measure both positive valence (e.g., "interested," "proud") and arousal (e.g., "active," "strong"), thus leaving it open to question how each of these two dimensions contributed to the pattern of findings (for unique effects of arousal, see, e.g., Mather & Sutherland, 2011).

Three critically important messages follow from this set of studies. First, reading can prompt strong emotions, and these emotions are pivotal for understanding processes and effects of reading on learning. Emotions can promote reading and comprehension, as documented in all five lines of research represented in these studies. However, as shown, for example, by the backfire effects in Jacobson et al.'s (2021) study, emotions also have the power to invert otherwise positive effects of reading texts, thus reducing conceptual progress and attitude change.

Second, different emotions can exert different effects. Surely the average effects of positive (i.e., pleasant) emotions on overall learning outcomes are typically positive, and the effects of negative (i.e., unpleasant) emotions are typically negative (for meta-analytic evidence, see Barroso et al., 2020; Camacho-Morles et al., 2021; Loderer et al., 2020). However, according to the evidence of the present studies, it would be misleading to conclude that positive emotions are always beneficial and negative emotions always detrimental. For example, as noted, in the study by Mensink (2021) happiness was a negative predictor of performance, and in Dever et al.'s (2021) research, combinations of positive and negative emotions proved to entail reduced performance. Obviously, for any given emotion, it depends on situational context, type of task, and individual propensities if the resulting effects are beneficial or not.

Third, as suggested by Bohn-Gettler and McCrudden's (2021) findings, it is also important to acknowledge that emotions influence different stages and levels of processing information from texts. In Bohn-Gettler and McCrudden's study, this was especially clear for different cognitive strategies that readers can apply to extract information from text, such as rehearsal and elaboration. These different strategies, in turn, can be interpreted as recruiting various lower-level processes (attention, inhibition, activation of memory networks, etc.). As such, it depends on the interplay of emotions with a range of cognitive processes how emotions impact resulting performance.

However, there are also limitations to this research, in terms of theory, methods, and contexts represented in the eight studies (see below). This begs the question, where do we go from here? As aptly argued by Bohn-Gettler and McCrudden (2021, p. <>), "Ignoring important interactions between the reader, text, and activity can result in oversimplification and a concomitant lack of understanding the complex systems that influence reading." To make further progress in understanding these interactions and disentangling the effects of different emotions on various cognitive processes under different task conditions, additional advances in theory and use of empirical research methods may be crucial. In the following sections, I outline five areas of possible future progress, including (a) theory development; (b) use of causal study designs and analysis of reciprocal effects; (c) consideration of both between-person and within-person paradigms; (d) dynamic multichannel measurement of emotion; and (e) consideration of multiple groups of readers, types of texts, and contexts to examine the relative universality of links between emotions and reading.

## Theory development

The first generation of emotion-performance models, and related empirical studies, used simple, binary classifications of both emotion and cognitive performance. An example is experimental mood research that investigated differences in creative versus analytic processing in positive versus negative mood. This research failed to render consistent evidence (e.g., in some studies positive mood facilitated creative thinking; in others it rendered null effects; Baas et al., 2008; Da Costa et al., 2015; Davis, 2009), suggesting that binary classifications are not sufficient. As such, researchers proceeded to use more fine-grained conceptions of either emotions or cognitive processing. Examples are Pekrun's (1992, 2006) cognitive-motivational model of emotion effects that considered both the valence and activation dimensions of emotions, and both cognitive and motivational mechanism mediating effects on cognitive performance, and Bohn-Gettler's (2019) PET model of emotion and text comprehension that considers a range of different cognitive processes.

However, it seems that even these models do not fully capture the complexity of emotion-performance relations. Although Pekrun's model considers both valence and activation, it does not sufficiently disentangle the effects of different emotions within the four categories distinguished in the model (positive activating, positive deactivating, negative activating, and negative deactivating emotions). For example, as argued by Pekrun and Linnenbrink-Garcia (2021), enjoyment of task performance (positive, activating) is likely to facilitate on-task attention, reduce irrelevant thinking, and promote task-related motivation. In contrast, pride about a recently won award (also positive and activating) might detract attention, generate irrelevant thinking, and undermine motivation to fully engage with current tasks.

Similarly, both Pekrun's and Bohn-Gettler's models may need to be expanded to more fully cover the multitude of cognitive processes during cognitive task performance, including reading. Using a bottom-up perspective on information processing from sensory perception to memory encoding, emotions can influence at least the following stages, levels, and components of processing: sensory memory (e.g., Kuhbandner et al., 2011; Spachholz et al., 2014); selection of information to be processed in working memory (i.e., attention); executive working memory processes like switching and inhibition; affective working memory (Mikels & Reuter-Lorenz, 2019); activation and inhibition of networks in long-term memory, including retrieval-induced forgetting and facilitation (Kuhbandner & Pekrun, 2013); assimilative and accommodative processes of integrating information and revising cognitive schemas (Fiedler & Beier, 2014); higher-level cognitive strategies such as rehearsal, organization, elaboration, and critical thinking that recruit and combine various lower-level strategies; and metacognitive strategies of monitoring, controlling, and evaluating cognitive performance. Moreover, the effects of emotions on various dimensions of task motivation need to be considered, with motivation, in turn, also exerting profound influences on cognitive processing.

In addition, it is important to consider the dynamic nature of emotions. Emotions typically change during task performance, suggesting that effects on cognitive and motivational processing change as well. Emotional change can be due to progress in performing the task but can also be achieved through emotion regulation (Harley et al., 2019). It is a task for future theory development to systematically integrate emotion regulation into process models of emotion and cognition.

In sum, adapted models are needed that more fully disentangle reading performance in terms of emotional processes, on the one hand, and cognitive and motivational processes, on the other. In developing such models, it will be important to consider different levels of construct granularity. For example, cognitive processes can be conceptualized at the level of information processing within sensory, working, and long-term memory; at the level of molar strategies (such as rehearsal and elaboration or assimilation and accommodation) that integrate lower-level strategies; and at the level of overall quality parameters, such as percentages of correctly recalled information from text. Emotions can influence reading at all these levels of cognitive processing, from basic sensory recognition of letters and phonemes to high-level construction of situation models. Principles of construct symmetry (see Ajzen, 2005; Brunswik, 1955) may be considered in appropriately fine-tuning

constructs. For explaining lower-level cognitive processes and outcomes, more granular constructs are needed; to explain higher-level outcomes, such as students' overall learning outcomes resulting from reading multiple texts during a school year, more molar predictors may be more suitable.

Different levels of cognitive processes may also be important to explain the impact of emotions in different groups of readers, including readers with disorders affecting reading. For example, the impact of emotions on low-level processes, such as recognition of letters and phonemes, may be crucial for dyslexic readers; how emotions influence situation models derived from text may be important to understand reading in autistic children suffering from deficits in theory of mind and situational perspective taking. Developing theoretical models on the influence of emotions on reading in cognitive and affective disorders may be an especially fruitful and practically important area for future research.

### **Causal designs and reciprocal effects**

The studies reported in this special issue used experimental as well as nonexperimental designs. However, even in the experimental studies, the relations between emotions and their presumed antecedents and outcomes were correlational. Especially if emotions, antecedents, and outcomes are assessed at the same time, it is difficult to derive causal conclusions from their correlational associations. For example, in the study by Trevors (2021), identity conflict, emotions, and threat were measured simultaneously. As noted, the associations between these variables were largely consistent with theory: Identity conflict related to negative emotions, and negative emotions, in turn, related to perceptions that the text was threatening. However, it remains open to question if these relations represented a causal sequence from conflict to emotions and from emotions to threat. Causation could flow in the opposite direction—threat triggering emotions (as posited, e.g., in Lazarus's transactional stress model; Lazarus & Folkman, 1984) and emotions prompting perceptions of identity conflict. It seems likely that both causal directions play a role, suggesting that the variables were linked by reciprocal rather than unidirectional causation.

Similarly, in the studies by Dever et al. (2021), Mensink (2021), Jacobson et al. (2021), and Bohn-Gettler and McCrudden (2021), the relations between emotions and performance may have been due to effects of performance on emotions, in addition to effects of emotions on performance. To more fully capture the causal processes linking emotions during reading to their antecedents and outcomes, we will need to employ causal study designs, such as designed experiments, natural experiments, or longitudinal studies controlling for autoregressive effects, reciprocal effects, and confounding variables. For emotion research specifically, some of these options may be challenging. For example, given the technical and ethical problems in experimentally manipulating emotions, it is difficult to design experiments that generate different emotions during reading. One specific challenge is that current methods of emotion elicitation typically use task-irrelevant stimuli (such as pictures or music) to induce emotion. The findings from studies using these methods pertain to the effects of incidental emotions rather than task-related emotions. However, given that texts themselves can generate strong emotions, it is critically important to consider the emotions that relate to the topics and processes of reading rather than to other objects as in incidental emotions. Using texts that are known to prompt specific emotional responses, such as texts representing participants' own autobiographical memories, may be one way out of the dilemma (Joseph et al., 2020).

### **Between-person versus within-person research**

Research in psychology and education, and in the social and behavioral sciences more broadly, is dominated by studies inspecting between-person distributions of variables and the links between these distributions. This is true both for nonexperimental field studies and for laboratory experiments. The former use between-person covariation between variables to investigate their relations, the latter between-subject experimental designs. A major problem with this approach is that between-person data are not suited to infer any conclusions about the within-person mechanisms that explain relations



between variables, except if specific conditions hold that are rarely met (ergodicity; see Murayama et al., 2017; Voelkle et al., 2014). From a methodological perspective, the reason is that between-person and within-person covariations of variables are statistically independent.

An empirical example provided by Schmitz and Skinner (1993) is the relation between duration of sleep and frequency of migraine headaches. On the between-person level, the correlation between these variables is positive, indicating that people who sleep longer suffer more from headaches. However, the within-person correlation is negative—short sleep precipitates headaches. As such, the within-person mechanism linking sleep and headaches cannot be inferred from their between-person correlation. Obviously, when misinterpreting the between-person covariation as causal evidence on the within-person mechanism, misguided conclusions would follow not only for theory but also for practice.

Similar principles apply to studies of emotion and cognition. An example is research on epistemic emotions, learning from texts, and cognitive problem solving. In some of our studies in this field, we used between-person designs. The studies yielded promising findings (e.g., Muis et al., 2015), but not all of the results were as consistent as we had hoped for. As such, we turned to within-person designs in more recent research and found relations between epistemic emotions, antecedents, and effects that were clearer. A case in point is the studies by Vogl et al. (2019, 2020) on epistemic emotions and knowledge exploration. For example, across three studies (Vogl et al., 2020), within-person analysis yielded robust, consistent effects. The findings indicated that positive feedback about having successfully answered trivia questions related negatively to participants' surprise, curiosity, and confusion. If one knows the answer to a question, positive feedback does not come as a surprise. In contrast, at the between-person level, the correlations between accuracy and epistemic emotions varied from positive to negative, and most of them were not even significant.

Similarly, caution should be exerted in interpreting the between-person findings documented in this special issue—within-person analysis may have rendered different results. As such, we need to complement between-person research with intra-individual studies. In judging the relative value of between-person and within-person perspectives for any given research question, careful attention to the nature of the presumed mechanisms is needed. Not all types of causation are best captured using a within-person paradigm. Specifically, for research on antecedents and outcomes of interindividual differences, between-person research is often more adequate (see Orth et al., 2021). Which of the two perspectives is better suited depends on research questions and theories about causal mechanisms.

In emotion research, stable trait emotions are often examined using between-person analysis, whereas state emotions that fluctuate within persons afford opportunities to conduct within-person analysis. However, traits can show developmental change, and states can vary between persons, implying that traits can alternatively be considered from a within-person perspective and states from a between-person perspective. If relations between variables are conceptualized in terms of both between-person differences and within-person mechanisms, then it may be fruitful to integrate both perspectives into one coherent empirical paradigm (see Goetz et al., 2016; Hamaker et al., 2015; Orth et al., 2021).

## **Multichannel dynamic measures**

Disentangling different emotional, cognitive, and motivational processes during reading is challenging not only in terms of theory and study design; in addition, adequate measurement is needed. This is also a demanding task. For example, as documented in Dever et al.'s (2021) study, blended emotions may be the rule rather than the exception in learning from texts, making it difficult to detect effects that can be attributed to one emotion alone. Similarly, as suggested by Bohn-Gettler and McCrudden's (2021) findings, cognitive tasks such as reading texts typically involve various cognitive processes, making it difficult to examine the effects of emotion on one specific process alone. In all studies reported in this special issue, task performance likely involved various cognitive processes. If it is not possible to conceive "pure" emotion-cognition studies that induce no more than one single target

emotion and one target cognitive process, then ways need to be found to use measures with sufficient resolution to disentangle variables. Some of these measures are already available, such as measures of cognition that provide sufficient temporal resolution to assess cognitive processing at different stages (e.g., EEG) or measures that provide the spatial resolution needed to disentangle different networks recruited at the level of brain systems (e.g., fMRI, fNIRS).

In addition to issues of resolution, it is important to consider triangulation through use of different indicators for the same process. Closed-format self-report instruments continue to be needed (Pekrun, 2020) but should be complemented by other methods. The study by Dever et al. (2021), which used eye-tracking and automatic facial expression decoding in addition to performance measures, and the research by Bohn-Gettler and McCrudden (2021), which employed a think-aloud protocol in addition to structured self-report, are important steps in this direction. Use of these methods may be resource-expensive, suggesting that there is a trade-off in balancing type and number of measurement indicators, on the one hand, and sample size (i.e., numbers of participants and measurement occasions), on the other. One way to counter the threats to generalizability that come with in-depth small-sample studies is using multilab strategies that combine the efforts of several research teams.

### **Relative universality of emotions across persons, tasks, and contexts**

In the studies reported in this special issue, the samples included adult learners. In the studies by Dever et al. (2021), Mensink (2021), and Bohn-Gettler and McCrudden (2021), samples of university students were used, and in the studies by Trevors (2021) and Jacobson et al. (2021), samples of adults recruited via MTurk. In terms of tasks, all of the studies employed texts on science topics (simple texts with less than 1,000 words in most cases), and in terms of context, all of them used experimental or online settings. This is a sensible approach given the challenges in investigating emotions in younger age groups, in reading more complex texts over longer periods of time, and in natural classroom environments. In the next stage of research, it may be useful to examine the direct replicability of the reported findings but also their generalizability across different groups of learners, tasks, and cultural contexts.

From a theoretical perspective, generalizability can be expected for some but not all aspects of emotions during reading. Specifically, as posited in control-value theory (Pekrun, 2006, 2018, 2021), the contents and process parameters of emotions typically show wide variation across persons, task domains, and contexts. For example, in terms of contents, emotions during reading can relate to the topics covered in a text (topic emotions); to cognitive discrepancies prompted by the text, such as discrepancies between one's goals and the text (epistemic emotions like surprise, curiosity, or confusion); or to one's performance in understanding the text (achievement emotions; see also Linnenbrink-Garcia, 2021). In terms of process parameters, the intensity, duration, and frequency of emotions can also vary widely, as documented, for example, in the between-person variation of emotion occurrence documented in the study by Dever et al. (2021). On the other hand, the functional relations of emotions with their antecedents and outcomes are thought to be universal across persons, tasks, and contexts.

We found supportive evidence for these principles of "relative universality" (Pekrun, 2006) in studies of emotions across genders, academic domains, and cultures (for summaries, see Pekrun, 2009, 2018). For example, students' emotions in mathematics varied substantially between girls and boys and between Chinese and German students, but their relations with students' self-confidence and performance in math were equivalent across genders and cultures. Similarly, in the assessments of the OECD Programme for International Student Assessment (PISA), emotions such as anxiety in mathematics varied across genders and countries, but their relations with math performance were consistent across countries (Organization for Economic Cooperation and Development [OECD], 2013). Principles of relative universality may also hold for emotions related to reading. It is an important avenue for future reading research to examine variation and consistency in the emotions occurring during reading, and in their relations with task features and performance, across individuals, age groups, task domains, institutional settings, and sociocultural contexts.



## Conclusion

The findings reported in this special issue document the pivotal role of emotions for reading. According to the findings, emotions impact processes of reading as well as resulting outcomes, including knowledge acquisition, conceptual change, and attitude change. As such, this research is also foundational for designing texts in ways that help people to reap benefits from reading. To make further headway in this research, several lines of development may be most important. We need fine-grained theoretical models that help to understand the complexity of emotion-reading relationships as documented in the present studies. Moving beyond first-stage exploratory and correlational self-report research, we need studies that enable us to derive causal conclusions about the relations between emotions and reading; we should complement between-person studies with intra-individual research that analyzes within-person mechanisms; and we need to adapt dynamic measures involving multiple indicators of emotions and processes of reading. Finally, for drawing more general conclusions and deriving evidence-based recommendations for practice, we need to examine the generalizability of reading emotions across individuals, groups of learners, text domains, settings, and cultural contexts.

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## ORCID

Reinhard Pekrun  <http://orcid.org/0000-0003-4489-3827>

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